

Warsaw University  
Faculty of History

The Earliest Middle Palaeolithic Bifacial  
Leafpoints in Central and Southern Europe.  
Technological Approach

Małgorzata Anna Kot

*PhD Thesis*

supervisors

dr hab. prof. UW Karol Szymczak  
prof. dr hab. Maria Łanczont

*Dissertation created within the framework of the  
Inter-University Programme of Interdisciplinary PhD Studies at the  
»Artes Liberales« Academy*

Warsaw 2013





# CONTENTS

ACKNOWLEDGEMENT-----	7
<b>1. INTRODUCTION -----</b>	<b>9</b>
1.1. DISSERTATION'S OBJECTIVE -----	11
1.2. SAMPLE-----	11
1.3. ANALYSIS METHODS -----	12
1.4. DISSERTATION'S LAYOUT -----	13
<b>2. ANALYSED ARCHAEOLOGICAL SITES. HISTORY OF RESEARCH, STRATIGRAPHY, DATINGS. -----</b>	<b>19</b>
2.1. KEY SITES -----	19
2.1.1. BULGARIA-----	19
2.1.1.1. Musilievo -----	19
2.1.1.2. Samuilitsa Cave II-----	32
2.1.2. CZECH REPUBLIC -----	42
2.1.2.1. Brno Bohunice -----	42
2.1.2.2. Moravský Krumlov IV -----	46
2.1.2.3. Vedrovice V -----	53
2.1.3. GERMANY -----	58
2.1.3.1. Ehringsdorf -----	58
2.1.3.2. Lenderscheid -----	66
2.1.3.3. Kösten -----	67
2.1.3.4. Mauern (Weinberhöhlen)-----	69
2.1.3.5. Rörshain-----	73
2.1.3.6. Wahlen -----	78
2.1.4. GREECE-----	79
2.1.4.1. Kokkinopilos -----	79
2.1.5. HUNGARY -----	85
2.1.5.1. Jankovich Cave -----	85
2.1.5.2. Sajóbáony Méhésztető-----	89
2.1.6. ROMANIA -----	92
2.1.6.1. Ripiceni Izvor -----	92
2.1.7. UKRAINE -----	99
2.1.7.1. Korolevo -----	99
2.2. COMPARATIVE SITES-----	109
2.2.1. KLAUSENNISCHE -----	109
2.2.2. KÖNIGSAUE -----	112
2.2.3. SZELETA CAVE -----	116
<b>3. SCAR PATTERN ANALYSIS. TECHNO-FUNCTIONAL APPROACH</b>	<b>123</b>
3.1. ANALYSIS METHOD-----	123
3.1.1. SAMPLE CHOICE -----	123

3.1.2.	ARTIFACT CONSTRUCTION AND POSITIONING, TERMINOLOGY CLARIFICATION	124
3.1.3.	ANALYSIS PROGRESS	131
3.1.4.	SCAR PATTERN ANALYSIS POTENTIAL	139
3.1.5.	SCAR PATTERN ANALYSIS LIMITATIONS	139
3.2.	OUTPUT OF SCAR PATTERN ANALYSIS	141
3.2.1.	KEY SITES	141
3.2.1.1.	BULGARIA	141
3.2.1.1.1.	Musilievo	141
3.2.1.1.2.	Samuilitsa Cave II	158
3.2.1.2.	CZECH REPUBLIC	162
3.2.1.2.1.	Brno Bohunice	162
3.2.1.2.2.	Moravský Krumlov IV	169
3.2.1.2.3.	Vedrovice V	174
3.2.1.3.	GERMANY	182
3.2.1.3.1.	Ehringsdorf	182
3.2.1.3.2.	Lenderscheid	187
3.2.1.3.3.	Kösten	194
3.2.1.3.4.	Mauern (Weinberhöhlen)	198
3.2.1.3.5.	Rörshain	213
3.2.1.3.6.	Wahlen	224
3.2.1.4.	GREECE	239
3.2.1.4.1.	Kokkinopilos	239
3.2.1.5.	HUNGARY	246
3.2.1.5.1.	Jankovich Cave	246
3.2.1.5.2.	Sajóbábony Méhész-tető	252
3.2.1.6.	ROMANIA	260
3.2.1.6.1.	Ripiceni Izvor	260
3.2.1.7.	UKRAINE	270
3.2.1.7.1.	Korolevo	270
3.2.2.	COMPARATIVE SITES	281
3.2.2.1.	Klausennische	281
3.2.2.2.	Königsau	287
3.2.2.3.	Szeleta Cave	292
3.3.	RESULTS	302
3.3.1.	EDGES TREATMENT	305
3.3.2.	EDGE REPAIR	311
3.3.3.	TOOL SYMMETRY	313
3.3.4.	TIP EXPOSURE	314
3.3.5.	BASE FORMATION	315
3.3.5.1.	Triangular bifaces	316
3.3.5.2.	Leafpoints	317

## 4. SEQUENCE ANALYSIS----- 321

4.1.	ASSUMPTIONS	321
4.2.	ANALYSIS PROCEDURE	323
4.3.	OUTCOMES OVERVIEW	324
4.3.1.	SINGLE CUTTING EDGE TOOLS	326
4.3.2.	LEAFPOINTS	329
4.3.3.	DOUBLE CUTTING EDGE TOOLS	331
4.4.	CONCLUSIONS	332

<b>5. EDGE ANALYSIS-----</b>	<b>335</b>
5.1. MEASUREMENT PROCEDURE-----	337
5.2. SAMPLE-----	339
5.3. OBSERVATIONAL ERROR -----	339
5.4. RESULTS-----	340
5.5. EDGE ANALYSIS UTILITY REVIEW -----	341
 <b>6. CONCLUSIONS -----</b>	 <b>343</b>
6.1. DEFINITION OF THE TERM “LEAFPOINT” -----	343
6.2. ASSEMBLAGES CHARACTERISTICS -----	344
6.3. LEAFPOINTS SITES’ LOCATION-----	347
6.4. LEAFPOINTS SITES’ CHRONOLOGY -----	348
6.5. ASSEMBLAGES WITH INTENTIONALLY BROKEN TOOLS -----	350
6.6. LEAFPOINTS VERSUS BACKED KNIVES -----	352
 <b>BIBLIOGRAPHY -----</b>	 <b>357</b>



# Acknowledgement

I would like to express my deepest gratitude to my supervisors, dr. hab. prof. UW Karol Szymczak and prof. dr hab. Maria Łanczont for their wise guidance and constructive feedback related to my ideas. Prof. Jürgen Richter, who was my advisor, for awarding me with the opportunity of scholarship at the University of Cologne, and for all the fruitful discussions concerning my doctoral thesis and its findings.

I would also like to give my special thanks to prof. Barbara Bokus, the Head of Inter-University Program of Interdisciplinary PhD Studies at the »Artes Liberales« Academy for her priceless organizational support, and all the Members of the “Artes Liberales” Academy Committee for the possibility of conducting my studies and realizing my project within the framework of cotutelle system.

This dissertation would not have been created without the kind help of all museum, university and heritage protection office workers and private collectors, who had granted me access to the collections stored in all these locations. My most sincere thanks go to: Dr. Svoboda Sirakov and Dr. Prof. Nikolai Sirakov from the National Archaeological Museum in Sofia; Dr. Zdeňka Nerudová and Dr. Petr Neruda from the Anthropos Institute, the Moravian Museum in Brno; Dr. Petr Škrdl from the Institute of Archaeology, the Academy of Sciences of the Czech Republic in Brno; Dr. Walter Diethard, Dr. Tim Schüler and Mrs. Ehrlich from the Museum für Ur- und Frühgeschichte Thüringens in Weimar; Dr. Erich Claßen from the Archaeological Museum in München; Dr. Leif Steguweit and Prof. Dr. Thorsten Uthmeier from the Erlangen-Nürnberg University; Dr. Judith M. Grünberg from Landesamt für Denkmalpflege und Archäologie Sachsen-Anhalt in Halle; Dr. Irina Görner, Museumslandschaft Hessen in Kassel; private collectors: Hella Winschenk from Deggendorf, and the Braml Family from Fürstenstein; Dr. Andreas Boos from the City Museum in Regensburg; Dr. Michael Rademacher from the Heritage Protection Office in Regensburg; Dr. Eugenia Adam from the IB' Ephory of Prehistoric & Classical Antiquities, Ioannina; András Markó and Katalin Biro from the National Museum in Budapest; Árpád Ringer from the University of Miskolc; Dr. Roxana Dobrescu from the Institute of Archaeology "Vasile Pârvan", the Romanian Academy in Bucharest; Dr. Larisa Kulakovska and Dr. Vitaly Usik from the Institute of Archaeology ASNU in Kiev; Dr hab. Prof. UR Aleksander Sytnik, from the Ukrainian Academy of Sciences in Lviv.

I would also like to thank Ewa Jabłońska, Agata Balińska and Jan Skupiński for translating and patiently editing this dissertation; Prof. Teresa Madeyska, Dr. Damien Flas, Dr. Panagiotis Karkanis, Dr. Vangelis Tourloukis, Dr. Olaf Jöris, Dr. Thomas Hauck, Gianina Balbaie and Jakub Adamski for their kind help. Last but not least, I would like to give my special thanks to my Mum and Grandfather for their continuous support.



# 1. Introduction

The main objective of this dissertation is to analyse the Middle Palaeolithic leafpoints from the technological perspective, to reconstruct their production scheme, as well as the original idea (ideal type, Czesla, 1989) underlying particular assemblages with leafpoints.

Those slender, bifacially knapped stone tools in the shape of a leaf, with an exposed tip, began to be discovered in Central Europe as early as in the 19<sup>th</sup> century. Initially, inventories containing leafpoints were connected with the Solutrean culture, whose area of presence spans across France and northern Spain, and its dates of development range from 22,000 to 17,000 BP (Zotz, 1951; Freund, 1952; Hillebrand, 1935; Kadič, 1916).

Due to intensive exploration of mainly cave related sites in Germany, Poland and Hungary, consecutive inventories containing symmetrical bifacial forms were appearing. Based on them, local archaeologists created their own cultural and chronological divisions (Szeletian, Jerzmanowician, Ranisian, Altmühlian) (Chmielewski, 1961; Hülle, 1977; Prošek, 1953; Bohmers, 1939; Bohmers, 1951; Freund, 1987; Freund, 1954; Zotz, 1959a; Zotz, 1955; Luttrupp & Bosinski, 1967; Kadič, 1916; Hillebrand, 1935).

Nevertheless, even before the Second World War, voices of protest occurred which stated that the said inventories ought not to be linked with the Upper Palaeolithic Solutrean assemblages (Allsworth-Jones, 1986 p. 9), but should be treated as a separate cultural phenomenon. A specific feature of inventories with leafpoints, which attracted particular attention, was the presence of both the Middle and Upper Palaeolithic elements (Prošek, 1953; Vértes, 1956; Chmielewski, 1961; Hülle, 1977). Further examinations, as well as a thorough analysis of particular cultural levels' stratigraphy confirmed the above mentioned suggestions. Thus, the assemblages began to be referred to with a common name of MP/UP transitional industries (Škrdla, 2003; Adams, 1998), Initial and Early Upper Palaeolithic "transitional" industries (Jöris & Street, 2008) or just "transitional industries" (Moncel & Voisin, 2006; Bar-Yosef, 2006).

Leafpoints started to be regarded as the signifier of transitional cultures, and also as one of the elements present in the discussion on the transition between the Middle and Upper Palaeolithic, which encompassed the replacement of Neanderthal populations by Early Modern Humans (Conard, 2006; J.A. Svoboda, 2005; Jöris & Street, 2008; Kozłowski, 2008; Neruda, 2008; Orschiedt & Weniger, 2000; Kozłowski, 1990; Otte, 2000; Flas, 2011). It had not been fully clarified how the transition between the Middle and Upper Palaeolithic took place. Some people opt for the transitional assemblages to be regarded as the result of reciprocal contacts between *Homo sapiens sapiens* and Neanderthal (Djindjian, Kozłowski & Bazile, 2003; Valoch, 1990; Kozłowski, 1988). Others see their growth as a development line independent of assemblages with backed knives (Bosinski, 1967; Bohmers, 1951; Valoch, 1968; Neruda & Nerudová, 2009; Neruda, 2000; Kozłowski, 1990; Neruda, 2008; Kaminská, Kozłowski & Škrdla, 1995; Valoch, 2000). Since the transitional assemblages are devoid of human remains (Flas, 2011), it cannot be decided which of the two species was the creator of assemblages with leafpoints (Škrdla, 2003; J.A. Svoboda, 2001).

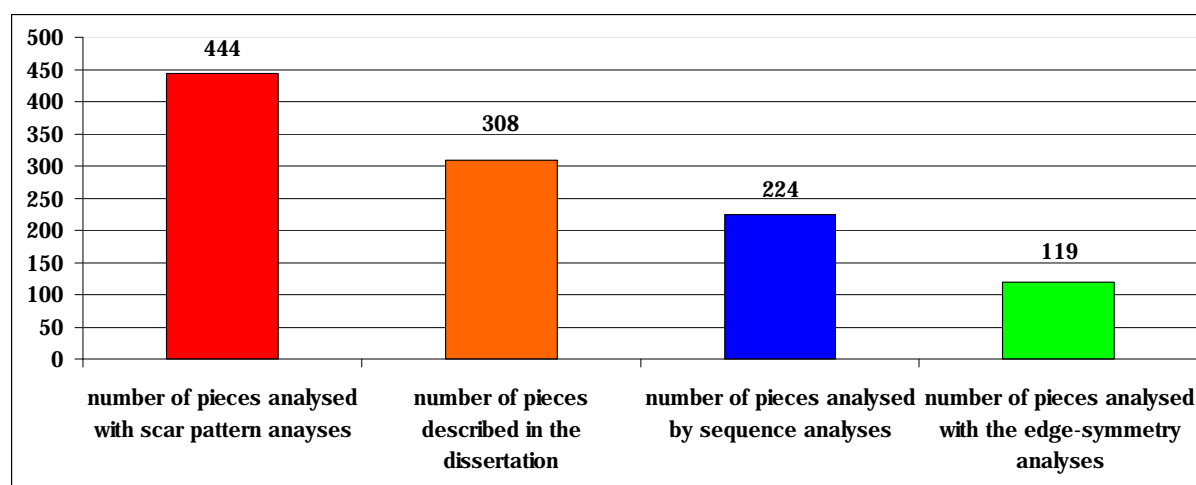
The date of 38,160±1250 uncal BP (Chmielewski, 1961) and 37,600±1300 uncal BP (Kozłowski, 2002 p. 57) obtained for the Jerzmanowician layer in the Nietoperzowa Cave, or 42,960±860 uncal BP and 32,620±400 uncal BP for the Szeletian layers from the Szeleta cave (Vértes, 1968), pointed to the fact that the assemblages with leafpoints appeared before the early settlement wave which brought Early Modern Humans to Europe, and which is traditionally connected with the Aurignacian culture. Thus, it would seem logical to conclude

that the transitional industries should be referred to as late traces of Neanderthal settlement (J.A. Svoboda, 2001; Flas, 2011). Therefore, further research was concentrated on tracing the origins of leafpoints. Archaeologists from different countries made attempts at finding the earliest local traces of leafpoints' presence in particular stone inventories. Years of conducting research resulted in distinguishing several local cultures based on inventories which contain symmetrical bifacial forms in the leafpoints type. More often than not, these assemblages are also marked by absence of the Upper Palaeolithic elements. Among such cultures, the following can be mentioned: the Bohunician in Czech Republic (Valoch, 2008; Valoch, 1982; Oliva, 1984), the Babonyian (Ringer, 1983; Ringer, 2000; Ringer & Kordos, 1995) and Jankovichian (Gábori-Csánk, 1990; Gábori-Csánk, 1993) in Hungary, or the Altmühlian in Germany (Bohmers, 1939; Bohmers, 1951). These assemblages could bear witness to the local origin of certain later assemblages with leafpoints.

Additionally, apart from distinguishing separate cultures, consecutive sites were discovered, the inventories of which contained leafpoints, such as Musilievo in Bulgaria (Dzambazov, 1967a; Dzambazov, 1971), Ripiceni Izvor in Romania (Paunescu, 1993; Paunescu, 1965), Kokkinopilos in Greece (Dakaris, Higgs & Hey, 1964; Higgs & Vita-Finzi, 1966), or Korolevo in Ukraine (Gladilin, 1989). On the last of mentioned sites, the earliest layers with leafpoints were dated to OIS 7, so around 200-250 thousand years BP (Koulakovskaya, 2001; Haesaerts & Koulakovskaya, 2006). This allows to conclude that together with the Ehringsdorf inventories (Mallick & Frank, 2002; Schöler, 2003), they would have constituted the earliest leafpoints.

Many years of studies concerning the transition between the Middle and Upper Palaeolithic, as well as the presence of symmetrical bifacial forms in several assemblages with differing morphology, caused the frequent treatment of leafpoints as "index fossils"; whereas their presence in a given inventory decides about it being included among the leafpoint industries (Allsworth-Jones, 1986; Hopkinson, 2007; Bolus, 2004; Freund, 1952).

Owing to several years of research, a large list of both surface and stratified inventories was assembled, where the artifacts referred to as leafpoints older than classical Szeletian or Ranis-Jerzmanowician are present. These sites are located in Central and Southern Europe, from contemporary Greece to Germany and Ukraine, and are dated from OIS 7, to a period only slightly earlier than the transitional assemblages.



*Fig.1 The number of artifacts subjected to analyses of particular type and the number of artifacts described meticulously in the dissertation.*



## 1.1. Dissertation's objective

The aim of the dissertation was, then, to gather all the earliest assemblages with leafpoints, and next, to analyse the leafpoints included in those inventories.

The initial goal was to verify to what extent assemblages so different in terms of geography and chronology were coherent in terms of their production technology and their creator's general idea. Such analysis seemed justified as very often, leafpoints constitute the sole element that joins particular artifact assemblages. Yet, as soon as during initial analysis it became clear that in the light of the obtained results, it will be necessary to redefine the concept of a "leafpoint" and supplement it with the technological aspect.

What was found was the fact that at least some of the analysed artifacts, during technological analysis proved to have, in many cases, numerous traces of edge rejuvenation, or they displayed lack of care for edge line/symmetry, or finally, the artifacts became symmetrical as a result of rejuvenation. These were of course the artifacts which fitted within the generally accepted, basic leafpoint definition (a tool in the shape of a leaf, equipped with a sharp tip placed at the junction of converging edges, with a flat retouch covering over 2/3 of its surface, and at least three times wider than thick—Ginter & Kozłowski, 1975).

Eventually, the specific objective was defined as distinguishing, within the analysed sample, artifact groups which share the production and rejuvenation idea (*chaîne opératoire*) (Bar-Yosef & Van Peer, 2009 pp. 104–105). Moreover, based on the conducted analyses, the existing definition of a leafpoint was supplemented, so that it could span over an artifact group coherent from the perspective of their technological idea.

## 1.2. Sample

Altogether, 444 artifacts from 46 sites in seven countries were submitted to analysis (Czech Republic, Hungary, Germany, Ukraine, Bulgaria, Romania and Greece) (Tab.1). The Crimean inventories were excluded from the sample due to wide distribution and large number of leafpoints originating from this area, which by itself could constitute the theme of another doctoral thesis. Chronologically speaking, those sites were taken into consideration, where the literature claims the presence of leafpoints, and which are dated to a period older than the transitional assemblages with the Szeletian, Ranisian or Jerzmanowician leafpoints.

Due to preliminary analysis results, and in order to maintain the dissertation's clarity, the analysed sample was reduced. The thesis does not include artifacts from most surface sites with unclear chronology (except for Wahlen, Lenderscheid and Kokkinopilos). Eventually, the analyses of artifacts from Albersdorf, Zeitlarn, Langenhardt, Flintsbach-Hardt, Rykhta, Líšeň, Mohelno were not considered in the dissertation. In the thesis, it was crucial to show certain trends, which necessitated the analysis of large artifact groups. Hence, results concerning the following scarce samples containing individual artifacts were omitted as well: Grosse Schulerloch, Kleine Ofnet, Grosse Ofnet, Obernederhöhle, Mitoc-Izvorolui, Palaiokeastron, Balla, Dzerava Skala, Jezupol I, Jezerany I, Kůlna cave, Ocelivka, Puskaaporos, Reutersruh.

For comparative purposes, the analysis of bifacial knives from two sites devoid of leafpoints was conducted as well (Klausennische and Königsau). These knives, however, proved to be a curious material for the knappers's idea reconstruction, as they are marked by

considerably symmetrical form. Also, younger leafpoints from the Szeleta cave were submitted to analysis in order to compare the production technology of classical Szeletian leafpoints from transitional assemblages with that of their older counterparts.

The dissertation presents technological analyses of 308 artifacts gathered from 20 sites<sup>1</sup>. Additionally, 224 artifacts were subjected to sequence analysis, whereas 119 artifacts to edge analysis (see Chapter 3.2) (Fig.1).

For the purpose of the dissertation, all the analysed assemblages were placed under one common name of “early assemblages with leafpoints”. This name refers to all the sites where artifacts termed in the literature as leafpoints occur, and which are chronologically prior to the Szeletian assemblages (Allsworth-Jones, 1990; Allsworth-Jones, 1986; Adams, 1998; Vértes, 1968), or the Lincombian-Ranisian-Jerzmanowician (Chmielewski, 1961; Flas, 2008; Flas, 2011).

### 1.3. Analysis methods

The first stage of this work was based on establishing possibly the most accurate chronology of the analysed assemblages. In order to achieve this, all available data concerning the archaeological sites under scrutiny was collected. This data included the sites' stratigraphy, geomorphological, palynological, archaeozoological analyses and the results of absolute datings. Next, all this information was submitted to critical examination. Additionally, in case of a few sites it was necessary to correlate profiles from several subsequent excavations. Only then, a critical examination of the available data made it possible to determine the chronology of particular assemblages and, at the very end, to establish the chronology of the earliest assemblages with leafpoints in Central and Southern Europe. In the dissertation, the newest chronostratigraphic divisions for the OIS 7–OIS 2 period were adopted (Fig.2).

The second stage of work was based on the analysis of leafpoints themselves. Choosing the method of artifact material analysis was strictly linked with the preset objective, which was the reconstruction of leafpoints technological idea (ideal form).

While choosing the research method, though, it was necessary to consider the fact that in some collections only bifacial tools were preserved, or the amount of debitage products was too scarce to use the refittings method. Parallel to that, it was considered as suitable to use one coherent analysis for all the examined stone inventories.

In view of those limitations, it was resolved that the so-called scar pattern analysis method will be applied. This method had been used for a short time only (Richter, 2001) and so far it was mostly applied in the analysis of backed knives and handaxes (Boëda, 2001; Boëda, 1995; Graßkamp, 2001; Soressi & Hays, 2003; Soressi, Dibble & Clark, 2003; Urbanowski, 2004; Migal & Urbanowski, 2008; Jöris, 2001). Thus, some elements of analysis were tailored in accordance with the needs of leafpoints. The chapter devoted to methodology of analysis (Chapter 3.1) contains a thorough description of this process.

Using the knowledge of conchoidal fracture properties, it was possible to establish the relative chronology of scars visible on tool surface. Techno-functional units were as a result distinguished on the tools, defined as certain tool parts characterized by different, specific

---

<sup>1</sup>On the Korolevo site, two inventories from levels Korolevo II and Korolevo Va were analysed. On the Ripiceni Izvor site, artifacts from levels MIV and MV were examined. The artifacts from Brno Bohunice and Bohunice Kejbaly were analysed together.

knapping and type of derived removals. Based on that, it was possible to reconstruct particular tool manufacturing stages, the formation and rejuvenation process (*chaîne opératoire*) of particular artifacts. The method's limitations were introduced in the methodology chapter (Chapter 3.1).

Apart from scar pattern analysis, two other analysis methods were postulated, which ought to be treated as supplementary methods. The first was aimed at establishing which tool parts were knapped with higher intensity, which could possibly show differences in the design of particular artifact types. This analysis was termed as sequence analysis (Chapter 4).

The second method was targeted at estimating the differences in both edges knapping precision on certain tools. It was based on measuring the edge profile's S-shape in its side-view, and on analysing statistically valid differences between measurements taken for both tool edges (Chapter 5).

The analysis methods introduced above were designed for the needs of thesis, and consequently, the presented results are strictly pilot in their character.

## 1.4. Dissertation's layout

The dissertation is, then, composed of two main parts. The first entails the description and chronology analysis of certain assemblages referred to as the earliest assemblages with leafpoints. The second concerns the technological analysis of leafpoints found on particular sites.

The initial chapter is equivalent to the introduction at hand.

The second chapter concerns the description of all the examined sites. It is divided into two parts. Part one is a presentation of key sites alongside an alphabetical division into countries where particular sites are located (Bulgaria, Czech Republic, Germany, Greece, Hungary, Romania and Ukraine). Within each country, the sites were also alphabetically ordered. Part two contains the descriptions of comparative sites. The presentation of each site contains research history, stratigraphy, dating and artifact inventory descriptions. This part of dissertation was targeted at establishing detailed chronology for particular assemblages.

The second part of the dissertation entails descriptions of the conducted artifact examinations. Chapter 3.1, which opens this part, is composed of scar pattern analysis description and the introduction of terminology applied in the dissertation.

The subsequent chapter (3.2) includes the results of scar pattern analysis performed on the examined artifacts. This chapter is divided analogously to chapter two, into two parts describing the results concerning the key sites (part one—Chapter 3.2.1) and the comparative sites (part two—Chapter 3.2.2).

As much as it was possible, each sub-chapter concerning the results of scar pattern analysis is organized in a similar manner. First, the analysed collection is described in general terms, next, groups of artifact are distinguished. Within a particular artifact group, first techno-functional units are distinguished on the artifacts, and then consecutive knapping stages are described, with special strain placed on the interrelation between the distinguished techno-functional units and the aim of a given knapping stage. Such scheme could have been modified if a given group was not coherent and did not allow to create a collective description. Then, it was resolved that such artifacts will be described and summarized individually.

Chapter 3.3 is the summary of scar pattern analysis results. In chapter 4, sequence analysis results are presented, whereas in chapter 5 edge analysis results are placed. Overall assumptions for those methods had been described above in general, and their detailed description can be found in suitable reference chapters.

Chapter 6 summarizes the entire dissertation. It contains an idea for a new technological definition of a leafpoint. It also contains collective chronology, and the analysis of geographical distribution of sites with leafpoints and other specific artifact types distinguished on the basis of conducted analyses.

Separate plates at the end of the dissertation present individual results of artifact analyses, together with the scheme of removal sequences arrangement, and a graph depicting the chronology of sequences arrangement.

Tab.1 Archaeological assemblages with earliest “leafpoints” analysed in the dissertation. Sites marked in bold were described in details.

N°	site	country	collection stored at:	number of pieces analysed with scar pattern analysis (1)	number of pieces described in the dissertation (2)	number of pieces analysed by sequence analysis (3)	number of pieces analysed with edge analysis (4)	number of pieces called “leafpoint” (5)
1	Albersdorf	Germany	private collection, the Braml Family	10		7	9	
2	Albersdorf 1	Germany	private collection, the Braml Family	15		15	12	
3	Balla cave	Hungary	Magyar Nemzeti Múzeum, Budapest; the Otto Herman Múzeum, Miskolc	9		9		
<b>4</b>	<b>Brno Bohunice-Kejbaly</b>	<b>Czech Republic</b>	<b>Ústav Anthropos, Moravské Zemské Muzeum</b>	<b>6</b>	<b>6</b>			<b>5</b>
<b>5</b>	<b>Brno Bohunice</b>	<b>Czech Republic</b>	<b>Archeologický ústav AV ČR, Brno</b>	<b>4</b>	<b>4</b>			<b>4</b>
6	Dzerava Skala	Slovakia	Magyar Nemzeti Múzeum, Budapest	1		1		
<b>7</b>	<b>Ehringsdorf</b>	<b>Germany</b>	<b>Museum für Ur- und Frühgeschichte Thüringens</b>	<b>36</b>	<b>36</b>	<b>25</b>		<b>12</b>
8	Flintsbach-Hardt	Germany	private collection, the Weinschenk Family	2				
9	Flintsbach	Germany	private collection, the Braml Family	0				
10	Gr. Schulerloch	Germany	Archäologische Staatssammlung, München	6				
<b>11</b>	<b>Jankovich cave</b>	<b>Hungary</b>	<b>Magyar Nemzeti Múzeum, Budapest</b>	<b>12</b>	<b>12</b>	<b>11</b>	<b>12</b>	<b>12</b>
12	Jezerany I	Czech Republic	Ústav Anthropos, Moravské Zemské Muzeum	14				
13	Jezupol I	Ukraine	the Institute of Archaeology, the National Academy of Sciences of Ukraine, Lviv	2				
<b>14</b>	<b>Klausennische</b>	<b>Germany</b>	<b>Archäologische Staatssammlung, München</b>	<b>15</b>	<b>15</b>	<b>15</b>		
<b>15</b>	<b>Kokkinopilos</b>	<b>Greece</b>	<b>the Archaeological Museum in Ioannina</b>	<b>8</b>	<b>8</b>			<b>6</b>
16	Königsau B	Germany	Landesmuseum für Vorgeschichte, Halle	1		1		
<b>17</b>	<b>Königsau A</b>	<b>Germany</b>	<b>Landesmuseum für Vorgeschichte, Halle</b>	<b>7</b>	<b>7</b>	<b>7</b>		
<b>18</b>	<b>Korolevo V</b>	<b>Ukraine</b>	<b>the National Museum of Natural History at the National Academy of Sciences of Ukraine, Kiev</b>	<b>7</b>	<b>8</b>			<b>4</b>
<b>19</b>	<b>Korolevo II</b>	<b>Ukraine</b>	<b>the National Museum of Natural History at the National Academy of Sciences of Ukraine, Kiev</b>	<b>7</b>	<b>6</b>			<b>2</b>

N°	site	country	collection stored at:	(1)	(2)	(3)	(4)	(5)
20	Kösten	Germany	Institut für Ur- und Frühgeschichte, Universität Erlangen-Nürnberg; Archäologische Staatssammlung, München	9	13	9	9	10
21	Kůlna cave	Czech Republic	Ústav Anthropos, Moravské Zemské Muzeum	1				
22	Langenhardt	Germany	private collection, the Braml Family	12			11	
23	Lenderscheid	Germany	Museumslandschaft Hessen, Kassel	11	10		9	10
24	Líšeň	Czech Republic	Ústav Anthropos, Moravské Zemské Muzeum	8				
25	Mauern	Germany	Archäologische Staatssammlung, München	23	21	12		19
26	Mitoc Izvorului	Romania	Institutul de Arheologie "Vasile Pârvan", Academia Română, Bucurest	1				
27	Mohelno	Czech Republic	Ústav Anthropos, Moravské Zemské Muzeum	10				
28	Musilievo	Bulgaria	Natsionalen Arheologicheski Muzey, Sofia	19	19	17		19
29	Moravský Krumlov IV	Czech Republic	Ústav Anthropos, Moravské Zemské Muzeum	8	8			8
30	Obernederhöhle	Germany	Institut für Ur- und Frühgeschichte, Universität Erlangen-Nürnberg	5				
31	Oceliwka, 1968	Ukraine	the Institute of Archaeology, the National Academy of Sciences of Ukraine, Lviv	1				
32	Kleine Ofnet	Germany	Archäologische Staatssammlung, München	1				
33	Grosse Ofnet	Germany	Archäologische Staatssammlung, München	1				
34	Ranis	Germany	Landesmuseum für Vorgeschichte, Halle	9				
35	Puskaaporos cave	Hungary	Magyar Nemzeti Múzeum, Budapest	5				
36	Reutersruh	Germany	Museumslandschaft Hessen, Kassel	3				
37	Ripiceni Izvor	Romania	Institutul de Arheologie "Vasile Pârvan", Academia Română, Bucurest	28	25	22	23	22
38	Rörshain	Germany	Museumslandschaft Hessen, Kassel	34	34	12	26	14
39	Rykhta	Ukraine	the National Museum of Natural History at the National Academy of Sciences of Ukraine, Kiev	5				
40	Sajóbábony Méhésztető	Hungary	Miskolci Egyetem- the University of Miskolc	16	16	8		2
41	Samuilitsa cave II	Bulgaria	Natsionalen Arheologicheski Muzey, Sofia	4	4			4
42	Szeleta cave	Hungary	Magyar Nemzeti Múzeum, Budapest; the Otto Herman Múzeum, Miskolc	15	15	16		
43	Vedrovice V	Czech Republic	Ústav Anthropos, Moravské Zemské Muzeum	16	16	12	8	12
44	Wahlen	Germany	Museumslandschaft Hessen, Kassel	26	25	18		21
45	Zeitlarn-Petlberg	Germany	the Heritage Office, Regensburg	5		2		
46	Zeitlarn 1981/102	Germany	Historisches Museum, Regensburg	6		5		
<b>TOTAL:</b>				<b>444</b>	<b>308</b>	<b>224</b>	<b>119</b>	<b>186</b>

CHRONOSTRATIGRAPHIC SUBDIVISION <i>(Behre 1989, Frechen et al.2001, Guiter et al.2003, Kukla et al.1997, Liedtke 1993, Litt et al.1996, Van der Hammen 1995)</i>				Age Kyr	OIS	Arctic structure soil	Unaltered sediment	Gleyed soils/ tundra gley	Arctic brown soil	Chernozemic soil	Luvisol	Strong luvisol	TL Age ka BP <i>Kusiak (2007)</i>	Pedo-stratigraphy	LOESS AND PALAEOSOLS STRATIGRAPHY								
															WESTERN UKRAINE <i>Boguckij, Lanczont 2002</i>	CENTRAL UKRAINE <i>Gožik et al.2001</i>	POLAND <i>(Maruszczak 1996, 2001)</i>						
H O L O C E N E					1									S0	Holocene soil	Holocene soil (hl)	Holocene soil						
V I S T U L I A N	L A T E G L A C I A L			10	2									L1	Krasyliiv horizon	Pryčernomorsk loess	Upper Younger Loess LMg						
	P L E N I G L A C I A L	UPPER	H1 H2	20											Rivne horizon			Dofinovka set of (1-2) soils					
		MIDDLE		H3 H4	30	3	3.1 3.2 3.3	soil from slope deposits					Middle Pleniglacial Loess		Dubno 1 set (1-5) of palaeosols	Bug Loess (bg)	Vytáčiv set of (2-3) soils (vt)	Middle Younger Loess LMs					
	soil from loess																						
	soil from loess																						
	soil from loess																						
	LOWER		H5 H6	50 60									Lower Pleniglacial Loess	Uday Loess (ud)	Lower Younger Loess LMd								
	E A R L Y G L A C I A L		EARLY GLACIAL	Odderade Interstadial	70	4									S1	Kolodiiv set of soils with loess interbeddings	Pryluki complex (pl)	Lowest Younger loess					
				Rederstall stadial	80		5a	soil from slope deposits															
				Brörup Interstadial	90	5b																	
				intra-Brörup stadial	100	5c1 5c2 5c3																	
				Amersfoort Interstadial		5d																	
Herning stadial				110	5e1 5e2 5e3																		
E E M I A N				120									Horohiv set of soils	Horohiv I palaeosol Horohiv II palaeosol					Interstadial superimposed turfy humus horizons Gi/GJ				
W A R T A N I A N				130	6																L2	Wartanian Loess	Tyasmyn Loess(ts)

Fig.2 Detailed division of the last glacial in Western Europe; sequence of palaeosols and loess stratigraphy in the Eemian and Vistulian in Ukraine and Poland (after: Lanczont & Boguckij, 2007, Fig.8)..





## 2. Analysed archaeological sites. History of research, stratigraphy, datings.

### 2.1. Key sites

#### 2.1.1. Bulgaria

##### 2.1.1.1. Musilievo

An open-air loess site located on the right, steep bank of the river Osam about 8km before its confluence to the Danube (Bulgaria). The site is located on the cape of the Nanin kamâk hill, made of limestone, at the mouth of a valley where the Jevlogiejevski brook confluences to the Osam river. The hill, in its part located near the river creates a small plateau about 50m above the bottom of the Osam valley. The site is located on the southern and western slopes of the plateau about 35m above the river level (Madeyska, 1977 p. 299).

The site was discovered by Dzambazov in 1968 (Haesaerts & Sirakova, 1979) because the construction of a local road revealed the loess profile with stone artifacts. He led the excavations starting from that year. The main trench was located at the foot of the cape and was an extension of the loess profile which revealed itself when the road under construction cut into the slope. Musilievo was then the first open-air loess site explored in Bulgaria.

In 1970–71, fieldwork was carried out in collaboration with Chmielewski from the University of Warsaw and Madeyska from the Polish Academy of Sciences (Chmielewski, 1977 p. 97). Chmielewski, apart from exploring the main trench also opened a trench at the top of the plateau. In the trench's upper layers he encountered Neolithic artifacts and dwelling structures. Due to the limited duration of research, it was impossible to explore further layers of this trench.

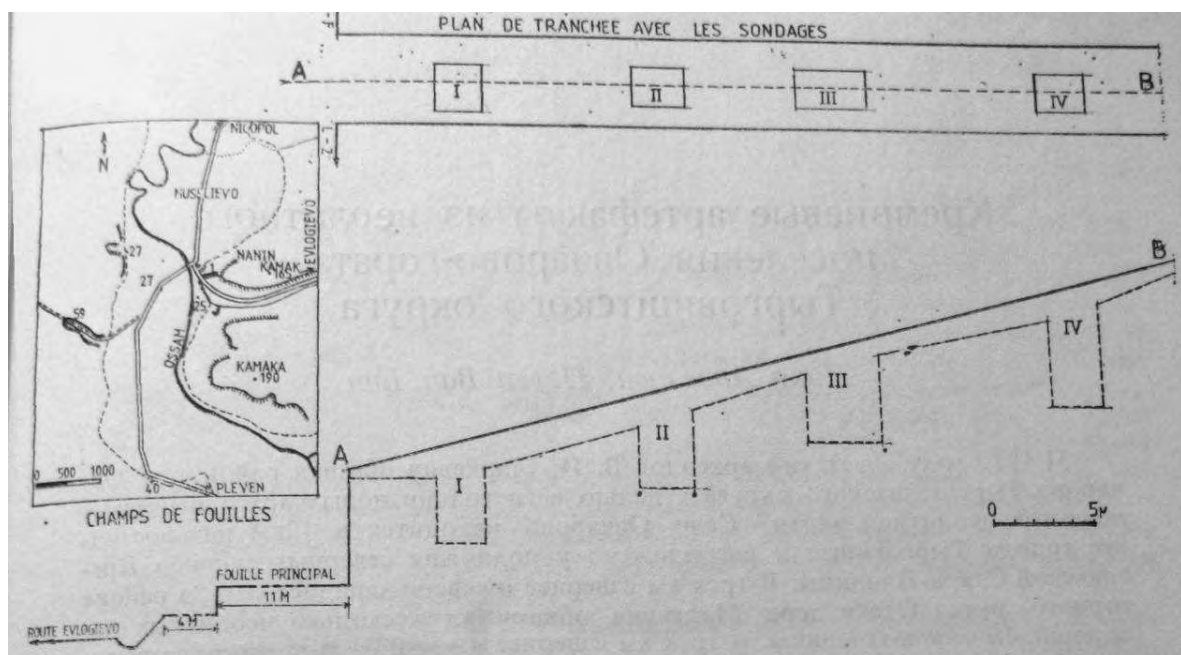
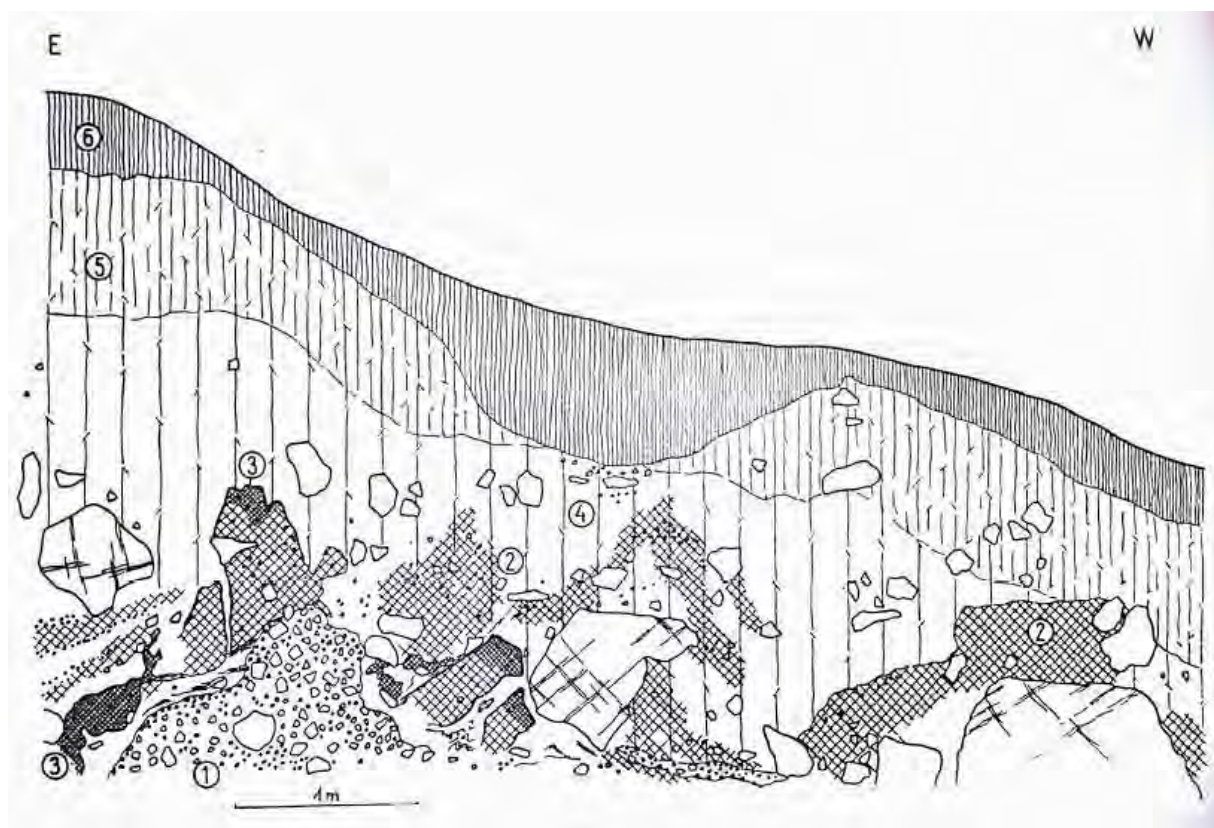


Fig.3 Musilievo trenches arrangement according to Sirakova and Haesaerts studies (after: Sirakova & Ivanova, 1988, Tab. VII).

During the entire study, a large flint inventory was acquired on the site, with over 500 leafpoints and huge amounts of debitage flakes from the production of bifacial tools and their preforms (Ivanova & Sirakova, 1995 p. 31).

In 1970–71, next to the archaeological trenches, a profile on the opposite, northern side of the plateau was revealed and studied, the so called “behind the sewing mill” profile (Madeyska, 1977 pp. 301–303; Chmielewski, 1977 p. 106). Due to no chance of further cooperation, preliminary research results were presented in brief articles by Polish researchers (Chmielewski, 1977; Madeyska, 1977). In the archives left after Chmielewski, fieldwork documentation from the years 1970–1971 in the form of inventory books, profile and artifact drawings was preserved.

In 1975, the site’s research was resumed by Sirakova in collaboration with Haesaerts (1979). The aim of this project, run until 1981, was to accurately determine the site’s stratigraphy and chronology. During the study, test trenches located in the NS axis (intersecting the cape’s slope) were opened (Fig.3). Some of the trenches were as deep as 8–10m (Sirakova & Ivanova, 1988). In addition to that, geological profiles in other parts of the valley: in Melnitza and Kariera and on the left bank of the river Osam (Put Germanic, Terrasse, Latcheva Tchechma) were revealed (Haesaerts & Sirakova, 1979). The main three profiles (from the sites of Melnitza and Kariera) allowed to establish the chronology of soil horizons F.B., M.B. and M.C., which in the profiles on the river’s left bank are younger than the three brown cambisol paleosols, corelated with the Eemian Interglacial (OIS 5e) and the beginning of the last glaciation (Haesaerts & Sirakova, 1979).



*Fig.4 Main trench southern wall profile depicting Musilievo layer system (after: Madeyska, 1977, Fig.2).*

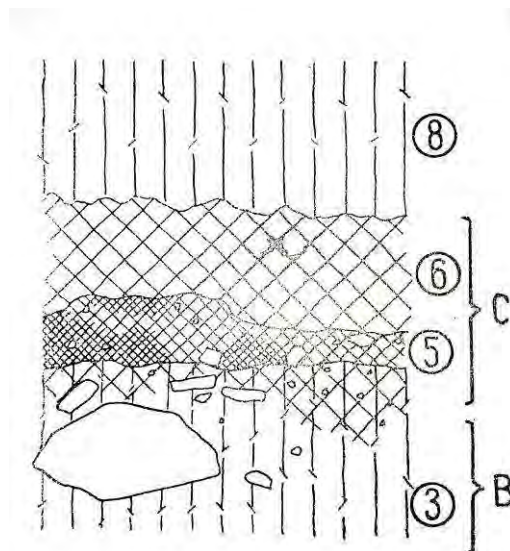
## Stratigraphy

On the basis of initial profiles diagnosis, Madeyska (1977 p. 300) submitted the following description of main trench layers' arrangement (Fig.4):

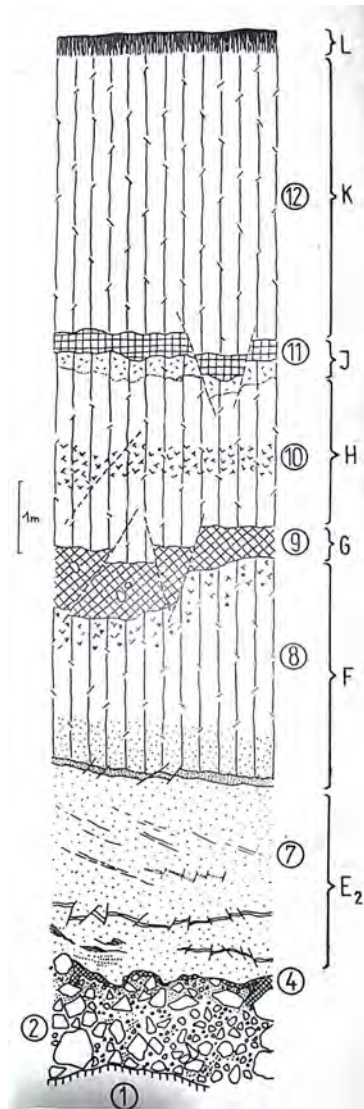
6. Holocene humus
5. light gray loess with admixture of organic matter
4. fawn loess with a small admixture of slightly weathered limestone rubble and scarce limestone blocks; fills the spaces between soil packages (layers 2 and 3), thickness of ca. 2m
- 2 and 3.** packages and blocks of red-brown paleosol in the form of clayey-loess material with scarce, highly chemically weathered limestone rubble, some of the packages have sharp boundaries and preserved "the original diversity of color and composition" (Madeyska, 1977 p. 301), in the form of the red-brownish level (2) 0.5–0.6m thick changing into dark brown (3) 0.1m thick, interpreted as a landslip
1. white, highly fractured Maastrichtian limestone, generally sharp-edged, separating itself into individual blocks, highly crushed, with a little light fawn dust binding them; they gradually pass into the layer of weathered rubble in which flint nodules and Palaeolithic artifacts are present, the upper part constitutes the upper level of artifacts deposition. Weathered rock surface uneven, with denivelations of 1–2m.

In the cape's northern part two profiles were studied, of which I exposed the loess wall floor at a depth of about 15m. The profile revealed bipartite paleosol. The stratification was as follows (Fig.5):

8. rubble-less loess (19YR 6/3)
6. red-brown paleosol (clayed loess) (7.5YR 5/6), thickness of ca. 0.6m
5. reddish-brown paleosol (10YR 3/3)
3. loess with small quantities of heavily weathered limestone rubble and single, large limestone blocks.



*Fig.5 Profile I in the cape's northern part (after: Madeyska, 1977, Fig.4). Numbers correspond to descriptions in the text.*



*Fig.6 Profile II in the cape's northern part (after: Madeyska, 1977, Fig.4). Numbers correspond to descriptions in the text.*

In the IInd profile opened on the plateau's northern side, the stratigraphy looked the following way (Madeyska, 1977 p. 302) (Fig.6):

- 12.** the youngest loess level with contemporary humus soil close the surface
- 11.** pale brown (10YR 5/4) paleosol with an elluvial level (10YR 6/3) in the lower part; the least developed
- 10.** loess with coarsely grained level in the middle, the thickness of 0.4m
- 9.** red-brown (10YR 4/3) paleosol with crotovinas and lighter coarsely grained level; limestone nodules at the bottom, the thickness of 1.5m
- 8.** loess (19YR 6/3), sandy in the lower part
- 7.** a series of fine-grained sands and dusts (redeposited sandy loess), stratified or laminated, no limestone rubble, the thickness of ca. 3m
- 4.** thin layer of reddish-brown clay (redeposited paleosol) placed on the surface of weathered limestone, bent according to the shape of the loess floor level



2. large and small, smooth limestone rubble with rounded edges; limestone sand bound with loess

1. limestone-marl.

Haesaerts presented the description of three profiles, one of them originating from the site, and the next two from other places in the Osam valley, located on the river's right bank. The profiles were created during the excavations of 1975 and 1976.

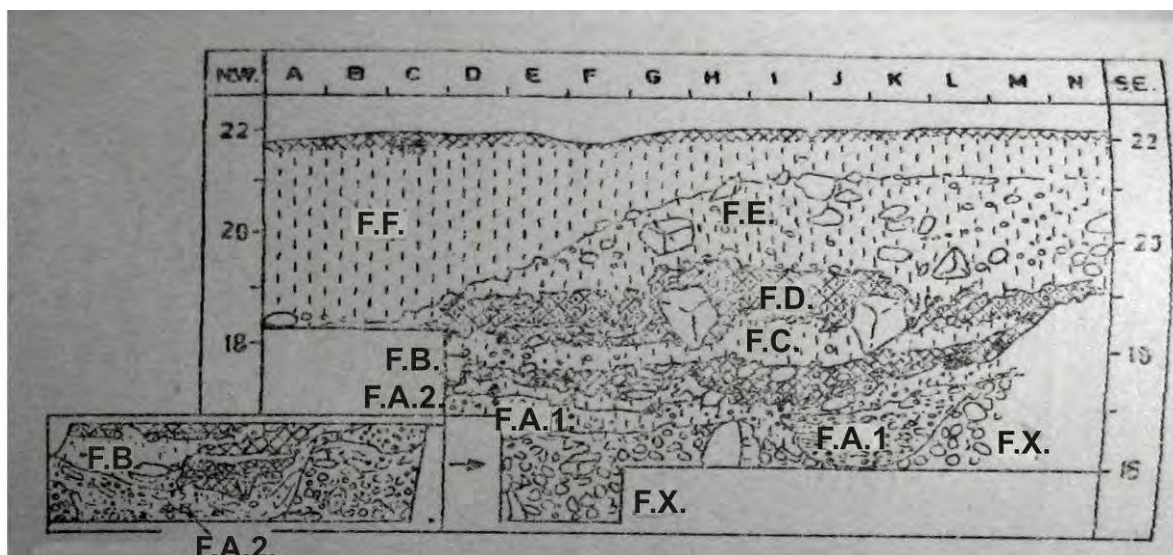


Fig.7 Musilievo site profile (after: Haesaerts & Sirakova, 1979, Fig.2). Names correspond to descriptions in the text.

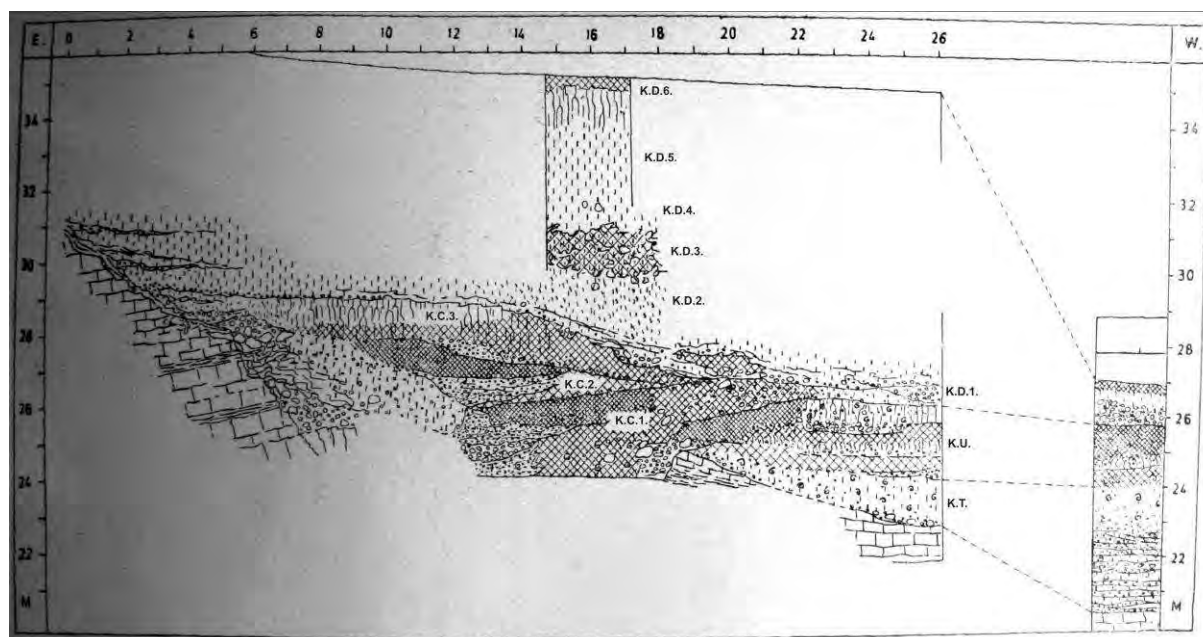


Fig.8 Kariara profile (after: Haesaerts & Sirakova, 1979, Fig.1). Names correspond to descriptions in the text.

Musilievo site's profile in the NW–SE axis (Fig.7):

**F.G.** contemporary humus, about 0.3m thick, numerous animal bioturbations traces—probably from the present

**F.E.** light yellow loess containing small amounts of limestone rubble, and numerous crotonas

**F.D.** brown paleosol, poreux, containing sand and numerous limestone blocks; in the layer's upper part vertical fissures filled with lighter sediment; contains land snail shells and a small number of flint artifacts; colour: 10YR 6–5/4 dry state, 10YR 4/4 to 4/6 moist state

**F.C.** sandy and gravel clay with blurred streaks and polygonal structures

**F.B.2.** sandy clay with yellow-brown streaks between humus layers; contains flint artifacts similar to F.A.2

**F.B.1.** lenses and streaks of sandy humus layer; blocks of different size; contains molluscs shells; colour: dry state 7.5YR 4/2 to 3/2, moist state 7.5YR 5/4 to 5/6, contains flint artifacts

**F.A.2.** sandy clay with limestone rubble, contains Palaeolithic artifacts throughout its entire thickness

**F.A.1.** eroded limestone rubble layer

**F.X.** sharp-edged limestone blocks.

Kariera profile (Fig.8):

**K.D.6.** Holocene humus with loess, a well-developed upper soil level 0.4–0.5m thick, at the base slightly lighter and of prismatic structure

**K.D.5.** highly uniform, homogeneous loess; colour: 10YR to 2.5Y 6/4

**K.D.4.** transition to a more uniform loess layer, bioturbation traces

**K.D.3.** layer with organic matter and strong bioturbations, contains small stones and limestone rubble; color: 10YR 5/4 with darker spots

**K.D.2.** gradual transition to more uniform loess with pseudomycelium; bioturbation traces

**K.D.1.** a non-homogeneous, interstratified loess, spotty, contains blocks of limestone; the floor is eroded

**K.C.** sandy paleosol containing streaks and lenses, numerous bioturbations and molluscs shells

**K.U.** lenses containing limestone rubble, sand of prismatic structure and sub-layer of organic matter (moist state 10YR 3/2), contains molluscs shells

**K.T.** tuff/calc-sinter, silty structure containing numerous snail shells limestone rock.

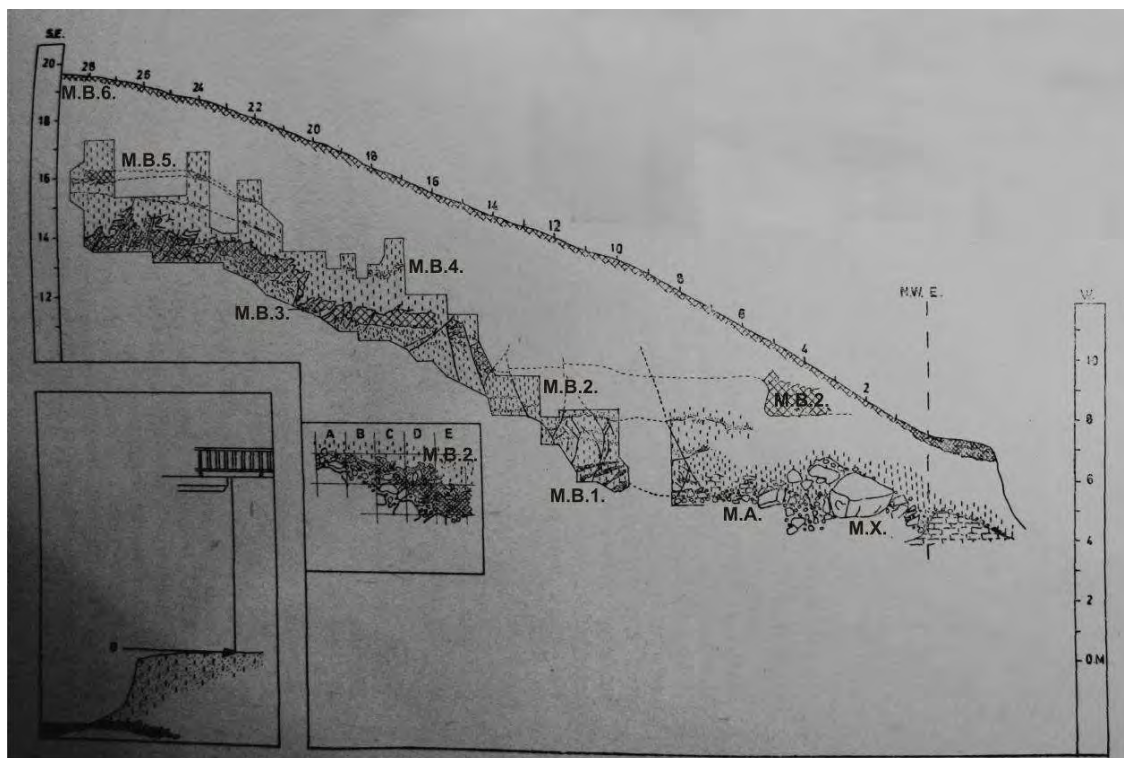


Fig.9 Melnitza profile (after: Haesaerts & Sirakova, 1979, Fig.2). Names correspond to descriptions in the text.

The Melnitza profile is located about 100m to the W off the site. Here, two profiles were discovered, the following description is a combined description (Haesaerts & Sirakova, 1979) (Fig.9):

**M.B.6.** Holocene humus with loess; similar to the one in the Kariera profile but thinner

**M.B.5.** very fine-grained, brown, dusty loess, more compact than M.B.4., but still dusty

**M.B.4.** dusty loess with many bioturbations, mainly crotovinas, fills the spaces between the sediment of M.B.3. layer

**M.B.3.** paleosol (10YR 6 to 5/4) with a small amount of limestone rubble, contains lenses filled with dark sediment, and poorly developed soil blocks; colour: 10YR 5/4–wet state; contains snail shells and scarce flint artifacts. The layer is highly disturbed due to erosion

**M.B.2.** in Melnitza I: sand gradually changing into sandy clay; contains single limestone blocks; colour 10YR to 2.5Y 6/4

**M.B.1.** stratified layer situated on limestone blocks, consisting of dark brown paleosol blocks with limestone rubble and smaller loess lenses; streaks of paleosol as a result of intensive erosion, colours of blocks in Melnitza II: 4–3/3 10YR dry and wet; 10YR 5/4–6–dry, 4/4–wet

**M.A.** limestone rubble blocks which are more smoothed and weathered in the upper part of the layer, bound with loess lenses. Melnitza I: 7.5YR 5/4 to 4/4, contains fragments of sandstone blocks

**M.X.** limestone blocks (typical of the Melnitza II profile)

Limestone rock.

## Profiles correlation

The site's location on a slope, as well as obvious erosion signs, make the profiles' interpretation highly complicated. The redeposition of layers in trench profile is confirmed by packages and blocks of bipartite paleosol, which have kept their original, bipartite structure but exist as separate, large blocks, which eroded from higher site parts. Within the paleosol blocks/packages, there were isolated flint artifacts which Madeyska and Chmielewski were willing to consider as a separate archaeological horizon. Sirakova treated all flint inventories together (Haesaerts & Sirakova, 1979).

The main cultural level, and the most numerous stone inventory, were located in a limestone rubble layer filled with limestone dust and loess (Fig.10). Above this layer bipartite paleosol blocks were placed, which according to Madeyska (1977 p. 303) came from a landslide. The space between packages was filled with loess, which also overlapped with the paleosol layer.

The key factor from the perspective of archaeological horizon chronology was to determine the paleosol blocks' age and reconstruct the processes which had occurred on the site. For this purpose, two profiles on the cape's northern side were opened. They displayed three paleosols separated by loess layers. In the main profile, the lowest paleosol occurred in the form of residual, thin layer (4) directly above a limestone rubble layer. In the second profile, an analogous paleosol was bipartite, with darker level in the lower part (5), and lighter (6) in the upper part. The soil was covered with clean loess free of limestone rubble, correlated with layer 8 in profile II. Two paleosols located above are less developed and monolayer.

Since only the lowest paleosol has bipartite structure, Madeyska assumed that it is this level that is analogous to the eroded paleosol blocks/packages layer in the main trench on the site.

However, determining the soil's age became problematic. Based on analogy to the profiles of Ruse published by Minkov (which she had the opportunity to study herself), Madeyska correlated the two upper layers with paleosols F.B.1. and F.B.2. from Ruse. She was also willing to further correlate the layers with OIS 3, following Fotakijeva's interpretation. Madeyska correlated the bipartite soil with the F.B.3. and F.B.4. soils from Ruse, which in some of the site's places are present together, thus forming bipartite paleosol. Sometimes they are separated by a thin loess layer. These paleosols were correlated as Eemian and Early Vistulian paleosol by Fotakijeva (Fotakijeva, 1970 after: Madeyska, 1977 p. 306).



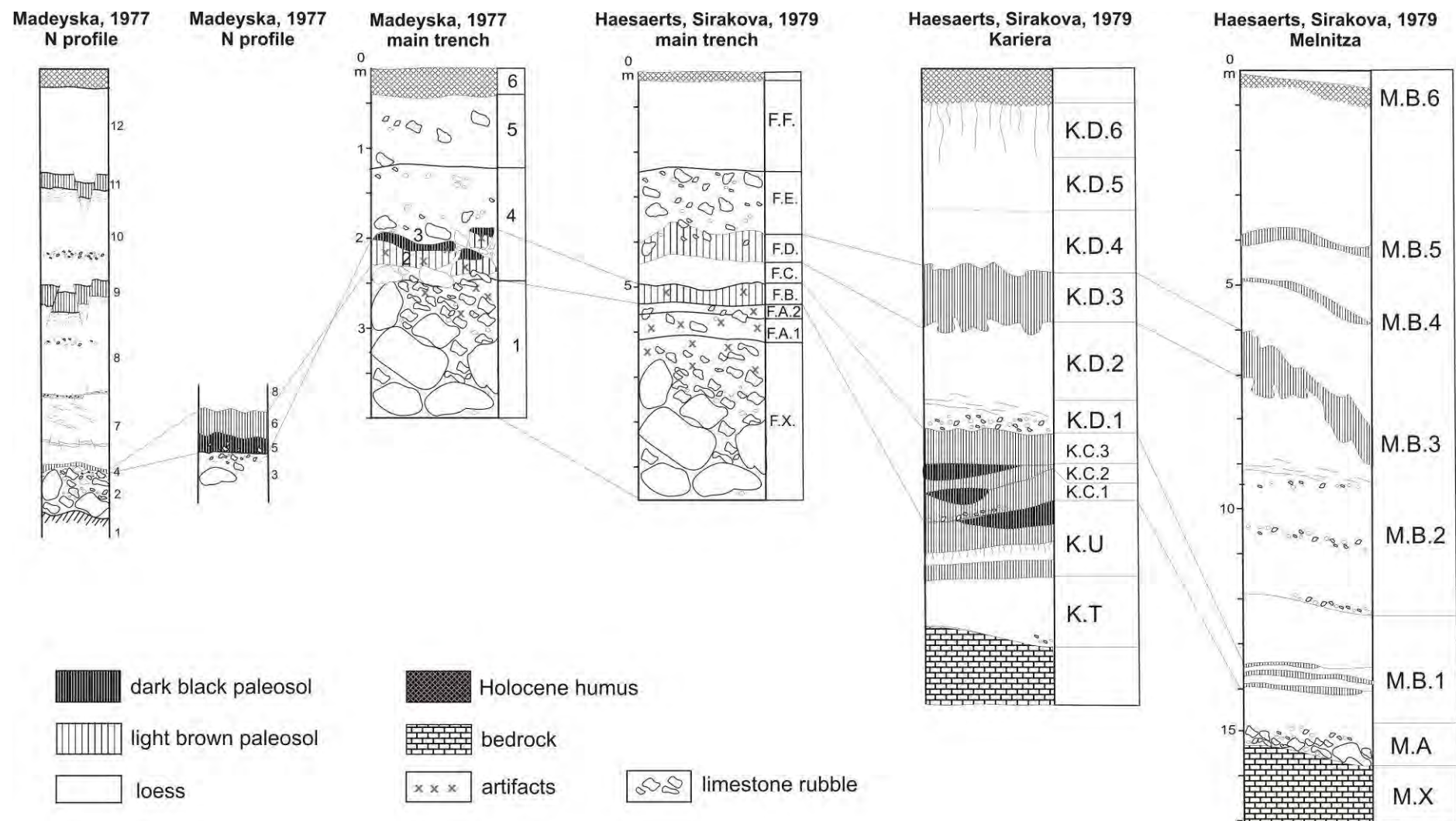


Fig.10 Musilievo profiles correlation.

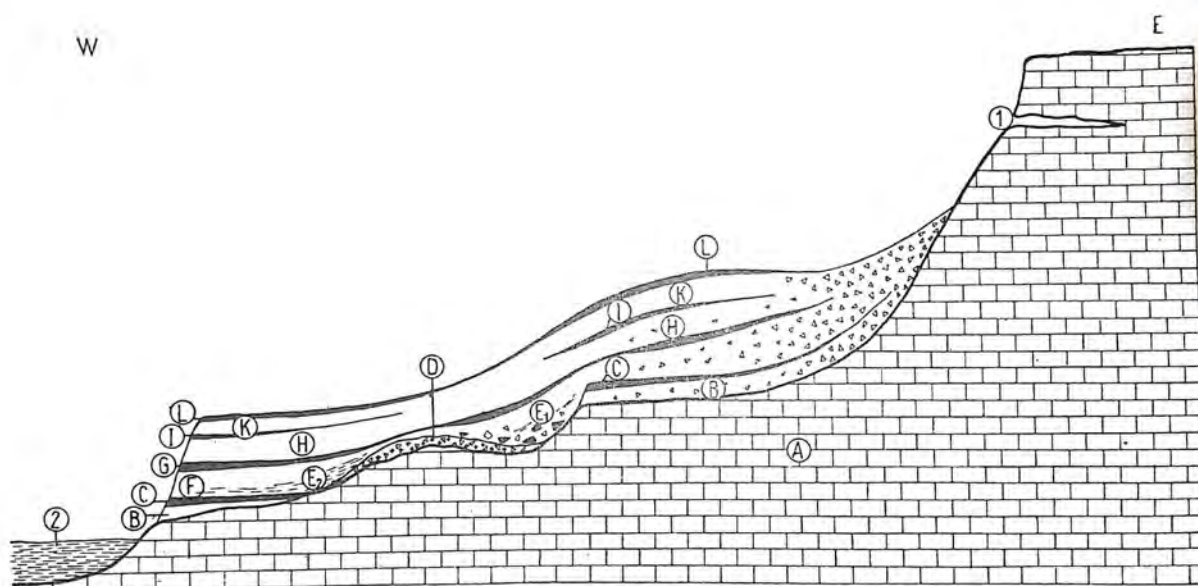


Fig.11 The Osam valley slope's schematic cross-section showing hypothetical Musilievo layers arrangement; 1. the cave, 2.alluvial terrace sediment, A. bedrock, B. loess, C. bipartite paleosol, D.human settlement remains, E1.paleosol solifluction layer, E2. solifluction layer, F. loess, G. paleosol, H. loess, I. paleosol, K. the youngest loess, L. Holocene chernozem (after: Madeyska, 1977, Fig.5).

Therefore, it should be clear that the lowermost limestone rubble, containing stone artifacts located below the bipartite paleosol, should be older than OIS 5e. However, analysing all the profiles, Madeyska reached the conclusion that in this case one is dealing with the inversion of layers. She presented a scenario (Fig.11) according to which the Eemian and Vistulian paleosol formed on the bedrock, was subjected during a cold period to intensive erosion processes which led to soil removal from the areas located directly on the rocks. The slope, devoid of soil in some places, revealed the underlying rock rubble, which contained a block of flint nodules. It was therefore a very convenient place to acquire raw material and to manufacture flint tools. Further erosion processes or an erosion intensification period caused, at some point, tearing off the soil horizons preserved in the slope's upper parts. The soil, descending down the slope in the form of blocks, sealed the upper part of the archaeological level. Currently, the soil blocks are arranged in such a way that the darker level is above the brighter level. As Madeyska had noticed, if this soil can in fact be correlated with the bipartite soil level from the cape's N part, it must be assumed that at the time of landslide and tearing-off, soil fragments underwent inversion (1977 p. 304). For in their original arrangement, the lower placed level 5 is darker than the overlapping layer 6 (Fig.5). Another cool period brought loess accumulation, which eventually covered the artifact layers.

Such profile interpretation presented schematically by Madeyska in a drawing (Fig.11), would result in the fact that the lower level of limestone rubble containing artifacts should be dated to the period of Early Vistulian or Pleniglacial I (Lower Pleniglacial).

Haesaerts correlated the layers from the site's longitudinal profile of the NW–SE intersection with the profiles in Melnitz and Kariera, located in other areas of the Osam valley. The highest levels were the easiest to correlate. Humus in all three profiles was covered with fine, clear loess (F.F. and F.E., M.B.4. and M.B.5., K.D.4. and K.D.5.),

overlying paleosol with numerous bioturbation traces F.D., M.B.3. and K.D.3. Below the paleosol there were the loess levels F.C., M.B.2. and K.D.2. (Fig.10).

Further correlations were more complicated. While in all three profiles below the second loess layer paleosol or paleosol blocks were present, the levels' correlation is questionable. The most developed and maintained *in situ*, according to Haesaert, is the paleosol from Kariëra where the K.C. layer was divided into three different coloured subhorizons of considerable thickness (altogether even >3m). In the profile under layer F.C. paleosol blocks F.B. were found, the residue of redeposited paleosol. Also, in the Melnitz profile, layer M.B.1. is characterized by the presence of thin layers of washed, redeposited soil. Haesaerts correlated the three levels with each other, recognizing that both in Melnitz and on the site a strong slope denudation is being dealt with.

In none of the additional profiles, was Haesaerts able to find analogies to the F.A.2 and F.A.1 layers of limestone rubble with a little admixture of loess, in which most of the flint inventory was present.

Haesaerts also mentions that in the profiles on the Osam's left bank, there are three paleosol horizons of Endoeutric cambisols type. The researcher correlated them with the Eemian Interglacial and Early Vistulian. Parallel to that, he stressed that all the analysed paleosol layers from the valley's right bank, also those on the site, are younger than the tricuspid Eemian soil "*nous en retenons seulement la conclusion que les sols humiques nommés ci-après F. B., M. B. et M. C.<sup>2</sup> sont postérieurs à un complexe de trois sols bruns lessivés observé sur la rive gauche de l'Ossam et qui, croyons nous, représente le Dernier Interglaciaire suivi des premières améliorations climatiques du Début Glaciaire*" (Haesaerts & Sirakova, 1979 p. 38).

Results correlation by the two researches (Madeyska and Haesaerts) poses some difficulties. In none of the profiles described by him, had Haesaerts encountered the three paleosol levels, which were clearly visible on Madeyska's profile from the cape's N part. Thus, the correlation of particular levels appears to be problematic.

Nevertheless, it is more simple to correlate profiles obtained within the site itself. As it was assumed by Madeyska in her paleosol arrangement scheme (Fig.10), Haesaerts encountered one paleosol in the slope's upper part, a paleosol which he had termed as F.D.

Thus, starting from the bottom, the layer of limestone blocks with loess admixture, containing Palaeolithic artifacts would horizontally correspond to levels F.A.1. and F.A.2. by Haesaerts. Blocks/packages of paleosol described as layers 2 and 3 by Madeyska, would correspond to the first eroded paleosol F.B. Both levels included single flint artifacts. The overlying layers F.C.–F.E described by Haesaerts were probably absent in the slope's lower part and are not included in Madeyska's main trench profile description. Only the F.F. loess layer can be correlated with the clean loess layer 4 in the main trench profile.

It remains unclear which soil level in the profile from the slope's northern part should be correlated with Haesaerts's F.D. paleosol. Due to numerous bioturbations, the most probable layer correlation is with the lower paleosol described by Madeyska as layer 9. In both cases, the paleosol layer is covered with loess containing limestone rubble. This could also confirm the presence of a very thin, brown, compact paleosol layer (M.B.5) in the Melnitz profile. This level should probably be correlated with the upper soil level in the cape's northern part (layer 11).

---

<sup>2</sup> The K.C. paleosol layer is probably discussed, since the M.C. layer is absent from the description.

It is not clear, though, whether Madeyska's interpretation of layer arrangement inversion is correct. Moreover, it is not known if the paleosol packages (layers 2 and 3), and probably also the Haesaerts' F.B. layer, should be correlated with the bipartite Eemian soil found in the profile's bottom, on the northern cape side. Madeyska assumed that the landslip, even though invisible on the surface due to being covered with a thick loess layer, should manifest itself in trench profiles from the slope's upper part. Yet, on the profiles from Haesaerts examinations, which were located high up the slope, neither the landslide point nor the bipartite Eemian soil layer underlying the rubble-loess layer with flint artifacts can be seen.

However, it is still impossible to fully determine where the paleosol's original location was, and where the paleosol blocks (covering the layer containing flint artifacts) visible in the profile were eroded. Although there are no observations confirming the hypothesis of Madeyska, it must be assumed that the site did not probably undergo any layer arrangement inversion. The overlying paleosol layers constitute the evidence for 3 subsequent stages of climate warming, and are younger than the limestone blocks layer which contains flint artifacts.

If the level of F.F. (clean clear loess) correlates with OIS 2, then subsequent paleosols would have to relate to further warm periods during OIS 3, of which there were several.

### **Dating**

Dzambazov, based on analogies with other sites containing leafpoints and the results of earlier research conducted in the Samuilitsa II cave, correlated the inventory with the Szeletian industry (Dzambazov, 1971 p. 11; Dzambazov, 1967a p. 62).

Madeyska and Chmielewski, due to the initial stage of studies, refrained from determining the site's chronology. In his article, Chmielewski stressed the fact that the artifacts are located near the border of two sediment fractions, which points to a period of climate change. He observed a similar artifact placement in Samuilitsa II. Based on analogy with sites such as Königsau, Baume Bonne, he was willing to date the inventory to the Brørup Interstadial (OIS 5b), or a bit later.

Haesaerts' studies showed that the two paleosol layers visible in the profiles exposed and analysed by him are later than the Eemian and Early Vistulian cambisols observed in the profiles on the river's left bank. Hence, Haesaerts correlated the two paleosols with OIS 3. The layer containing the main flint inventories level was deposited in a cool climate, as evidenced by numerous fragments of sharp-edged limestone rubble. Since the layer resided below the lowest soil level, it can be correlated with the Lower Pleniglacial's end (OIS 4) (Haesaerts & Sirakova, 1979).

Moreover, this interpretation is confirmed by the C14 date obtained for the upper soil level (F.D.) on the site, which gave the result of 35,100±500 uncal BP (Sirakova & Ivanova, 1988).

### **Archaeological inventory**

In a trench in the cape's upper part, in the highest layers, Dzambazov and Chmielewski discovered some Neolithic artifacts, accompanying a pit-house construction (Madeyska, 1977, p.300).

Additionally, apart from the Neolithic level, the remaining artifacts were of Middle Palaeolithic type and were related to limestone rubble layers. Very poor flint inventory was

also associated with paleosol blocks (layer 2 and 3 on the site and 5, 6 in the profile N of the cape). Chmielewski was willing to interpret these artifacts as a separate inventory.

The bipartite soil inventory is made of about 70 artifacts in total. These are mainly small and medium-sized flakes with smooth butts and exposed bulbs. Two artifacts are retouched. One of them was found in bipartite soil in the profile on the cape's N side. Chmielewski described them as asymmetrical convergent side scrapers. According to the researcher, "*their manufacturing technique differs from that of rubble-loess series side scrapers*" (Chmielewski, 1977 p. 106)

According to Sirakova's description, the artifacts were present within the F.A. loess and occasionally in the level of F.B. paleosol. She was willing, however, to treat them as a coherent inventory (Sirakova & Ivanova, 1988).

The limestone hill is also an outcrop of flint nodules. Rock erosion from the past resulted in the peeling-off of large rock fragments and their slow slipping down the slope. At that time, further denudation caused flint nodules leaching. The site is located on a flint outcrop, but its placement on the slope probably caused further sediment slipping together with the accumulated artifacts. According to Ivanova and Sirakova (1995, p.28), the artifacts could have been moved about 30–35m down the slope from their primary accumulation place. It might be additionally evidenced by their large dispersal within layers (Chmielewski, 1977). As pointed out by Chmielewski (1977) and Sirakova (Haesaerts & Sirakova, 1979), the assemblages' morphological consistency requires to consider them as made in one period, and asks for treating them as a uniform inventory despite the obvious evidence of its redeposition.

The stone inventory of Musilievo currently counts several thousand artifacts. As already noted by Sirakova (Haesaerts & Sirakova, 1979), after analysing about 2,000 items, the characteristics of this assemblage include:

1. large presence of cores, Levallois cores among them
2. large number of flakes from bifacial forms manufacturing
3. small typological variety of artifacts, including double and single side scrapers and leafpoints
4. very large presence of leafpoints; over 500 items or their fragments, as well as unfinished forms were found here (Ivanova & Sirakova, 1995, p.31)
5. most artifacts and debitage waste are made of local flint nodules which are found within the eroded limestone on the slope.

All authors stressed the fact that these features clearly indicate the site's workshop nature, which was aimed at producing leafpoints (Ivanova & Sirakova, 1995 p. 31; Sirakova, 2009 p. 120).

Geological analyses give grounds for dating the "leafpoints" assemblage to the end of the Lower Pleniglacial (OIS 4).

### 2.1.1.2. Samuilitsa Cave II

The cave is located in the Iskar Valley created in limestone rocks, 3km to the N of Kunino village in the NW of Bulgaria. The site is located in the karst caves region, rich in caves and shelters. The cave is 30m long and consists of a main corridor and a small side chamber. The cave's wide opening faces W (Dzambazov, 1967b).

The Iskar Valley had been the subject of geological and archaeological research in the nineteenth and early 20<sup>th</sup> century. First sites in the region were located here in the 20s by Popov. In 1951, the Bulgarian Academy of Sciences started a systematic research project in the Kunino region caves. During the project, more than 40 archaeological sites were investigated (Dzambazov, 1967b), including the discovery of first Palaeolithic artifacts in the caves of Samuilitsa I and II, located opposite each other on either side of the gorge.

Excavations on both sites were started in 1954 from cleaning the surface. In subsequent years, first trenches were opened and the exploration of both caves was initiated (Dzambazov, 1967b). Due to great thickness of sediments, the main focus was put on the Samuilitsa II site. Studies were conducted by Dzambazov in cooperation with local teachers until 1969 (Sirakov, 1979). During this time, the researcher explored the whole of cave deposits, making it difficult for later attempts to verify the results (Sirakov, 1983). The site was dug fairly quickly, without sieving or wet sieving. From subsequent explored layers only retouched and interesting artifacts, large flakes and cores were collected. Most of the debitage waste was not collected (Sirakov, 1983).

The examination results were not fully developed by Dzambazov. He only devoted a few short articles to the site (Dzambazov, 1959; Dzambazov, 1964; Dzambazov, 1967b), and later one larger paper (Dzambazov, 1981). None of his publications provided any profile drawings (only black and white profile photographs with marked certain layers appear in the articles). Also, the archaeological inventory was not developed; and the literature mentions the most distinctive artifacts solely.

The examination of collections was undertaken by Sirakov in his doctoral dissertation from the 70's. He examined a whole collection of artifacts except for cores, to which he had no access. Sirakov presented general site stratigraphy description based on the publications by Dzambazov (from before 1975) but, not being able to correlate the different artifacts with separate layers of their origin, he introduced his own division into 10 mechanical levels and analysed the artifacts within those levels. Despite the difficulties, Sirakov made a very detailed, typological analysis and, above all, technological and statistical analysis of the collection at hand.

In the late 60's, Chmielewski began his work with Dzambazov, which resulted in the pursuit of joint research in 1970–71 in Musilievo. At that time, Chmielewski had access to the collection of Dzambazov stored in Sofia and Pleven. Some notes by Chmielewski made during his stay in Bulgaria and recovered in his documentation were used for the purpose of this study. In his notes, there are handmade drawings of some artifacts from different Bulgarian sites. In one of the notebooks, Chmielewski drew the profile of Samuilitsa II (Fig.12), which corresponds to the layers division from A to P, presented in full by Dzambazov in 1981 (1981). The notes also cover descriptions and artifact inventory from different layers (A, G, H, I, K, L) (Fig.13), as well as drawings of the most interesting forms with the attribution to their layer of origin (A to P). The dates located in the corners of pages show that the artifacts were drawn in 1968 and 1969. There is also a separate, cumulative artifact inventory with their division by layers (A, G, H, I, J) (Fig.14).



Unfortunately, it is not possible to verify how the profile drawing was created (Fig.12). On one hand, it is generally known that the excavations ended in 1960 and since 1968, the cave profile was probably not available. The figure below shows a simplified cumulative profile and provides division into cultural horizons and geological periods, so it is possible that Chmielewski drew a sketch or created it based on drawings or photos of the original profiles.

Currently, this is the only known drawing of the Samuilitsa II profile.

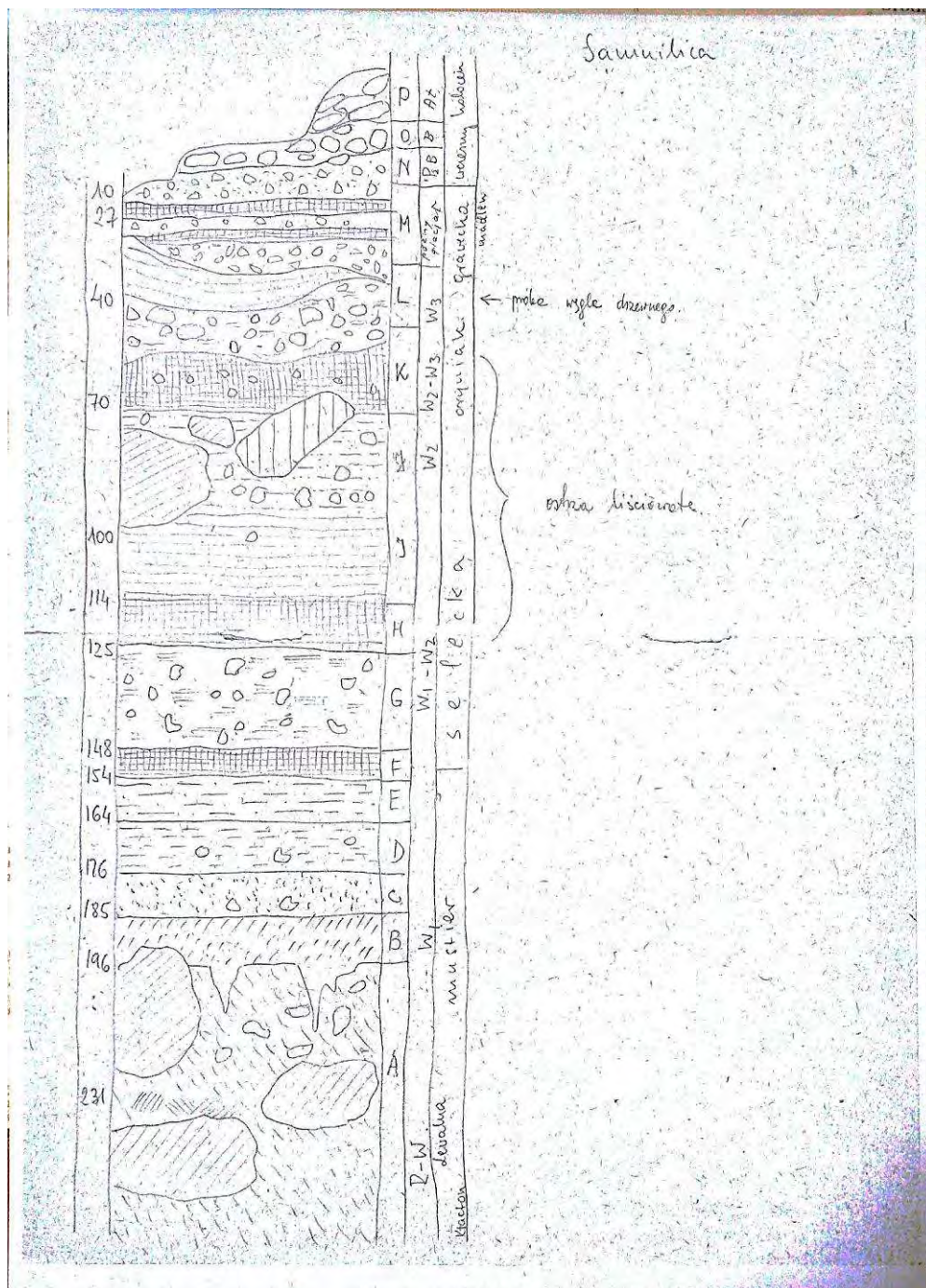


Fig.12 Page from prof. Chmielewski's notebook, with Samuilitsa II profile drawing, showing division into layers (from documentation by prof. W. Chmielewski, IAUW collections).

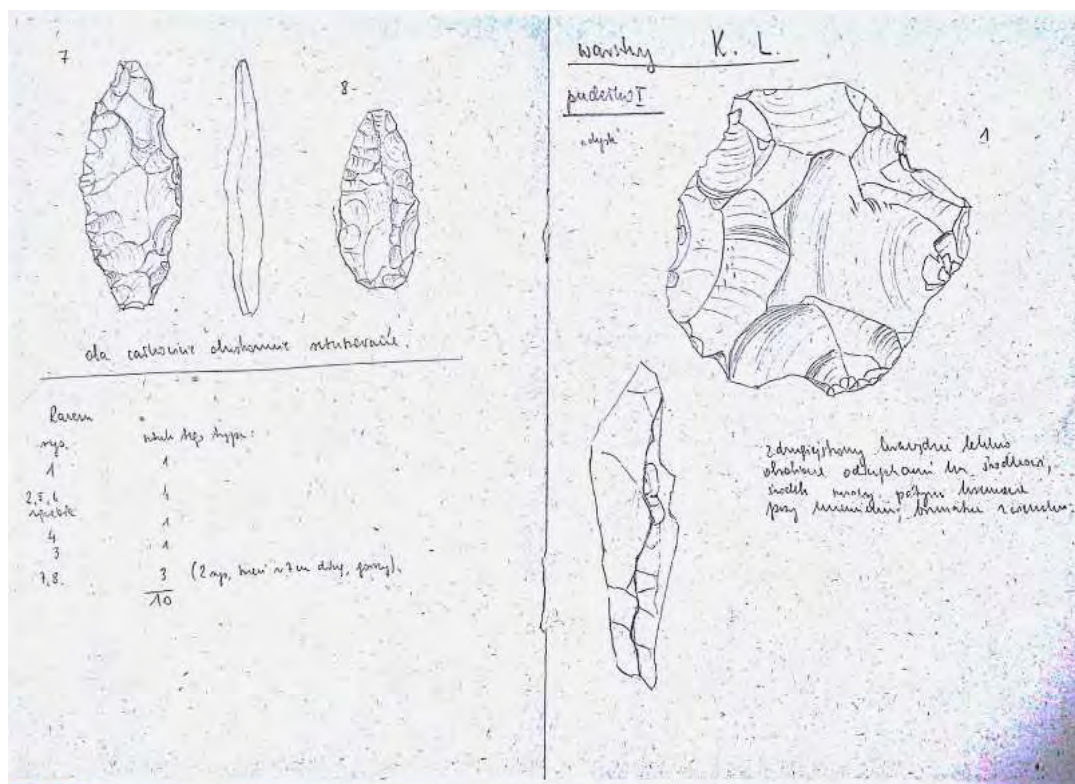


Fig.13 Page from prof. Chmielewski's notebook, with Samuilitsa II artifacts drawings, showing division into layers (from documentation by prof. W. Chmielewski, IUAW collections).

## Stratigraphy

In the initial reports of his studies, Dzambazov presented the site's layer arrangement description, where the profile contained 4 layers (1959 p. 48):

1. 0.8–0.9m (thick)- light yellow clay with lots of limestone rubble, containing Mousterian artifacts
2. 0.8m- red clay without limestone rubble, containing stone artifacts with leafpoints among them
3. 0.6m- light yellow clay containing no limestone rubble, including stone artifacts.
4. dark clay explored to the depth of 6m, archaeologically sterile

In the publication from 1967, Dzambazov introduced a division into layers marked with the alphabet letters. In his text, he described the layers from A to K. The layers description was as follows (1967b p. 57):

**K.** light gray cave clay interpreted as “soil”, accumulated in warm climate, the level is correlated with the period of “Würm 2/3” (Middle Pleniglacial)

**J.** clay covered by limestone rubble layer which can be correlated with the transition between Würm 2 and 3; the limestone rubble layer decays toward the left side of the cave; clay contains archaeological artifacts

**I.** yellow clay, cultural level containing Szeletian artifacts, correlated with “Würm 2” (Lower Pleniglacial ?)

**H.** cave clay interpreted as “soil”, a leafpoint fragment was found there



At the cave's very bottom there is a level of gravels correlated with the gravel layers of the oldest Iskar river terrace dated to the Eemian.

[illegible]

*Fig.14 Samuilitsa II artifacts inventory with division into layers (from documentation by prof. W. Chmielewski, IUAW collections)*

Sirakov presented the following site stratigraphy description (Sirakov, 1983):

6. *The remains of stalagmitic crust, over ten cm thick, covering only some parts of the top of the clay and rubble series. Both layer 6 and the top of series 6 seem to have been destroyed or seriously damaged during the utilization of the cave as a shelter for domestic animals (...). Thus data relating to these units are particularly unreliable. For example, it is very probable that the series of clay and rubble (5) was in fact somewhat thicker.*

5. *Light red and yellowish clays. Thickness 0.9—1.0 m. In the bottom part of this series some fine limestone rubble also occurs. The top part, on the other hand, ie characterized by the presence of rubble with chunks of a greater diameter. At the top there are also limestone blocks of larger dimensions (probably in the range of 0.3—0.4 m, although individual specimens may be much bigger).*

4. *Reddish clays mixed with a smaller quantity of sand and also probably of fine and medium-sized rubble. Thickness 0.8—1.0 m.*

3. *Sandy clays, light yellow in colour, mixed with fine limestone rubble. Thickness approx. 0.6—0.8 m.*

2. *Sandy clays, dark red and brown in colour, almost devoid of limestone rubble. In the bottom part of this series, directly on the rock bottom of Samuilitsa II, there was an intense rubble layer with large limestone blocks, some approx. 0.6—0.7m in diameter. The general thickness ranges from 0.8—1.5 m.*

1 *Sand interbedded with fine gravel with grain diameter of 2—3 cm. Much of this gravel consisted of rounded chunks and small fragments of flint rocks. The general thickness of the layer was about 3 m. It should be explained that this series rests directly on the rock bottom in Samuilitsa I, forming the top of the sediments of the terrace before the entrance to Samuilitsa II. In Samuilitsa II itself, however, there is probably a lack of rocks from this sequence. 1. (Sirakov, 1983 pp. 8–9).*

It was not until the 1981 publication that Džambanov described all the layers from A to P. The description fits the drawing of Chmielewski, which had been earlier presented in this dissertation (Fig.12).

#### **17. layers O and P** present limestone rubble

**16.** 0.15–0.2m- **layer N**—filled with large flat slabs of limestone, thickening towards the end of the cave

**15.** 0.4m- **layer M**—similar to L, but with smaller, strongly weathered limestone rubble (0.03–0.05 m), in the middle divided by two thin sub-layers of “soil” (ca. 0.03–0.04m thick)

**14.** 0.3–0.5m- **layer L** of yellow-red clay with a large amount of limestone rubble. The layer becomes thinner at the front of the corridor, disappears at the cave’s entrance; contains rare stone artifacts

**13.** 0.4–0.5m- **layer K**—cultural layer, gray and black sandy clay, interpreted as “brown soil”; clearly distinguishable in comparison with other layers, the layer contains a rich stone inventory

**12.** 0.18m- **layer J**—brown-red cave clay, plastic, sinuously arranged, containing organic matter and large amounts of sharp-edged limestone rubble fallen from the walls and the top, the layer corresponds to “middle Würm” (OIS 4)

**11.** 0.4m- **layer I**—sandy clay containing small limestone rubble (average particle size of 0.05m and rarely 0.10m), gravel and manganese nodules

10. 0.32–0.35m- **layer H**—cultural layer, red-brown cave clay with a small amount of limestone rubble; described as “the level of soil”, contains rich stone inventory
9. 0.18–0.2m- **G layer**—red-brown clay with a small amount of limestone rubble, the top sinuously deformed which points to chemical and mechanical denudation
8. 0.35m- **F**—sandy layer, partly composed of clean sand, containing small amounts of limestone rubble; lenses of sand are wavy, dark red and porous
7. 0.1–0.2m- **layer E**—the lower part is clear, loamy and does not contain any rubble. The upper part has a brownish-gray colour, contains scarce stone artifacts
6. 0.2–0.3m- **layer D**—cultural layer consists of brown sandy clay, mixed with a small amount of gravel and flat, heavily broken stones; in the lower part enriched with organic matter and lime precipitation, grayish-brown in colour, probably associated with warmer climate, the layer contains a number of artifacts and animal bones
5. 0.2–0.3m- **layer C**—gravel coloured by limonite and hematite compounds, has sharp-edged limestone rubble especially in the lower part, contains numerous animal bones
4. 0.2–0.25m- **layer B**—composed of sandy clay containing smooth limestone rubble, clay contains brown and lighter lenses and extended horizontal streaks rich in organic matter
3. **layer A**, upper sand layer—cultural level, crossed by narrow fissures (0.03 to 0.06m) with the depth of 0.15 to 0.18, filled with clay from layer B. In the upper part there are lenses of reddish clay up to 0.2m thick, stone artifacts occur in the layer.
2. 0.2–0.25m- yellowish sand filling spaces between rock debris blocks
1. 3m- chalk blocks lying directly on limestone bedrock, the higher the more cracked, archaeologically sterile layer correlated with the Eemian Interglacial.

## Dating

From layer L comes the C14 date of  $42,780 \pm 1270$  uncal BP (Sirakov, 1983). The location of its sampling was described in the publication from 1959 as originating from a layer of yellow clay with limestone rubble, from the depth of 50cm (Dzambazov, 1959 p. 51). Chmielewski, on his profile, marked the sampling spot as layer L, therefore, the date was ascribed to the layer situated above the one with leafpoints (Fig.12). Sirakov referred to the place of sampling as uncertain and, as a result, did not take it into account (Sirakov, 1983).

Dzambazov correlated the entire cave profile with successive periods of the last glaciation. The lowest layer of gravel was dated on the basis of analogy with sediments of the oldest Iskar river terrace as originating from the Eemian Interglacial (OIS 5e). The lower layer A, with sharp-edged limestone rubble, and the sand layers B–F were dated to the Early Vistulian. The clay layers G–I were correlated with “Würm 2” (OIS 4). The layer of limestone rubble which separates levels J and K was correlated with the Upper Pleniglacial (OIS 2)<sup>3</sup> (Dzambazov, 1967b p. 191).

Chmielewski was willing to extend the lower layers chronology. He drew attention to the fact that the layer with leafpoints is set on the border of two deposit series. Above them there are layers of inhomogeneous clay-rubble sediments, whereas below there are layers of multicoloured clays devoid of limestone rubble. Based on analogy with other sites, including

---

<sup>3</sup> Dzambazov did not distinguish or describe this limestone rubble level as a separate layer in a profile (Dzambazov, 1981).

Königsau, Chmielewski correlated the Musilievo and Samuilitsa II layers containing leafpoints with the second Interstadial of Early Vistulian (Brørup) (Chmielewski, 1977).

Sirakov was of the opinion that the lower layers should be undoubtedly correlated with the Early Vistulian, and was willing to place the upper layers in exactly the same period (Sirakov, 1983 p. 10).

### **Profiles correlation**

Dzambazov (1959) described only a very general site stratigraphy. His description, as one may presume from Sirakov's description, concerned only four middle profile layers containing archaeological artifacts (Fig.15). The researcher did not consider in his description the layer located higher, composed mostly of large limestone blocks. In Sirakov's profile description, which was based on Dzambazov's description as it can be seen from Sirakov's publications (Sirakov, 1983), Sirakov divides the profile into 6 layers. He also separated the upper level (layer 6) made of limestone blocks and divided Dzambazov's layer 4 (1959) into two levels—the upper one (layer 2), composed of red clay, and the lower level of gravel and sand (Fig.15).

In an article from 1967, Dzambazov introduced a brand new layer division on the site. He distinguished and described 12 layers (A to F), but according to the author's later publication, as well as from the profile drawing made by Chmielewski, the description related only to the 12 lower levels and did not take into account the layers from L to P, which were only described in the 1981 publication (Fig.15). Owing to the drawing recovered from Chmielewski's documentation, it is possible to accurately recreate stratigraphy and correlate individual levels. Chmielewski's profile does not include the lowest layer of gravel, which, according to Sirakov, was set 4m deep and was more than 2m thick.

The lowermost layer of light clay (A) contains in its lower part big amounts of limestone rubble and numerous blocks. It is probably to be correlated with layer 4 of Dzambazov (1959) and 2 of Sirakov (1983) (Fig.15).

Above, there were several layers of differently coloured sands, with the thickness of about 0.5m. These levels (B–F), together with the overlapping reddish clay layer (G) are likely to be correlated with level 3 of Dzambazov (1959) and Sirakov (1983).

Two layers of dark brown clay located above, and separated by light clay containing limestone rubble probably constitute layer 2 (Dzambazov, 1959) (Fig.15), in which the researcher found a stone inventory containing leafpoints. All highly placed levels of light clays, containing significant amounts of limestone rubble, should be therefore correlated with level 1 of Dzambazov (1959).

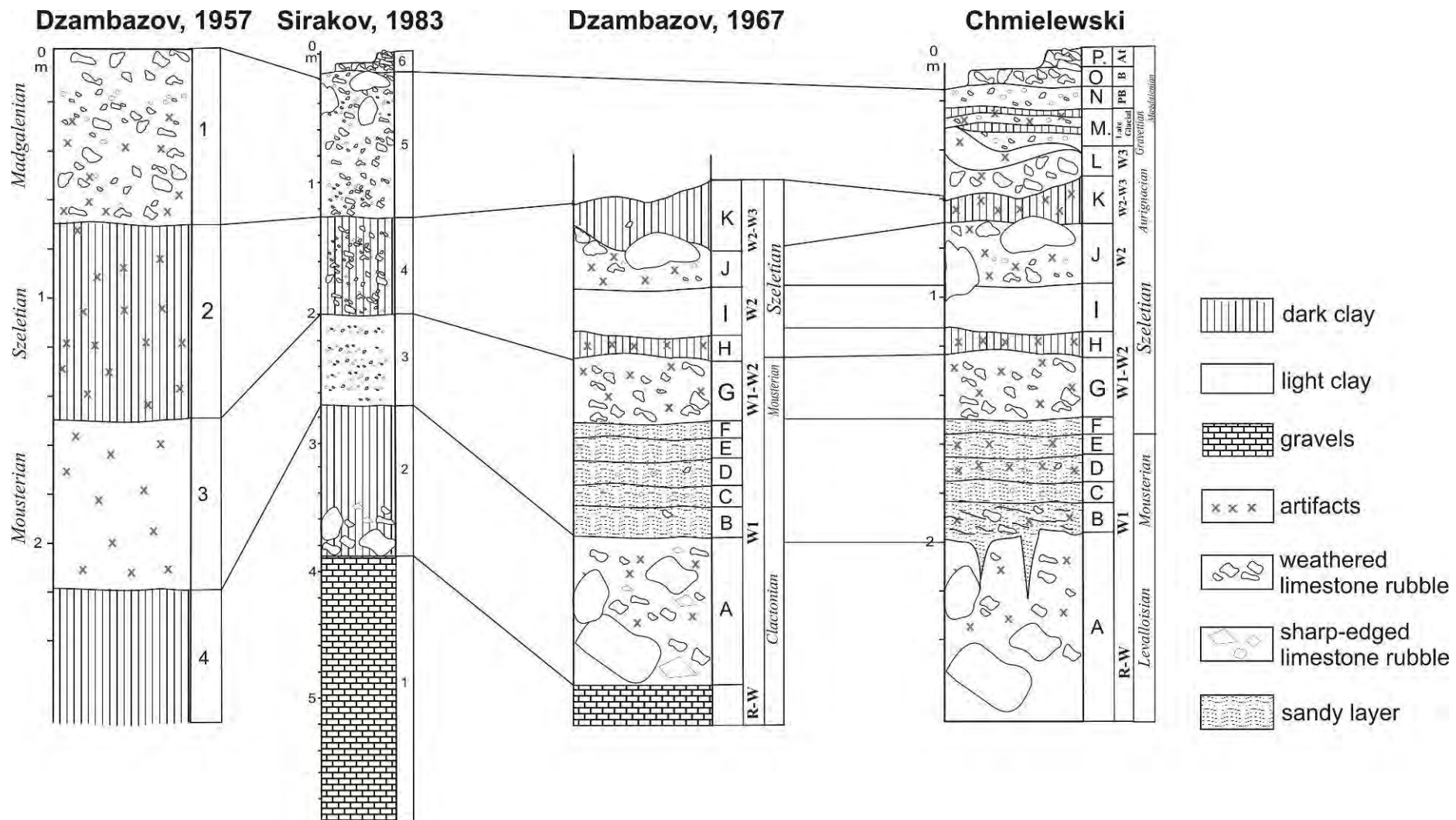


Fig.15 Samuilitsa II profiles correlation.

## Archaeological inventory

Samuilitsa stone inventory includes about 3,000 artifacts (Dzambazov, 1981), but is of selective nature, which is undoubtedly related to the manner of site researching (Sirakov, 1983). Dzambazov distinguished a few archaeological assemblages on the site, of which the most interesting is the one with leafpoints. He was looking for analogies with this assemblage in Szeletian (Dzambazov, 1959; Dzambazov, 1964). Below the layer with leafpoints, he distinguished two earlier settlement horizons, the earliest of which was placed in the lowest layer (A) and was called Clactonian with Acheulean elements (Dzambazov, 1967b). The artifacts from level G were termed as a Mousterian inventory. Above the layers with leafpoints, he distinguished Upper Palaeolithic artifacts which he described as Gravettian (Dzambazov, 1964). In his publication from 1981, he was still willing to separate a Magdalenian inventory, which is also marked on the profile drawing made by Chmielewski (Fig.12) (Dzambazov, 1981).

From the perspective of this thesis, levels I, K, L are of biggest interest as they included bifacially knapped artifacts.

The analysis of Samuilitsa II inventory was carried out by Sirakov in his doctoral thesis. Based on the analysis performed for artificially separated levels, he found that the differences between particular levels are not qualitative but only quantitative. Individual levels' inventories vary in terms of blade technology contribution, and flakes size, but no differing cultural levels can be determined on the basis of those results. The only qualitative element that distinguished the middle levels (5–6), was the presence of leafpoints. Due to lack of access to cores collection, Sirakov analysed the production technology on the basis of flakes and blades (1983).

Sirakov separated two dominant technologies of blank production in the assemblage: Levallois technology (focused on the production of flakes or blades), and blade technology (without Levallois elements) (1983). Frequency analysis showed that, though the involvement of Levallois technology is roughly constant for all levels, there is an increase of blade technology presence in higher levels. Flake technology of discoidal cores played a marginal role according to the quoted researcher.

Moreover, the lower levels are dominated by the use of hard hammer at all stages of core exploitation, while in the upper levels a soft hammer is used at least at the final stage of blanks removing (Sirakov, 1983).

The presence of individual artifact groups does not change, regardless of the layer. The author, however, pointed out a slightly larger presence of Upper Palaeolithic tools (endscrapers and burins) in the upper levels. Nonetheless, they are also present in the lowest levels which the author was willing to associate with low site exploration precision by Dzambazov (Sirakov, 1979; Sirakov, 1983).

In the collection, Sirakov found nine bifacial tools including four fully preserved leafpoints, two leafpoints fragments and three tools with bifacial retouching (including one preform), two side scrapers with a bifacial retouch of one edge. He noted that on levels 5 and 6, where the leafpoints were found, the other artifacts are characterized by a more extensive, multistep retouching or retouching done onto the ventral face (Sirakov, 1983).

Sirakov classified the assemblages from Samuilitsa as belonging to a Mousterian complex with Levallois facies according to Bordes' division (1983).

In the publication from 1977, Chmielewski states that several cultural levels can be observed on the site. In layers I, K, L there are "*slim leafpoints with a blunted edge at a*



*pointed base*” (Chmielewski, 1977 p. 107), which, according to the researcher, is a characteristic feature allowing to correlate the level with the Musilievo inventory. Chmielewski also drawn attention to the significant contribution of Levallois technology and the presence of side scrapers performed on elongated flakes and Levallois blades retouched convergently, which in terms of shape resemble the Upper Palaeolithic retouched blades (Chmielewski, 1977). Below the level with leafpoints, there were at least two Mousterian horizons devoid of bifacially worked tools.

Based on Chmielewski’s notes, an attempt can be made at recreating the original locations of various artifacts (mainly, though, tools and cores) within the layer description adopted by Dzambazov. This paper concentrates only on the location of the very bifacial forms.

The inventory list made by Chmielewski shows that layer G yielded one leafpoint preform, layer I revealed 5 leafpoints (including 2 unifacial), and in layers K and L (treated together) 3 leafpoints were recovered. According to Chmielewski’s figures, three of the analysed artifacts come from levels K/L (CII.63, CII.1116, CII.1117). The artifact CII.1115 still remains problematic. In 1981, this artifact was published by Dzambazov as originating from level G (Dzambazov, 1981, Fig.34.r). It is therefore assumed that in the inventory, this one is determined by Chmielewski as a preform (Fig.14); however, this artifact was not drawn by him.

## 2.1.2. Czech Republic

### 2.1.2.1. Brno Bohunice

Brno Bohunice Kejbalý, an open-air single-layer site, is located within the boundaries of Brno, more precisely on Red Hill (N49°10', E16°35'), as high as 280m amsl, 7km from the Stránská Skála site (Valoch, 1976 p. 5).

Various locations on Red Hill have yielded stone artifacts since the 19<sup>th</sup> century. Single specimens had been published by Karel Valoch as early as in the 1960s (Valoch, 1961). The site itself was discovered during the works done on the construction of a panel factory in 1969. Rescue excavations on the site were being conducted by Drmol and Klíma between 1969 and 1973, and supervised by The Moravian Museum representative, Karel Valoch. The works were done with the use of some heavy-duty equipment, the artifacts had been localized within the designated geological layers (Valoch, 1976 pp. 3–4). Different locations on the site were object of continuous rescue excavations until the early 80s (Nerudová et al., 2003).

Altogether, the artifacts come from four areas marked according to Roman numerals I–IV (Kejbalý I–IV). The most dense artifacts concentration was found on Kejbalý I. Kejbalý IV, located within a brickyard, was placed 70m NW of Kejbalý I (Nerudová et al., 2003 p. 295). The area of Kejbalý IV was once again subjected to archaeological examination in 2002 (Škrdlá & Tostevin, 2005).

As a result of rescue excavations conducted in the 70s and 80s, numberless stone artifacts, animal bones and charcoals have been found. Widespread works enabled quite a thorough recognition of the layer structure organization. The artifacts are to be found within two paleosols dated back to the Middle Pleniglacial (OIS 3). The main area of artifact concentration is placed within the bottom of a soil horizon. The C14 analyses of the archaeological horizon charcoals have yielded dates between 40–43 kya uncal BP (Valoch, 1976 pp. 84–86; Valoch, 1982).

The stone inventory was characterized by a fair presence of Levallois technology with a penchant for flaking prolonged, blade-like forms. At the same time, some of the artifacts included bifacial forms such as leafpoints, as well as Upper Palaeolithic burins and endscrapers (Valoch, 1976 p. 37). When the results were published, a debate ignited, concerning the assemblage's cohesion and its likely origin (Oliva, 1984; J.A. Svoboda & Škrdlá, 1995; J.A. Svoboda, 1983; J.A. Svoboda, 1987; Valoch, 1982). Considerable presence of Levallois elements bearing characteristics of blade processing was especially intriguing, as they were not to be found in any other Central European assemblage. Karel Valoch drew attention to their resemblance to the near-eastern materials as early as in 1970s (Valoch, 1976 p. 115; Valoch, 1982). After the examination of the Stránská Skála site (J.A. Svoboda, Jelinek & Ložek, 1991), which had also yielded plentiful Levallois inventories (without bifacial elements, however), Martin Oliva suggested the creation of a separate complex of assemblages, called Bohunician, in accordance with Valoch's idea (Oliva, 1984). The researcher had granted them the name of the earliest Upper Palaeolithic assemblages. What Svoboda underlines are the discrepancies between the Bohunician and Szeletian assemblages, and the fact that the bifacial artifacts of Brno Bohunice may have originated from the mixing of two separate archaeological horizons. According to him, the Bohunician assemblages include the inventories of Brno Bohunice and Stránská Skála site III, IIIa layer 4 and IIIc (J.A. Svoboda, Jelinek & Ložek, 1991; J.A. Svoboda, 1987; J.A. Svoboda & H. Svoboda, 1985).

New rescue excavations, undertaken in 2002 by the Institute of Archaeology in Brno and the University of Minnesota in the USA were connected with the construction of a



shopping centre. During these works, it was possible to analyse the untouched area of Kejbaly IV site. Their aim was to respond to doubts surrounding the chronological cohesion of the Brno Bohunice assemblages (Škrdla & Tostevin, 2003; Tostevin & Škrdla, 2006; Škrdla & Tostevin, 2005).

Researchers have formulated several likely hypotheses, supposed to explain the formation of the artifact inventory. They ranged from mechanical post-deposit mixing of two separate, sedimentary episodes to technological and archaeological cohesion of assemblages. In order to verify them, precise three-dimensional documentation of all gathered artifacts was undertaken: samples for geological analysis were extracted and C14, TL and OSL dates were obtained (Škrdla & Tostevin, 2005).

### **Stratigraphy**

The layer distribution on the site looked as follows (Valoch, 1976 pp. 7–9):

1. 0.3–0.4m- Holocene humus
2. 1.5–2.5m- brown and yellow loess
3. 0.3–0.4m- brown paleosol, in the bottom 10cm–stone artifacts and charcoals were present
4. 1.5m- pure, bright loess

During the research of 2002, the top level was completely removed and the distribution of the remaining layers was identical. The paleosol layer was divided into two parts and called layer 3 and 4. The top level of 0.3m thickness was characterized by scarce artifacts, whereas the bottom one of 0.4m thickness contained nearly the entire inventory. The junction of both levels was blurred (Škrdla & Tostevin, 2005 p. 36).

### **Dating**

The Brno Bohunice site is considered one of the best dated early Upper Palaeolithic sites (EUP) in Central Europe (Nejman et al., 2011). The very first C14 dates come from the 1970s research. Back then, dates were obtained from coal samples taken from the paleosol layer, as well as from the paleosol profile Cihelna located nearby (Valoch, 1976 pp. 84–86).

All of the acquired C14 dates (8 samples) fitted the following narrow date margin  $40,173 \pm 1200$ – $43,600 \pm 550$  uncal BP ( $42,221$ – $48,219$  cal BP) (Fig.16) (Valoch, 1976 pp. 84–86). The date for the Cihelna profile sample was established in 1985 as being  $36,000 \pm 1100$  uncal BP ( $38,689$ – $42,695$  cal BP).

During the research conducted in 2002, a series of dates was generated. All of the samples (but one) were taken from the lower paleosol layer. The resulting dates were less advanced than those of 1970s, and they fell within the margin of  $32,770 \pm 240$ – $40,050 \pm 360$  uncal BP ( $36,414$ – $44,647$  cal BP). For the upper paleosol layer the following date was obtained:  $29,490 \pm 240$  uncal BP ( $33,440$ – $34,668$  cal BP) (D. Richter et al., 2009; Nejman et al., 2011).

Sample no.	Date	Calibrated age range (2 $\sigma$ )*	Site	Layer	Industry	Year of excavation
OxA-18320	29 490 $\pm$ 240	33 440–34 688	B2002	3	?	2002
ANU 12024	32 740 $\pm$ 530	36 414–38 722	B2002	4	Bohunician	2002
OxA-18302	34 770 $\pm$ 240	38 974–40 596	B2002	4	Bohunician	2002
ANU 27214	35 025 $\pm$ 730	38 576–41 580	B2002	4	Bohunician	2002
GrN 16920	36 000 $\pm$ 1 100	38 689–42 695	Cihelna	4	Bohunician	1985
OxA-18298	36 050 $\pm$ 260	40 641–41 750	B2002	4	Bohunician	2002
OxA-18343	36 540 $\pm$ 310	41 068–42 074	B2002	4	Bohunician	2002
OxA-18303	38 200 $\pm$ 330	42 103–42 183	B2002	4	Bohunician	2002
OxA-18299	38 690 $\pm$ 320	42 408–43 575	B2002	4	Bohunician	2002
OxA-18300	38 770 $\pm$ 330	42 457–43 692	B2002	4	Bohunician	2002
OxA-18301	40 050 $\pm$ 360	43 305–44 647	B2002	4	Bohunician	2002
Q 1044	40 173 $\pm$ 1 200	42 354–45 750	Kejbaly	4	Bohunician	1973
OxA-14845	41 250 $\pm$ 450	44 221–45 591	Cihelna	4	Bohunician	1973
OxA-14848	41 350 $\pm$ 450	44 277–45 649	Kejbaly	4	Bohunician	1973
GrN 6802	41 400 $\pm$ 1 400	42 697–47 484	Kejbaly	4	Bohunician	1973
OxA-14843	42 100 $\pm$ 450	44 707–46 155	Cihelna	4	Bohunician	1973
OxA-14847	42 750 $\pm$ 550	44 961–46 894	Kejbaly	4	Bohunician	1973
GrN 6165	42 900 $\pm$ 1 700	43 846–49 686	Cihelna	4	Bohunician	1973
OxA-14844	43 250 $\pm$ 550	45 264–47 649	Cihelna	4	Bohunician	1973
OxA-14846	43 600 $\pm$ 550	45 525–48 219	Kejbaly	4	Bohunician	1973
Wk-17757	>40 000†	Uncalibrated	B2002	4	Bohunician	2002

\*Calibrated using Intcal.09.

†This is a minimum age; the Waikato Laboratory advises that the standard error overlaps with background within 2 $\sigma$ , so a finite age cannot be calculated.

Data compiled from Richter *et al.* (2009), Svoboda *et al.* (2002), Valoch (1976, 2008) and the present authors' data; all dates are on charcoal.

*Fig.16 C14 dates for Brno Bohunice Kejbaly (after: Nejman et al., 2011, Table 4).*

Additionally, the dating of layer 4 was confirmed by OSL and TL analyses results. It had got the TL dates of 47,3 $\pm$ 7,3 i 48,2 $\pm$ 1,9 kya BP (D. Richter et al., 2000; Valoch, Nerudová & Neruda, 2000) and the OSL dates within the margin of 38,30 $\pm$ 3,0–52,89 $\pm$ 3,81 kya BP (Nejman et al., 2011; D. Richter et al., 2009). The results testify to the fact that the site's dating is older than previously thought; nevertheless, the authors of TL analyses stress the necessity for further dating verification.

Consequently, the inventories of Brno Bohunice may be dated back to early Moershoofd–Oerel/Glinde Interstadials (OIS 3.1–3.3). This conclusion would be also supported by the distribution of artifacts in the paleosol bottom separating two loess levels, which in turn points to artifacts accumulation at the beginning of warm period connected with the paleosol.

### Archaeological inventories

The research done in 1970s provided a wide range of artifacts with the predominance of Levallois technology. The inventory entails numerous Levallois cores, as well as flakes and the site-specific, elongated Levallois points (Valoch, 1976 p. 16). This tendency to manufacture elongated Levallois flakes grabbed the researchers attention and they began to compare Bohunician artifacts with the artifacts of Boker Tachtit level 1 (Israel) as early as in 1980s (Oliva, 1984). A thorough comparative analysis of Levallois technology used in the

refittings from Stránská Skála and Boker Tachtit level 1 was done by Škrdla (Škrdla, 2003; Tostevin, 2003). Because of the similarities in terms of form and technology that he had found, he concluded that both inventories were interlinked with each other. The researcher went even a bit further in forming the conclusion that the Bohunician assemblages are proof to the early migrations of groups of Modern Humans to Europe (Škrdla, 2003).

Except for the Levallois element, the inventory contains bifacial artifacts classified as leafpoints (Valoch, 1976 p. 38). Some researchers have questioned the assemblage cohesion due to the fact that its artifacts from the 1970s inventory lacked flakes typical of this kind of tool manufacturing process (Oliva, 1984).

The Brno Bohunice inventory contains artifacts specific of the Upper Palaeolithic such as burins, endscrapers. The Levallois technology is accompanied by volumetric cores used for blade manufacturing. The assemblage, then, bears mixed Upper and Middle Palaeolithic traits.

The examination of 2002 was aimed at obtaining the largest possible number of artifacts using very precise exploratory methods. During that research, countless stone artifacts were gathered, among them some Levallois cores and flakes. The tools contained nine bifacially worked forms (four of them were said to be leafpoints). What is more, 12 flakes coming from the production of leafpoints were separated in the inventory, which suggests that this kind of tools were manufactured on the site (Škrdla & Tostevin, 2005).

The raw material used for tool production on the Brno Bohunice site was chert taken from two localizations. One of them was a chert outcrop in Stránská skála, the other one was taken from the vicinity of Moravský Les (Škrdla & Tostevin, 2005).

A meticulous raw material analysis had showed that the Levallois technology artifacts were made from Stránská skála chert, whereas all the bifacial forms (except for one flake) were made from Moravský Les chert (Tostevin & Škrdla, 2006). According to Oliva, this may testify to the inventories incohesion (1984).

Škrdla and Tostevin aimed at verifying the hypothesis about the stone inventories homogeneity. Micromorphological analyses showed that the artifacts were not subject to intense post-depositional processes which in turn proves that this could not have influenced the hypothetical mixing of inventories. According to Škrdla and Tostevin:

*“While a small assemblage of non-diagnostic artifacts is present in the Upper Paleosol (only 43 pieces), the Lower Paleosol contains a single vertical distribution of a large number of artifacts (3360 pieces) of about 30–50 cm spread, which is a common phenomenon for sites in pedogenically-altered loessic sediments. This also provides a relative age estimate for the assemblage as either pre-dating the formation of the paleosol, or its contemporaneity if the soil developed while sediment slowly accumulated.”* (D. Richter, Tostevin & Škrdla, 2008 p. 877)

Numerous refittings within the layer also show that the assemblage is in situ (Škrdla & Tostevin, 2005 p. 47). The authors of research have neither noticed any discrepancies in the artifacts composition between their particular concentrations (D. Richter, Tostevin & Škrdla, 2008 p. 877).

Summing up, the information acquired from research resulted in the conclusion that the Brno Bohunice assemblage constitutes a cohesive stone inventory (D. Richter, Tostevin & Škrdla, 2008 p. 877). Consequently, the Bohunician industry would be characterized by both the presence of bifacial artifacts (leafpoints mainly), as well as the use of Levallois technology to obtain elongated flakes.

### 2.1.2.2. Moravský Krumlov IV

The Moravský Krumlov IV site (MKIV) is situated in the area of Krumlovian Forest (Krumlovský Les) region (N49°01', E16°21'). The region is also known for other Palaeolithic sites such as Jezerany, Marsovice, Vedrovice. This mountainous region situated about 40km SW from Brno is rich in chert outcrops, which provided the main raw material for producing artifacts on the MKIV site.

The site is situated in the area characterised by SSE oriented ridges, separated by deep valleys. The site is on the border of a deep Late Pleistocene valley on one of the ridges eastern slope (Nerudová & Neruda, 2004, carte 4). The thickness of the quaternary cover is up to 10m in some places (excavations IV-3).

The site was discovered in 1999 by Martin Oliva from the Moravian Museum in Brno. Partial area deforestation in 2000 revealed patinated artifacts on the surface. In the same year, stationary excavations started and were continued until 2004. During this time, three bigger testing trenches were opened (IV-1, IV-2, IV-3), as well as four smaller trenches (IV-4–IV-7) named “sectors” (Nerudová, 2008). Multiple erosion factors had influenced the site’s stratigraphy due to its location on the slope. The location of particular trenches was dictated by the need to correlate the geological layers and archaeological horizons on the site. For that reason, a detailed profile as well as micromorphological soil samples analyses led by Smolíkova (2009) were of great worth.

#### **Stratigraphy**

From the perspective of the site’s stratigraphy reconstruction, the most important profiles were those of trenches IV-1 and IV-3. In the IV-3 sector, the upper layers were partly destroyed to the depth of 2m by a modern road (Nerudová, 2008). The trench is located between the road and a steep slope which additionally reinforced the upper layers erosion.

In the IV-1 trench, the following geological horizons were distinguished (Neruda, 2009 p. 59) (Fig.17):

- A.** upper humic horizon 5cm thick
- B.** eluvial level which contained non-patinated flint artifacts inventory
- C.** Holocene soil B level
- D.** loess with a lot of bioturbations, strongly mixed
- E1.** bronze-brown paleosol (10YR 3/6); numerous bioturbations; thickness 20–30cm
- E2.** yellow-brown Bt paleosol level, lessive paleosol of albeluvisol type (10YR 4,5/6); visible only in the IV-3 and IV-4 trenches
- F.** Ca-horizon; solifluction horizon mixed with humic substance
- G1.** loess
- H1.** poorly developed first paleosol
- G2.** loess
- H2.** poorly developed second paleosol
- G3.** loess

**I.** redeposited/coluvial loess with chert rubble, detritus of granodiorite and carbonate nodules ( $\text{CaCO}_3$ )

**Ia.** mottled loess containing molluscs shells. Horsak identified the presence of 6 species belonging to moderate steppe fauna type

**J1.** well developed, brown paleosol with carbonate layers; gradually passes to the loess layer below (J2)

**J2.** brown paleosol layer

**K1.** rust-coloured, compact paleosol layer (7,5–10YR 5/6), documented only in boreholes

**K2.** rust-coloured, compact paleosol layer identical to the upper level but containing detritus of bigger mineral grains; gradually passes to the loess layer below

**L.**  $\text{Ca}$  loess level.

The J2–L layers were only found in boreholes. Other are seen on testing trenches profiles. The E–J2 layers slope contrary to the present-day topographical surface. It allows to think that the present-day valley, placed south of the IV-1 trench, did not exist there during the horizons sedimentation process. Only the Holocene horizons A–C have a slope analogous to the present-day one.

Archaeological artifacts were found on three separate levels. The first archaeological level was placed within the D layer, the second within the E layer. They were separated from each other by a sterile sediment of approximately 20cm thickness. There was only one refitting found between those two archaeological horizons (Neruda & Nerudová, 2010 p. 79). The third archaeological level was located in layer I.

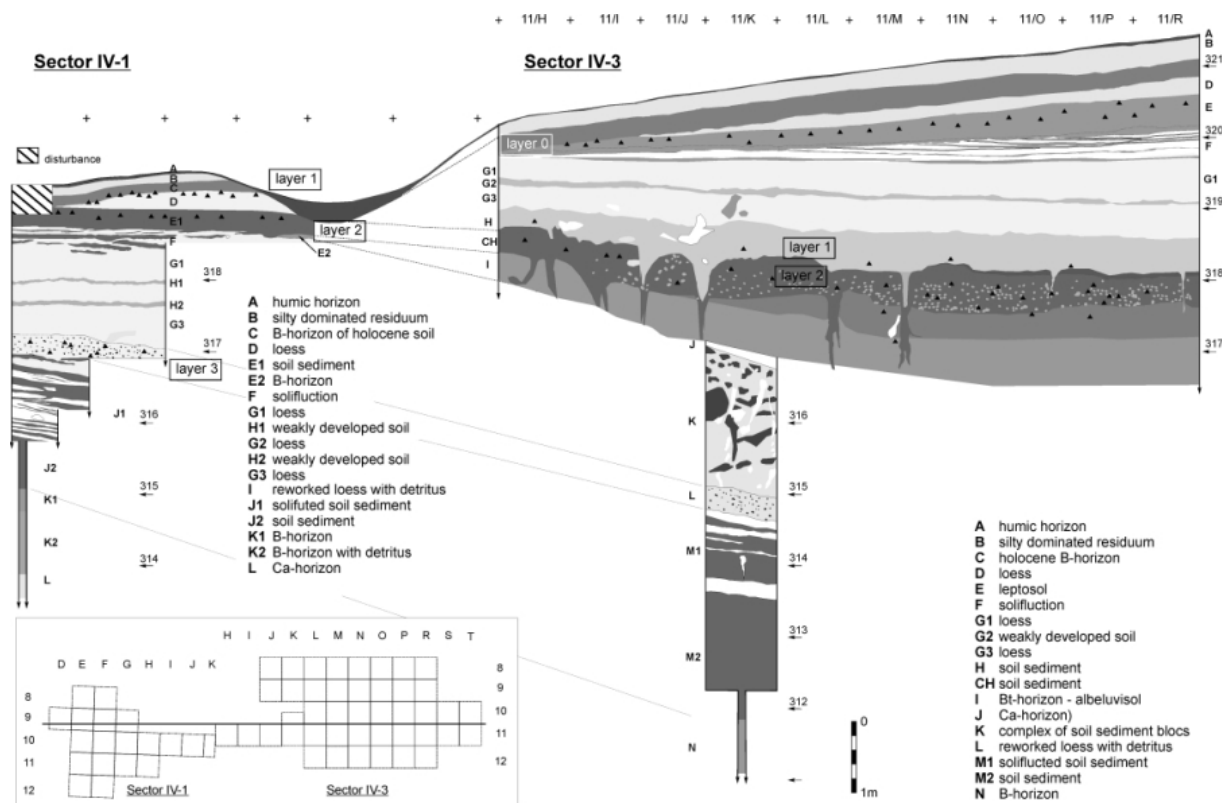


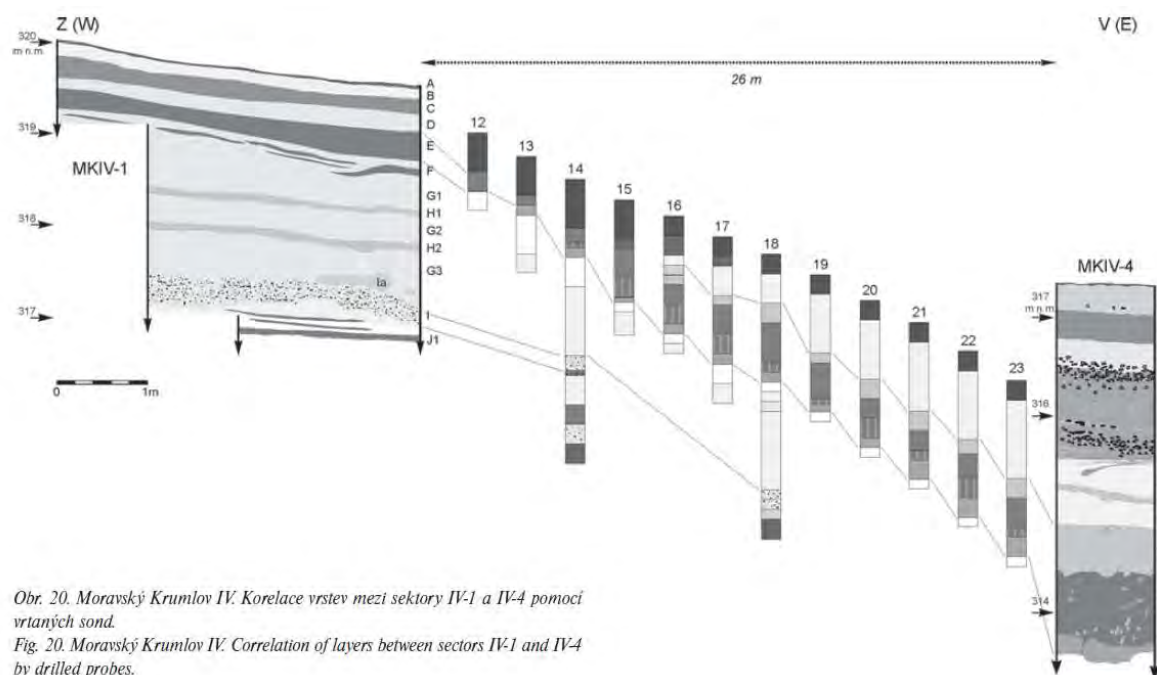
Fig.17 Moravský Krumlov IV: correlation of profiles IV-1 and IV-3. Triangles mark stone artifacts, arrows mark altitude (after: Neruda & Nerudová, 2010, Fig.2).

In the IV-3 trench, in a profile of 11m thickness, three separate complexes of paleosols separated by loess layers were distinguished. A detailed layer system looked as follows (Fig.17) (Neruda, 2009 p. 62):

1. upper humic horizon; 5cm thick
2. eluvial layer, contained non-patinated flint artifacts inventory
3. Holocene soil level B
4. loess with signs of bioturbations
5. para-rendzina divided by horizons composed of carbonate, carbonate detritus and small sized chert rubble existing mainly in the level's floor. Paleosol in the colour of 10YR 4/4, detritus layers in the colour of 10YR 4/6. Layer cut by frost fissures
6. solifluction level composed of sediment E and G1 levels
- G1. loess
- G2. poorly developed paleosol marked by its purple tint
- G3. loess
- H. entisol (10YR 3,5/3,5) of chernozem type
- CH1. dark brown and black paleosol (10YR 2/2), cut by fissures filled with material from the H level and carbonate inclusions
- CH2. paleosol with mugwort process features; rust-brown in colour (10YR3/6), with rusty spots, carbonate nodules, cut by fissures filled with material from the H horizon, which infiltrates the CH/I and I horizons in the shape of a wedge
- CH/I. paleosol analogous to CH2 (10YR 3/6), cut by fissures filled with deposit from the CH2 level and carbonate inclusions
- I. Bt paleosol level, fence podsollic soil (7,5YR 4,5/6)
- J. C<sub>Ca</sub> level
- K. complex divided into blocks by frost cracks
- L. reworked loess with detritus of thicker mineral grains
- M1. solifluction level (7,5YR 4/4–5)
- M2. compact brown paleosol, disturbed by vertical fissures filled with redeposited sediment
- N. B paleosol level of rusty-brown colour, containing chert rubble in the floor
- O. C<sub>Ca</sub> level
- P. loess

All the layers in the IV-3 sector have a slope which is identical to the present-day one, except for the lowest levels which are placed horizontally. The A–C Holocene layers' common thickness is approximately 60cm. The N–P levels were found only in boreholes.

The archaeological artifacts were in the floor of layer D and in the top of layer E (above the first detritus level). A mammoth or a rhinoceros rib was also found in this layer. It occupied the whole thickness of the archaeological horizon (Neruda, 2009 p. 76). The artifacts were also found in the CH paleosol complex.



Obr. 20. Moravský Krumlov IV. Korelace vrstev mezi sektory IV-1 a IV-4 pomocí vrtaných sond.

Fig. 20. Moravský Krumlov IV. Correlation of layers between sectors IV-1 and IV-4 by drilled probes.

Fig.18 Moravský Krumlov IV: correlation of profiles IV-1 and IV-4 with the profiles from drillings. Arrows indicate altitude (after: Neruda, 2009, Fig.20).

As far as archaeology is concerned, the IV-4 trench was also important. The trench profile presented the stratigraphical situation in the site's eastern part. Stratigraphy in the IV-4 sector appeared to be analogical to the one in the IV-3 sector (Neruda, 2009 p. 70) (Fig.18):

1. upper humic horizon of 5cm thickness
  2. eluvial level, contained non-patinated flint artifacts inventory
  3. Holocene soil level B, containing patinated artifacts, it is the top of the first archaeological level
  4. loess with the signs of bioturbations, archaeological artifacts can be seen in the floor of this layer
  5. paleosol in the type of para-rendzina, divided by levels composed of carbonate, small rock pieces detritus and small sized chert rubble (mainly in the floor of the level). It contains archaeological artifacts in the layer's top. The archaeological level is in the colour of 10YR 4/4, detritus layers within the sediment are in the colour of 10YR 4/6. The level is cut by frost fissures.
  6. solifuction level built of the E and G1 layers deposit
- G1.** loess
- G2.** poorly developed paleosol marked by its purple tint
- G3.** loess
- H.** entisol (10YR 3,5/3,5) in a chernozem type
- CH1.** dark brown and black paleosol (10YR 2/2), chernozem type, cut by fissures filled with material from the H layer and with spotted soil sediment



## CH2. paleosol

I. Bt paleosol level of, pseudopodzolic soil/lessive soil

J. Ca level

The archaeological artifacts were found on the border of D and E layers and in the CH layer.

## Dating

The layers were dated with the help of C14 and OSL analyses. All samples were taken in the IV-3 trench. The samples for C14 analysis were obtained from layer E (Davies & Nerudová, 2009). Three of them were taken from the charcoals of *Picea/Larix*, one (GrN 28451) from the rib of a rhinoceros/mammoth. The charcoal samples gave very similar results ( $36,820 \pm 250$ – $38,350 \pm 310$  uncal BP ( $41,818 \pm 299$ – $42,585 \pm 337$  cal BP) (Fig.19). The bone sample, due to insufficient collagen content, gave a date specified for  $>24,950 \pm 570$  uncal BP ( $>29,749 \pm 643$  cal BP) (Fig.19).

OSL samples were collected also from the IV-3 trench (Nejman et al., 2011). A total of six samples were collected: two samples from layer E, and one sample from each of the following: G1, H, CH and L (Neruda Nerudová, 2010, p.159). The samples from layer E gave the dates of  $43.6 \pm 3.3$  kya BP and  $64.6 \pm 7.0$  kya BP respectively. While the first sample dating results correlate well with the results of C14 analyses, the date for the second sample seems to be too old. The first sample came from the archaeological level's top, whereas the second one from the layer's floor. Nejman however, points out that the sample may have been contaminated with detritus while being taken, which could have negatively affected its dating (Nejman et al., 2011 p. 18).

A sample from the sterile G1 loess layer gave the date of  $93.2 \pm 7.3$  kya BP. The paleosol H layer was dated to  $97.2 \pm 7.3$  kya BP, while the CH layer located below, which includes archaeological artifacts, was given the date of  $115.3 \pm 8.8$  kya BP. These dates locate the complex of H and CH paleosols in the Eemian Interglacial (OIS 5e). The sample taken from the L loess layer gave the date of  $151.4 \pm 13.8$  kya BP, which allows to assign this layer into the middle stages of OIS 6.

All OSL dates are arranged in chronological order and provide a coherent dating line for particular geological and archaeological horizons.

	Lab. #	Date	+	-	$\delta^{13}\text{C}$	Calendar age (cal BP)
145 cm below surface, layer E, level 0; sector 3, sq. m. 10/Sb	OxA-18297	36820	250	250	-23.55	41816 $\pm$ 299
130 cm below surface, layer E, level 0; sector 3, sq. m. 10/Ta	OxA-18294	37550	280	280	-23.72	42175 $\pm$ 324
	OxA-18295	37980	290	290	-23.45	42392 $\pm$ 329
	OxA-18296	38350	310	310	-22.89	42585 $\pm$ 337
120 cm below surface, sector 3, sq.m. 10/S–T	GrN-28451	24950	570	530		29749 $\pm$ 643

Fig.19 The results of C14 dating of the samples from Moravský Krumlov IV (after: Davies & Nerudová, 2009, Tab. 2).



## Profiles correlation

Due to the site's location on a slope, researchers found it very difficult to correlate individual trenches' profiles (Neruda & Nerudová, 2010 p. 155). Both the layers and the artifacts were subject to erosion, as indicated by the layers' slope as well as by the presence of laminated solifluction layers (e.g. F).

So far, it was not possible to make a complete correlation between the layers in testing trenches IV-5–IV-7 and the layers in trenches IV-1 and IV-3 (Neruda, 2009 p. 74). Due to the layers' thickness, the IV-3 trench profile was taken as a reference point. Individual layers also underwent a meticulous micromorphological analysis. Palynological samples were collected and the C14 and OSL dating was performed.

The layers in the IV-4 trench seem to be perfectly correlated with the profile of the IV-3 trench, but the IV-1 trench, located even closer to IV-3, caused the most problems to the researchers. There is a modern road between the two trenches which destroyed the upper layers by cutting into the slope. Owing to geological drillings, it was possible to catch the correlation between the layers in trenches IV-4 and IV-1 (Fig.18). The paleosol (layer CH) in IV-4 correlates with layer E of the IV-1 trench. These results showed that in the IV-3 trench, the Vistulian layers are probably much more developed. The correlated paleosol (layer CH) in profile IV-4, and even more in IV-3, is well developed and consists of three paleosol sub-layers (Fig.17) (Neruda, 2009 p. 74).

The second correlation was made between paleosol–layer J in the IV-1 trench and layer M in the IV-3 trench (Fig.17). Both are characterized by the presence of solifluctious film on the sediment's surface and an overlapping loess layer (Neruda, 2009 p. 81). In this case, one also has to deal with a much more developed profile with at least three paleosol sub-layers in trench IV-3, and with a much less developed and less thick paleosol layer in trench IV-1.

## Archaeological inventory

If the interpretation by Neruda (2009) is valid, only the archaeological horizon in layer E of the IV-1 trench may be correlated with the layer CH of trenches IV-1 and IV-4. Other archaeological levels do not correlate with one another, and researchers treat them separately (Neruda & Nerudová, 2010 p. 160). In total, therefore, researchers distinguished four archaeological horizons, and this dissertation will concentrate on one of them, namely the highest archaeological horizon level known as 0.

### Level 3

Discovered in redeposited loess layer (I) in trench IV-1. Due to the correlation of layer I with layer L in trench IV-3, it can be dated to  $151,4 \pm 13,8$  kya BP (OIS 6). The scarce assemblage consists of 43 artifacts, dominated by debitage (Neruda & Nerudová, 2010, Fig.160). The artifacts are made of local cherts. The cores exhibit both Levallois and discoidal exploitation features (Neruda & Nerudová, 2010, Fig.4).

### Level 2

Discovered in layers E of the IV-1 trench and CH in trenches IV-1 and IV-4. Based on OSL analyses, dated to  $115.3 \pm 8.8$  kya BP. Palynological analysis showed the presence of the following plant species: *Pinus sylvestris*, *Pinus cembra*, *Quercus*, *Frangula*, *Picea/Larix*, *Salix*, *Pomoid/Sorbus*, *Juniperus* and *Rhamnus*, *Polypodiaceae*, which indicates steppe and forest steppe ecosystem. Species such as *Botryococcus*, *Pediastrum integrum*, *Pediastrum* cf.

*kawraiskyi* point to cool climate-based deposition, but also to the presence of oligotrophic lakes (Dolakova, 2009; Novák, 2009).

Among the 947 artifacts, almost all are made from local cherts (Neruda & Nerudová, 2010, Fig.163pp). Debitage accounts for more than half of the inventory. Cores are characterized by a discoidal or subdiscoidal exploitation with clearly distinguished striking platform and flaking surface (Neruda & Nerudová, 2010, Fig.5). In one case, a sub-prismatic, single-platform core is being dealt with (Neruda & Nerudová, 2010, Fig.5.5). Among the few tools, side scrapers with traces of bifacial knapping prevail (Neruda & Nerudová, 2010, Fig.6).

### **Level 1**

It is present in layer D of the IV-1 trench correlated with layer H from the IV-3 trench (Neruda & Nerudová, 2010 p. 166). On this basis, it is dated back to Early Vistulian (the OSL date of  $97.2 \pm 7.3$  kya BP). Charcoals of *Quercus* and pollens of *Pinus sylvestris*, *Pinus cembra*, *Betula*, *Salix*, *Ulmus*, *Asteraceae*, *Ranunculaceae*, *Galium*, *Poaceae*, *Plantago*, *Thalictrum*, *Cyperaceae*, *Saxifraga*, *Artemisia*, *Chenopodiaceae*, *Daucaceae*, *Sedum* and *Ephedra* indicate moderate and cold climate (Dolakova, 2009; Novák, 2009).

Among the 1073 artifacts, over 60% consist ofdebitage. The cores were exploited in a discoidal or sub-prismatic strategy. Among tools, there are bifacial forms and their preforms (Neruda & Nerudová, 2010, Fig.7), simple side scrapers and other flake tools.

### **Level 0**

From the perspective of this dissertation, level 0 is the most important one, discovered in the floor of layers D and E in trenches IV-3 and IV-1 (Neruda & Nerudová, 2010 p. 168). The level was directly dated with C14 (41,800–42,950 cal BP) and OSL method (43.6 and 64.6 kya BP). The last date, as mentioned above, comes from the archaeological layers' floor and could have been contaminated by the admixture of detritus from the lower levels.

Altogether, this level contained 6007 artifacts. The entire inventory is made on local cherts. More than 80% isdebitage, mostly flake fragments. Besides them, slabs of raw material used as hammerstones and retouchers with usewear were recovered. In their morphology and exploitation method, the cores are similar to those of the archaeological levels 1 and 2. The manufacturing technology was based on the reduction of subprismatic and discoidal cores (Neruda & Nerudová, 2010 p. 168). Rounded raw material nodules favoured the sub-prismatic cores reduction strategies and parallel flaking even without prior preparation of the striking platform (Neruda & Nerudová, 2010 p. 168). The inventory includes, apart from flake tools, side scrapers, denticulated tools, as well as bifacial tools and their preforms.

The refittings analyses allowed to describe the bifacial knapping technology typical of this site (Nerudová & Neruda, 2004; Neruda & Nerudová, 2005). It was based on blunting one of the edges with abrupt removals. Such abrupt surface formation created a convenient angle for deriving further flat removals on both tool sides which were aimed at reducing nodule thickness, while maintaining its dimensions as much as possible (length and width), for the raw material is here present in the form of small sized blocks (Neruda & Nerudová, 2010 p. 171).

Bifacial artifacts from level 0 are described as leafpoints and the entire inventory, on the basis of dating and by analogy with Vedrovice V inventories, was included into the Szeletian horizon (Neruda & Nerudová, 2010 p. 171; Neruda & Nerudová, 2009).

### 2.1.2.3. Vedrovice V

An open-air site located 40km SW of Brno in the Krumlovský Les (Krumlovian Forest) region (N49°012, E16°212). It is located on the eastern slopes of the boundary between two geographical units: Bobcava Drncolec Hill and Bohemian-Moravian Highlands. From the geological perspective, Krumlovský Les belongs to Brno Kromauer Eruptivmasse.

The site was discovered during the exploration of a Neolithic cemetery, run since 1961 by Ondruš. In 1981, in a very deep trench patinated stone artifacts were found at a depth of 90cm (Valoch, 1984a p. 5). Karel Valoch, summoned to the site, identified the artifacts location in a 30cm thick paleosol. From the next season, rescue excavations focused on exploring Palaeolithic artifacts were started. During the study, big trenches of a total area of over 260m<sup>2</sup> were excavated. This was made possible but also necessary thanks to the site's location on a state-owned farm, where a peach orchard was supposed to be planted. Studies were resumed on the site for one more season in 1989. Then, a 30m<sup>2</sup> trench was located between rows of trees. The layer containing archaeological artifacts was only slightly affected during agricultural work thanks to its deep placement (Valoch, 1993). In total, more than 17,000 stone artifacts were excavated. They were located in a coherent, ca.10cm thick horizon at the base of paleosol layer (Nerudová, 2000).

#### Stratigraphy

##### Profile.1 (Fig.20.1)

The profile of 1982 trench. It was a reference point for the other ones due to the most extensive nature of its archaeological levels (Valoch, 1993)

1. 40cm- Holocene humus
- 2a. 20–25cm- light/fawn carbonate loess with numerous caverns with the diameter of about 3cm. Includes CaCO<sub>3</sub> nodules
- 2b. 20cm- slightly darker carbonate loess with traces of strong animal bioturbations (crotovinas). Includes carbonate nodules (CaCO<sub>3</sub>). Discontinuous boundary. Light-fawn loess between crotovinas
- 2a. 15–20cm- carbonate loess with strong traces of bioturbations (crotovinas) filled with loess of the same or darker colour. Discontinuous boundary underlined by a cemented calcium carbonate layer and multiple nodules of variable thickness of about 5cm
3. 30–35cm- tripartite layer of fossil soil. The highest layer is dark brown with polymorphic carbonate nodules. A middle, dark, sandy layer has the thickness of about 3cm. The lowest dark brown layer is lighter than the overlapping ones. Brighter colours can be associated with traces of bioturbations. The soil floor level is lightened due to its enrichment with calcium carbonate (carbonate nodules and pseudomycelia-threadlike carbonate concentration are present here). In the floor of that layer stone artifacts were found in a coherent horizon of about 10cm thickness
4. 30cm- loess layer horizontally laminated with thin layers of fine carbonate nodules with the diameter of about 0.5cm.

### **Profile 2 (Fig.20.2)**

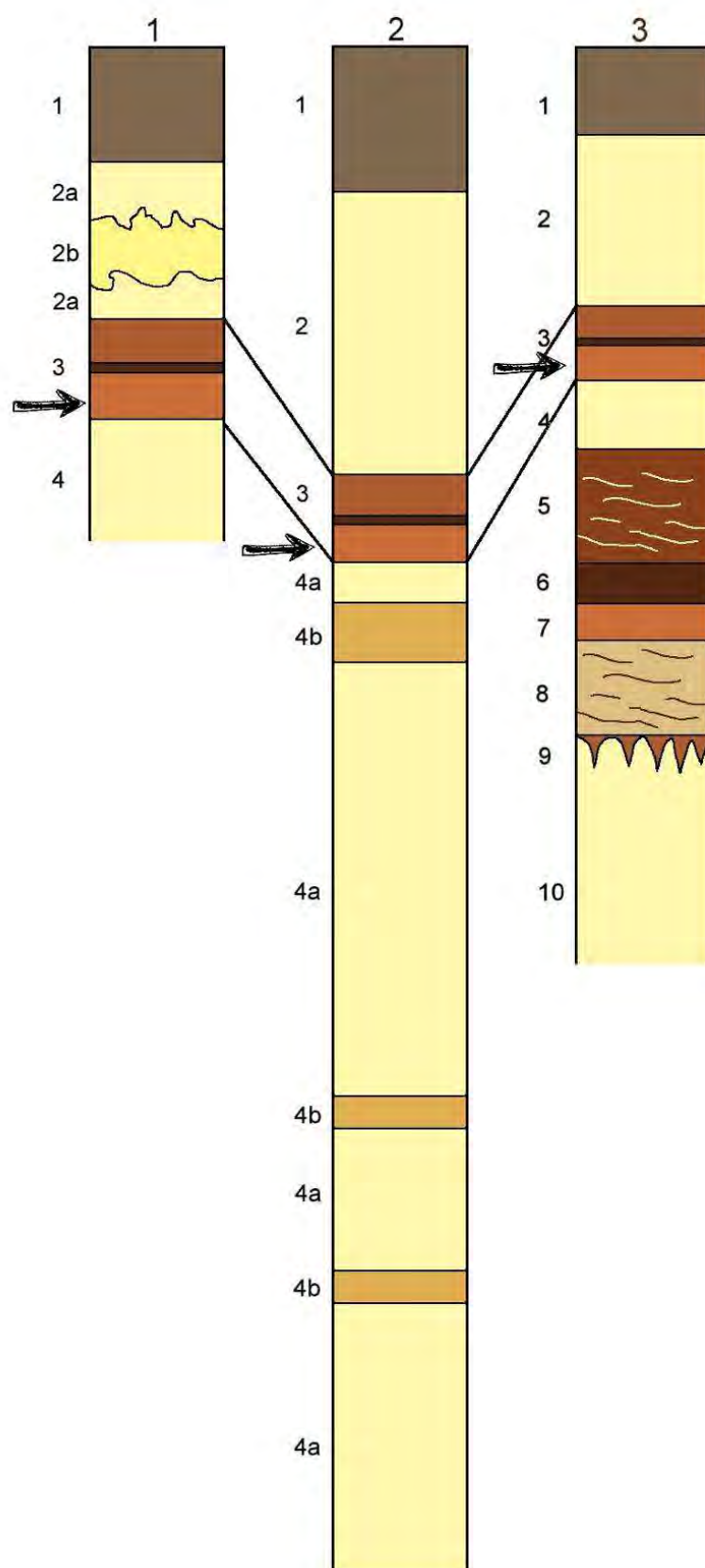
Profile obtained in the cross-section of a Neolithic object where the first artifacts were found in 1981. Research during the excavations was placed in such a way that the object constituted the central point, and could have been a reference point for the archaeological horizon location (Valoch, 1993).

1. 40–60cm- humus layer (Holocene soil with the B level preserved *in situ* in some places)
2. 100cm- light loess with crotovinas and numerous small carbonate concretions and pseudomycelium
3. 30–35cm- brown-colored paleosol with a thin layer of rock detritus in the middle, dividing it into two parts; archaeological artifacts located at the layer's base
- 4a. 15cm- light loess, heavily saturated with calcium carbonate to form dense, flat nodules.
- 4b. 20cm- light-brown entisol of a loess structure
- 4a. 150cm- loess with numerous bioturbations
- 4b. 10cm- light-brown entisol of a loess structure, gradual transition to the layer below
- 4a. 70cm- loess with lenses of sand in the lower part and single manganese concretions; traces of bioturbations
- 4b. 10cm- light-brown entisol of a loess structure
- 4a. 100cm- loess containing an admixture of coarse-grained sand (grain size up to 3mm in diameter).

### **Profile 3 (Fig.20.3)**

Profile of a trench located 60m to the SW of the main 1982 trench.

1. 30cm- Holocene soil
2. 60cm- light carbonate loess with numerous traces of crotovinas and bioturbations
3. 25cm- brown palesol with sand (*Detritussand*), single stone artifacts
4. 25cm- loess with traces of bioturbations
5. 35–40cm- black-brown paleosol containing lighter, compact loess laminates (2–15mm in thickness) cemented by calcium carbonates
6. 15cm- dark brown humus level of paleosol
7. 10cm- level C<sub>Ca</sub>, laminated (laminates of up to 2cm thickness), containing polymorphous carbonate nodules.
8. 35cm- light-coffee coloured paleosol with darker thin layers
9. 15cm- transition layer
10. 10cm- light loess with polymorphous carbonate nodules.



*Fig.20 Vedrovice V simplified profiles summary. Layers description in the text. Archaeological level indicated with arrows (after: Valoch, 1993, Abb. 3).*

## Profiles correlation

A characteristic feature present in all the profiles is a triple paleosol horizon with a thin sandy detritus layer. In the bottom part of paleosol stone artifacts were recovered. Above the paleosol horizon in all profiles, there is a loess layer of varying thickness (from 60cm in profile 3 up to 100cm in profile 2). Below the paleosol horizon there is also the loess layer. Profile 2 is deeper and shows the arrangement of subsequent loess layers separated by residual paleosol horizons. In profile 3, at a depth of about 150cm, there is a paleosol layer (layers 5–9), which was interpreted by Valoch as being an Early-Vistulian–Eemian paleosol complex (PKIII + II) (Valoch, 1993 p. 13). The same layers were not reported in profiles 1 and 2, which may be the result of erosion. Unfortunately, this paleosol horizon was not dated.

## Dating

The archaeological horizon chronology was established in the 80's through a series of C14 dates (Fig.21). Of the seven samples, four were taken during excavations in the years 1982 to 1983 and come from hearths accompanying stone artifacts. The last three samples were collected in 1989, and the authors of the study had had some reservations about them (Valoch, 1993). The GrN 17261 sample could have been contaminated, and the GrN 19015 and GrN 19106 samples were supposed to originate from the layers above and below the level of archaeological significance (Fig.21). The most reliable dates were obtained from hearth coal samples, which gave the results of 38,791–45,174 cal BP (Valoch, 1993).

Recent OSL dating results posed a question over the previous carbon dating. On the site, just 10m away from earlier excavations, a new testing trench was opened for sampling. Its stratigraphy corresponds to that of profile 1 from the excavations (Fig.20) Three samples were taken for analysis. The first (K0668) came from a detritus layer placed above the archaeological level and gave the result of  $45.09 \pm 2.49$  kya BP. Two other samples (K0669, K0670) were taken respectively from the top and floor of the archaeological horizon and gave the results of  $60.28 \pm 3.42$  kya BP and  $102.10 \pm 6.79$  kya BP (Nejman et al., 2011 p. 18).

Such old dates, especially in the context of similar results obtained for sites such as Moravský Krumlov IV and Stránská Skala (Nejman et al., 2011, Table 7), may indicate that the industries with leafpoints should be dated even before the OIS 4 Pleniglacial. However, the authors of OSL dating project (Nejman et al., 2011 p. 18) point to the fact that the results do not date the very artifacts, but the layer in they were found in. Thus, there are also possible alternative explanations of the obtained results. Samples from the archaeological horizon provide dates of about 55,000 years divergence between samples placed only 30cm deep. It can, therefore, be assumed that we are dealing with an Interglacial paleosol here, which is not preserved in the profile—it eroded, and the K0670 date would relate exactly to this very Eemian paleosol. One can also accept the hypothesis that settlement in Vedrovice V began at the top of the Interglacial paleosol horizon, which was a substrate for the Middle Pleniglacial layer that was being formed in between. This hypothesis would be sustained by the fact that the paleosol is located directly above the solifluction level (Nejman et al., 2011 p. 19).

Micromorphological analysis helped to determine the paleosol as being a chernozem/para-rendzinas soil type, and its dating, analogical to Praha-Sedlec, Modric, Bohunice and Vedrovice II as being the soils of the Stillfried A complex (PK II) (Valoch, 1993).

<i>Sample no.</i>	<i>Date</i>	<i>Calibrated age range (2σ)*</i>	<i>Industry</i>	<i>Year(s) of excavation</i>
GrN 15513	35 150 ± 650	38 791–41 465	Szeletian	1982–3
GrN 15514	37 600 ± 800	41 084–43 450	Szeletian	1982–3
GrN 12374	37 650 ± 550	41 519–43 087	Szeletian	1982–3
GrN 12375	39 500 ± 1 100	42 064–45 174	Szeletian	1982–3
GrN 17261, sample contaminated with recent rootlets	30 170 ± 300	34 405–35 267	Szeletian	1989
GrN-19105, sample originated from a layer above the archaeological horizon	>39 500	Uncalibrated	Szeletian	1989
GrN-19106, sample originated from a layer below the archaeological horizon	47 250 ± 3 700–2 500	Uncalibrated	Szeletian	1989

\*Calibrated using Intcal.09.

Data compiled from Valoch (1993); all dates are on charcoal.

*Fig.21 Vedrovice V C14 dates (after: Nejman et al., 2011, Table 6).*

### **Archaeological inventory**

On the site, a total of 17,064 stone artifacts were found, including 709 tools. The artifacts were being documented during excavations in three dimensions, which allowed the authors to make refittings and further interpret the scattering process and the postdepositional movement of artifacts within the layer. Numerous artifacts had frost fissure traces (Nerudová, 2000). Most artifacts were made in local cherts, only very few in radiolarite and flint.

The inventory is dominated by the use of flake technology, with specific uniplatform flake cores mainly. The assemblage also contains single Levallois cores (Nerudová, 2000).

Among the artifacts, side scrapers are the most numerous group. In addition to that, denticulated and notched tools were found as well. Endscrapers and burins are very scarce (Nerudová, 2000). Apart from flake tools, the inventory also contains bifacial tools classified as “leafpoints” (Valoch, 1993).



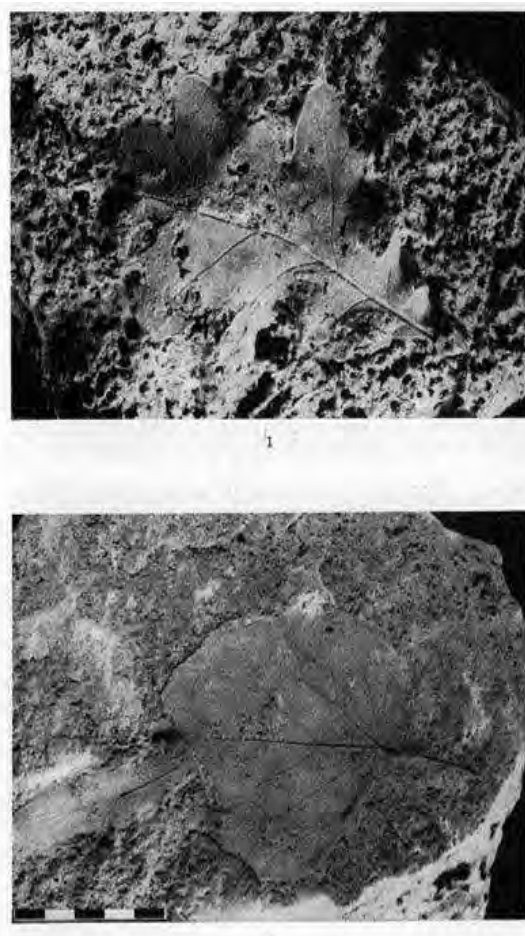
## 2.1.3. Germany

### 2.1.3.1. Ehringsdorf

Ehringsdorf is a Pleistocene site in Germany, one of the most well-known in the literature, most widely commented upon and interpreted. It is located in a travertine quarry near Weimar, in the valley of the River Ilm (Ilm Valley Graben) in Thuringia.

The first description of Ehringsdorf travertines dates back to the 18<sup>th</sup> century (J.C.W.Voigt, 1781 after: Behm-Blancke, 1960). Later, the outcrop attracted Johann Wolfgang Goethe, who drew one of the first schematic drawings of its sections.

Even before the Second World War, Soergel made a description of the site's stratigraphy, which became a reference point for future research (Soergel, 1926; Soergel, 1940). He separated the profile into the upper and lower travertine layers, divided by a layer known as Pariser Horizon. In addition to that, according to him the upper travertine layer was divided by the so-called Pseudopariser layer (Fig.23). Until today, geological research is being conducted in the quarry, seeking to establish a detailed layers stratigraphy and chronology (Blackwell & Schwarcz, 1986; Bridgland, Schreve, Keen, Meyrick, & Westaway, 2004; Brunnacker, Jager, Hennig, Preus, & Grun, 1983; Cook, Stringer, Currant, Schwarcz, & Wintle, 1982; Frank, 1997; Mania, 1988; Schreve et al., 2002; Schwarcz, Grun, Latham, Mania, & Brunnacker, 1988; Schäfer, Heinrich, Bohme, & Steiner, 2007; Steiner, 1979; Wagenbreth & Steiner, 1974).



*Fig.22 Fossilized flora remains preserved in the travertines (Behm-Blancke, 1960, Taf. XIX).*

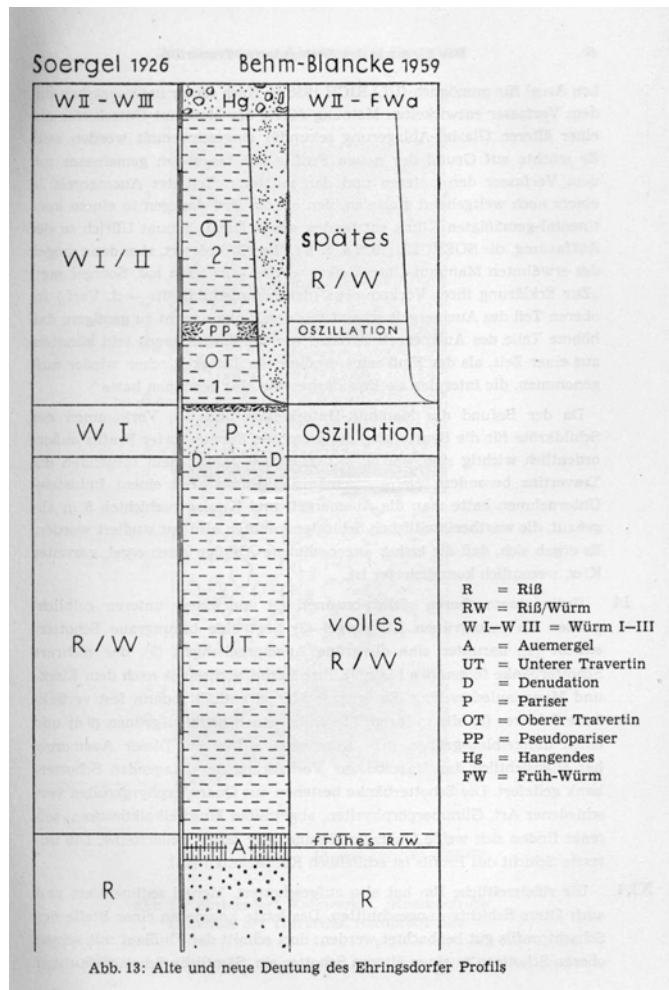


Fig.23 Summary stratigraphy of Ehringsdorf travertines from Soergel and Behm-Blancke investigations; Hg-tracks conical; OT-upper travertines; PP-"Pseudopariser" layer; P-"Pariser" layer; D- denudation level; UT-lower travertine layer; AA-Auemergel (marl clay) (after: Behm-Blancke, 1960, Abb. 13).

Animal remains, intact fossilized flora remains (Fig.22) and flint artifacts are found on the site, mainly in the lower travertine layers. The 20<sup>th</sup> century quarry was divided among several owners: Fischer, Haubold and Kampf. The artifact findings were located and described as coming from a particular quarry, from a specific layer. A discussion on the chronology of flint assemblages and their cultural classification began as early as in the 20<sup>th</sup> century. Wiegers (1913 after: Behm-Blancke, 1960) described them as belonging to Weimar culture (Weimarer Kultur) by treating together all artifacts originating from different site layers (Behm-Blancke, 1960).

The beginning of the 20<sup>th</sup> century witnessed an intensified interest in the site, when it began to yield not only fossilized flora and fauna remains and stone artifacts, but also human remains. The first remains were encountered already in the 19<sup>th</sup> century, though the most important discoveries were made in the years 1908–1925. During this period, in the quarry of Fischer and Kampf, in the lower travertine layer, remains of at least 6 individuals were discovered. Their anatomy was thoroughly analysed (Virchow, 1920, Weidenreich et al., 1928 after: Behm-Blancke, 1960; Vlček, 1993). Initially, the remnants were interpreted as Neanderthal. Today, it is assumed that the remains belong to the pre-Neanderthal specimen (Vlček, 1993).

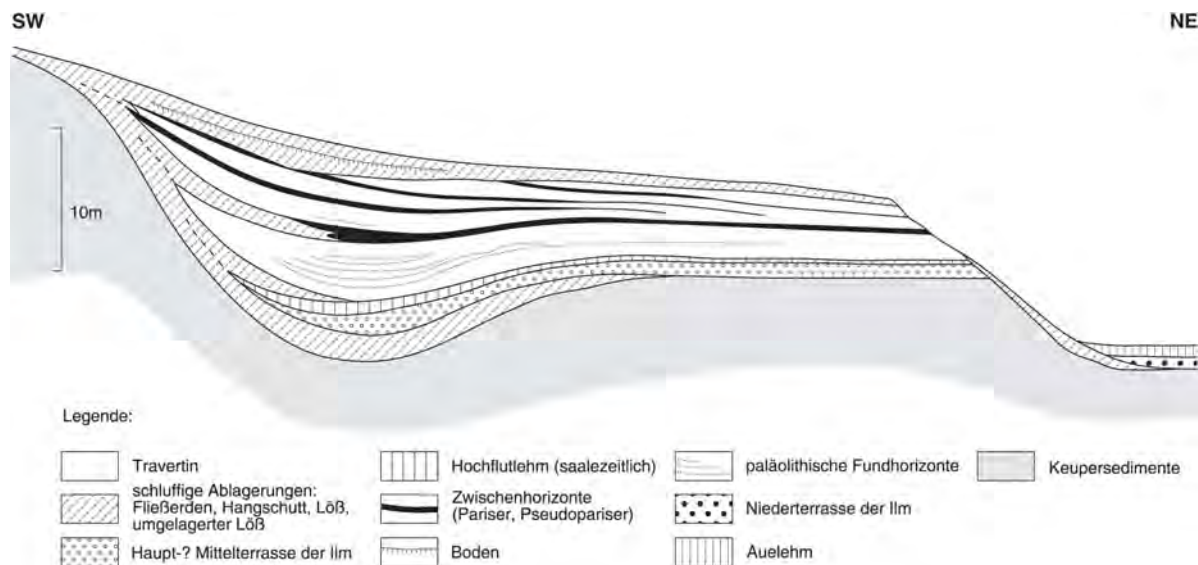


Fig.24 Revised schematic layers arrangement on the Ehringsdorf site (Dietrich Mania & Altermann, 2003 after: Steiner, 1976).

On the site, because of its location in the travertines, conducting regular archaeological excavations is almost impossible. The study was carried out between 1957–1959 by Behm-Blancke in several places throughout the quarry, but the richest in artifacts was the so called “central area” of the Kämpf quarry. Within the lower travertine layer Behm-Blancke distinguished several (depending on the location–up to 10) levels of “hearths”, the so-called *Brandschicht*. Here, flint artifacts were found.

Archaeological artifacts were also collected during subsequent geological research; some were found incidentally. In the years 1993–2003, during the mining operations a new archaeological level was discovered within the upper travertine layer (Schüler, 2003). Currently, the collection of the Museum in Weimar possesses several thousand of artifacts. The entire inventory is still being researched.

The site was formed in the vicinity of a spring rich in minerals. The minerals precipitated, thus forming subsequent travertine layers. The layers creation must have been very quick, because the rocks are not only rich in imprints of bones, but also plant macroremains such as leaves (Fig.22), or fossilized tree trunks preserved to the height of over a metre. For this reason, the site is an extremely valuable source of information for paleoclimatic-ecological reconstructions, as well as for very detailed archaeological and micro-stratigraphic analyses. However, due to the rocks considerable hardness, it is difficult to develop a suitable mining method which would allow for capturing and separating all the concentration layers. So far, the excavations were carried out with a controlled use of dynamite.

## Stratigraphy

Soergel profile (1926):

1. tracks conical (Hg)
2. upper travertines upper layer (OT2)
3. "Pseudopariser" layer (PP)

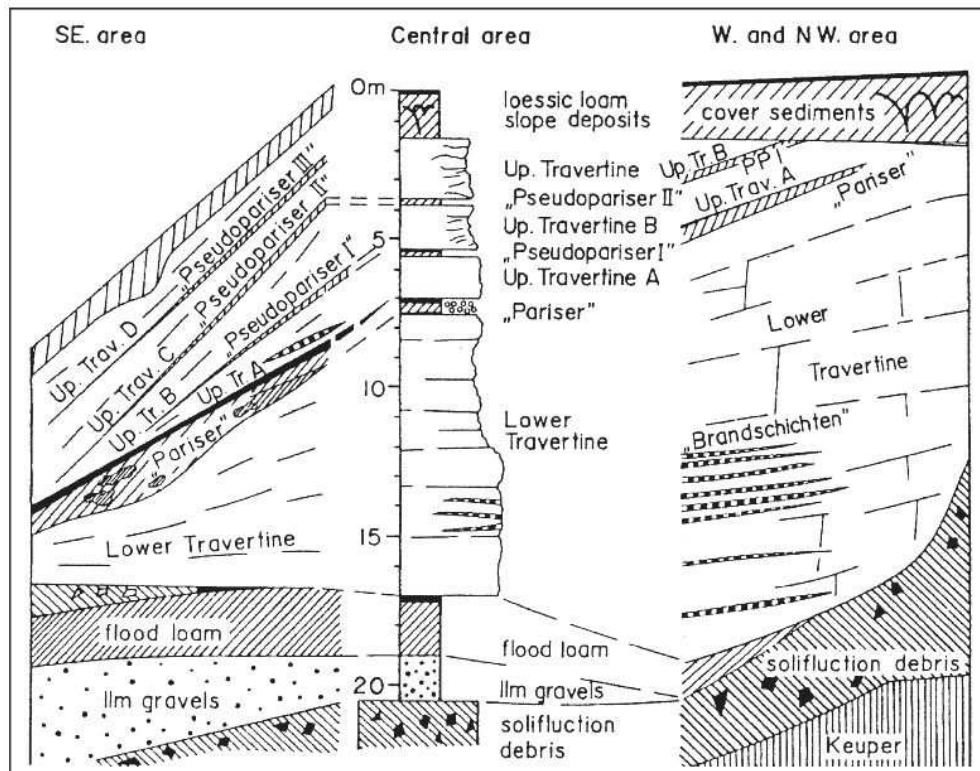


Fig.25 Revised stratigraphy of Ehringsdorf travertines (after: Kahlke, 1974).

4. upper travertines bottom layer (OT1)
5. "Pariser" layer<sup>4</sup> (P)
6. lower travertine layer (UT)
7. Auemergel (marl clay) (AA)

Behm-Blancke kept the overall stratigraphy described by Soergel (Behm-Blancke, 1960). He only added the presence of dark horizontal layers within the lower travertine layer to the overall profile. These were identified as hearth levels (Fig.23, 24).

The revised Steiner profile (1979).

The 70's research brought results in the form of Soergel profile verification. To this day, the profile then established is a point of reference for modern analyses and datings (Fig.24, 25), (Dietrich Mania & Altermann, 2003; Meyrick & Schreve, 2002).

1. Conical loam loessic layer, thickness of about 1m. Schäfers describes them as colluvial chernoziem (Schäfer et al., 2007)
2. Upper travertine layer (D)
3. Pseudopariser layer III
4. Upper travertine layer (C)
5. Pseudopariser layer II

<sup>4</sup> A layer between travertine levels, indicating a break in the process of their sedimentation and deposition of clastic sediments of different origins. The thinner layer known as pseudopariser; the thicker one, with traces of pedogenesis, known as pariser.

6. Upper travertine layer (B)
7. Pseudopariser layer I
8. Upper travertine layer
9. Pariser layer<sup>5</sup>—thickness of about 0.5m
10. Lower travertine layer, thickness of about 10m
11. Flood loam—thickness of about 2m
12. Ilm gravels—thickness of about 1.5m
13. Conical rubble meshes with gravels.

The numbers used are purely ordinal, and are not from the profile's original description.

### Dating

Behm-Blancke dated the whole travertine profile as Eemian (Behm-Blancke, 1960). In later works the upper travertine layer was dated to Amersfoort and Brørup Interstadials (Behm-Blancke, 1967). To this day, certain scholars think that such late sediment dating should be maintained (Schäfer, 1991), but their reasons are based on comparative analysis of flint inventories. In his analysis, Steiner retained the dating of the travertine layers and the fauna layers within as belonging to OIS 5e (Steiner, 1979). However, the uranium analyses carried out in the early 80's brought the date of ca. 230 kya BP for the lower travertine level (Brunnacker et al., 1983; Blackwell & Schwarcz, 1986). For the upper travertine layer Brunnacker (1983) received dates ranging from 33.7 kya BP to 150 kya BP.

Ehr1/ZS	Tooth enamel specimen, dental fragment of a herbivore, upper layers of Lower Travertine, 40 cm above the charcoal layer
Ehr2/ZS	Tooth enamel specimen, dental fragment of <i>Stephanorhinus</i> sp., Pariser Horizon, grey-green cemented
Ehr3/ZS	Tooth enamel specimen, fragment of cervid lower jaw, base of Pariser Horizon, cemented
Ehr4/ZS	Tooth enamel specimen, herbivore?, base of Upper Travertine
Ehr5/ZS	Tooth enamel specimen, <i>Equus</i> sp. molar, top layer, base of the upper soliflucted soil

Sample	Dose rate enamel (mGy/a)	Dose rate dentin (mGy/a)	U sediment (ppm)	Th sediment (ppm)	K sediment (%)	U dose rate sediment (mGy/a)	Th dose rate sediment (mGy/a)	K dose rate sediment (mGy/a)	Dose rate (mGy/a)	Age LU (ka B.P.)	Error LU (ka)	Age EU (ka B.P.)
Ehr1/ZS	0.33987	0.07441	0.330	0.19	0.25	0.03950	0.00936	0.06825	0.53	217.7	18.0	122.3
Ehr2/ZS	0.31266	0.07962	0.885	2.91	1.32	0.10815	0.14472	0.37562	1.02	202.1	72.5	145.9
Ehr3/ZS	0.31028	0.09557	0.310	0.19	0.25	0.03847	0.00952	0.07331	0.52	187.2	50.6	105.7
Ehr3b/ZS	0.31028	0.10723	0.310	0.19	0.25	0.03944	0.00963	0.07692	0.54	214.7	77.4	121.4
Ehr4/ZS	0.31028	0.09750	0.730	4.92	1.58	0.09096	0.25025	0.45584	1.20	26.4	10.4	19.7
Ehr5/ZS	0.31028	0.09679	0.885	2.91	1.20	0.10815	0.14472	0.34147	1.00	196.1	7.70	139.4

Fig.26 Tables showing the ESR results of teeth dating (after: Schüler, 2003, Tab.1,3).

<sup>5</sup> See ref. 4.

Table 5. Location, sample description (Ph. = phase), Th and U concentrations, activity ratios, and ages.

	Height <sup>+</sup> [m]	Res. [%]	Ph.	<sup>232</sup> Th [ng/g]	<sup>238</sup> U [ng/g]	$\delta^{234}\text{U}_t$ [‰]	$\delta^{234}\text{U}_0$ [‰]	$[\text{}^{230}\text{Th}/\text{}^{238}\text{U}]$	$[\text{}^{232}\text{Th}/\text{}^{238}\text{U}]$	$[\text{}^{230}\text{Th}/\text{}^{232}\text{Th}]$	age [ka]
Weimar-Ehringsdorf											
WUT3/15	0.75	2.4	m/s	89.0	593	194 ± 11	362 ± 15	1.079 ± 0.013	0.04978	21.7	221 ± 11
WUT3/16	1.2	n.d.	m/s	36.2	478	288 ± 21	471 ± 26	1.074 ± 0.021	0.02512	42.8	174 ± 11
WUT3/16	1.2	n.d.	b	28.3	518	255 ± 17	459 ± 23	1.121 ± 0.021	0.01812	61.9	208 ± 14
WUT3/14	1.65	n.d.	m/s	58.2	685	207 ± 12	387 ± 16	1.095 ± 0.012	0.02818	38.9	222 ± 11
WUT3/13	1.75	1.9	m/s	48.9	593	222 ± 10	391 ± 14	1.072 ± 0.013	0.02735	39.2	200.6 ± 8.4
WUT3/12	3.1	1.7	m/s	133.7	557	283 ± 16	491 ± 20	1.123 ± 0.017	0.07961	14.1	195 ± 10
WLT2/11	3.7	1.5	m/s	120.8	527	207 ± 17	424 ± 25	1.142 ± 0.021	0.07602	15.0	254 ± 22
WLT1/9	6.2	n.d.	b	13.0	536	272 ± 22	517 ± 31	1.175 ± 0.027	0.008044	146.1	(227 ± 21)
WLT1/9	6.2	1.7	pc	13.6	369	180 ± 11	361 ± 20	1.101 ± 0.020	0.01222	90.1	246 ± 18
WLT1/9	6.2	1.6	m/s	6.61	536	224 ± 10	448 ± 20	1.149 ± 0.020	0.004090	281.0	245 ± 16
WLT1/7	8.2	n.d.	pc	30.3	345	236 ± 27	420 ± 36	1.093 ± 0.030	0.02913	37.5	(204 ± 20)
WLT1/7	8.2	n.d.	m/s	8.14	542	200 ± 12	372 ± 20	1.084 ± 0.022	0.004981	217.6	220 ± 15
WLT1/4	11.3	n.d.	pc	99.1	450	357 ± 22	657 ± 31	1.246 ± 0.027	0.07304	17.1	(216 ± 17)
WLT1/3	12.6	n.d.	m	40.7	534	245 ± 11	519 ± 19	1.200 ± 0.015	0.02528	47.5	265 ± 16
WLT1/1	13.4	1.2	pc	18.3	393	237 ± 12	459 ± 17	1.148 ± 0.015	0.01544	74.3	(234 ± 13)
WLT1/1	13.4	2.8	m/s	66.3	511	182 ± 15	378 ± 25	1.118 ± 0.022	0.04303	26.0	258 ± 24
Peh	~3.5	24.9	c-s	2775	360	240 ± 41	n.d.	1.523 ± 0.055	2.556	0.596	
Peh	~3.5	n.d.	c-s	2038	270	328 ± 49	n.d.	1.845 ± 0.089	2.503	0.737	

Fig.27 Table showing the results of sample dating using U/Th method (after: Mallick &amp; Frank, 2002, Table 5).

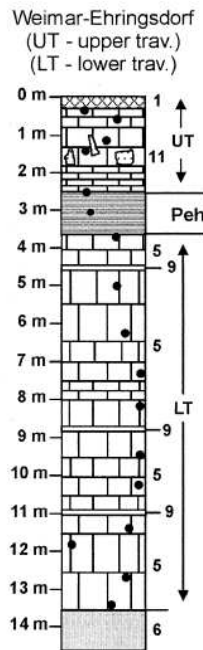


Fig.28 Stratigraphy of Ehringsdorf travertines with selected sampling location for U/Th analyses (after: Mallick &amp; Frank, 2002, Fig.2).

For the upper travertine layer, Blackwell and Schwarcz (Blackwell & Schwarcz, 1986) received the date  $111 \pm 47$  kya BP. Since then, the debate on the site's and individual levels' dating reignited and so it goes on to this day. Back in the 80's, the ESR datings were done, which confirmed the U/Th results (Schwarcz et al., 1988). With the aid of the Th/U method, Frank dated the lower travertine layer located just below the Pariser Horizon I, and obtained dates in the range of 97.5 kya BP–300 kya BP within the range of several centimetres. ESR analyses gave a date with an average of  $120 \pm 20$  kya BP for the upper travertine layer, while

the lower travertine layer gave the date in the range of  $127\pm 20$  kya BP and  $200\pm 35$  kya BP (Schwarcz et al., 1988).

Most recent ESR dates (Schüler, 2003) made for five teeth samples (Fig.26) from different layers of the lower travertine level up to the upper travertine layer, gave results similar to the average date of 204kya BP. Only the sample from the highest solifluction layer gave a much later date ( $26.4\pm 10.4$  kya BP); nevertheless, Schüler (2003) estimates the date to be wrong.

In 2002, Mallick and Frank published the results of a comprehensive profile dating with the use of U/Th method (Mallick & Frank, 2002). Altogether, 17 samples were taken from the profile (Fig.27, 28). The results showed that the lower travertine layer was accumulated around  $243\pm 6.2$  kya BP (average value from seven samples), while the upper travertine layer— $200\pm 7.3$  kya BP (average value from six samples) (Fig.27). The Pariser horizon was not dated with this method (Mallick & Frank, 2002).

Based on the absolute dating, the lower travertine layer containing flint inventories which are of interest here, is dated to OIS 7. The dating of upper travertine layer still remains uncertain.

The results of fauna analyses do not yield such consistent results. Behm-Blanke (1960) supported his travertine layers dating as being of the Eemian Interglacial with exactly those flora and fauna analyses. However, in the 80's Heinrich and van Kolfschoten began to undermine these discoveries (Heinrich, 1981; Kolfschoten van, 1990). Among the fauna, there is no snail species of *Helicigona banatica*, typical of OIS 5e. *Castor fiber* and *Stephanorhinus kirchebergensis* from the lower travertine layers display features which are clearly more primitive in comparison to the known Eemian remnants (Kretzoi, 1977; Made van der, 2000). Also the presence of species such as *Equus chosaricus* or *Megaloceros giganteus antecedent* points to the pre-Eemian period of the lower travertine levels accumulation (Eisenmann, 1991; Made van der, 2003). This fauna can be dated to “intra-Saalian” (OIS 7) (Schäfer et al., 2007). The dating of higher levels with faunal remains is less certain. Some species, such as *Apodemus maastrichtiensis* also indicate the pre-Eemian period (Schäfer et al., 2007 p. 144). The uppermost level of colluvial chernozem houses the remnants of *Arvicola terrestris* which may point to the period of Early Vistulian.

The animal species composition of lower travertine layer indicates interglacial forest ecosystem. The Pariser layer was accumulated in more temperate climatic conditions; still, the environment remained a forest ecosystem. The remains of the upper travertine layer do not give a consistent picture. On one hand, there are the already mentioned mammoth remains which indicate a temperate climate and ecosystem, on the other hand the microfauna, such as *Apodemus sylvaticus* or *Cletherionomys glareolus*, point to the forest environment and mild climate (Schäfer et al., 2007 p. 145). On the other hand, one ought to take into consideration the most recent statement of Nadachowski (Zdziebłowski, 2013). He stated that the Pleistocene megafauna quite often appears in the same geological layers as the remains of animals usually connected with forest environment, e.g. deer. Nadachowski claims that these findings do not point to the mixing of animal remnants from different periods. Nonetheless, he stresses the fact that the perception of homogeneous steppe-tundra ecosystems ought to be modified. What is more, the possible coexistence, during various periods, of animal species traditionally connected with forest or tundra should be considered as well.

The remnants of the uppermost chernozem layer point to the ecosystem of steppe and forest steppe (Schäfer et al., 2007 p. 145).



### **Archaeological inventory**

The inventory now includes several thousand of stone artifacts continuously collected for over 200 years. The artifacts are mostly made of flint and are characterized by a significant frost crack. After being recovered from their layer, the artifacts fall apart, but because they were normally hidden in rocks it is possible to reconstruct/refit them. The inventory is still under examination. Most artifacts were found in the lower travertine level and correlated with horizontal sublayers called hearths (Behm-Blancke, 1960).

The artifacts of lower travertine layer are characterized by small size. The inventory is fully of flake type (Schäfer, 2007 p. 177). The assemblages are dominated by various types of small side scrapers, also the bifacially worked ones. Certain artifacts, due to their regular shape, are defined in the literature as leafpoints (Gladilin, Slitlyj & Tkachenko, 1995; Feustel, 1983).

Blancke Behm (1960) named several settlement levels within the lower layer of travertines. The findings were the richest in levels 4 and 5. He defined the entire inventory as “old, developed Mousterian” (Behm-Blancke, 1960 p. 169). Due to the presence of bifacial tools, he eventually described them as "PreSzeletian Mousterian" (Behm-Blancke, 1960 p. 199) Both Andree (1939) and later Hülle (1977; 1939) drew attention to the similarity between some of the Ehringsdorf forms and Ranis leafpoints.

Only a few artifacts came from the upper travertine layer (Behm-Blancke, 1960). In the recent years, the discovery of a new archaeological horizon in the upper travertine layer was reported by Schüler (2003), but the examination results have not been published yet.

### 2.1.3.2. Lenderscheid

Open-air, surface site located in the outcrop of quartzites, about 17km to the NE of Rörshain. The site was discovered by Adolf Luttrupp (1955) during surface examinations and it encompasses the local quartzite rock outcrops. The rocks appearing on the surface make agricultural works impossible on the site, this is why the site was not destroyed despite the original quite shallow stone artifacts placement in the layer (Luttrupp, 1955).

The inventory, made on local quartzite, consists mainly of bifacial tools. Among them, except for the tools defined as “leafpoints”, bifacial knives were found in the types of Fäustel, Faustkeile, Halbkeile, as well as triangular and heart-shaped handaxes typical of the site, which enabled to classify the site as being late-Acheulean (MTA) (Junga, 2009; Luttrupp, 1955; Fiedler, 2006).

### 2.1.3.3. Kösten

Open-air, surface site, located on the north terrace of the Upper Main Valley in N Bavaria, about 135km to the N from the Altmühl valley.

The site was explored before the First World War by Rossbach. Then, more regular surface investigation was conducted by Obermaier and Wernert (1914; 1929). According to Rossbach (1913), the artifacts were located in eluvial deposit situated between Holocene humus at the top and Rhaetian sandstone bedrock (Upper Triassic) at the bottom.

The most extensive study was conducted here in the 50's by Zotz and Freund (Zotz, 1959a; Zotz, 1951; Freund, 1952; Freund, 1954).

#### Dating

The dating of the site remains problematic due to lack of stratigraphy and the surface nature of findings. Höhl (Zotz, 1959a p. 5), on the basis of geological layers detailed analysis within the valley, concluded that precise site dating is impossible. Only chronological specification of the terrace can be determined. It is a *terminus post quem* for the stone inventories. Höhl described the terrace as being early Pleistocene (Zotz, 1959a p. 13). This statement was upheld by Freund (Freund, 1963).

#### Archaeological inventory

During subsequent surface examinations stone artifacts were found on the site. 99% of the inventory is made on gray-green radiolarites (Kieselschiefer) and lidites (Hopkinson, 2007 p. 57). The raw material outcrop is located about 50m from the site, in a river valley (Bolus, 2004 p. 209). The inventory includes both the Middle and Upper Palaeolithic, as well as Neolithic tools. For the purpose of publications, the inventories were separated mechanically. Zotz ascribed the polished axe of lidit and the triangular bifacially retouched points to the Neolithic artifacts (Zotz, 1959a p. 96). Single blades and blade cores were classified as the Upper Palaeolithic forms (Zotz, 1959a pp. 118–119).

The most numerous–Middle Palaeolithic inventory (over 200 pieces) included, according to Zotz, discoid flake cores, flake tools, mainly side scrapers, and bifacial forms including those referred to as “leafpoints” (Zotz, 1959a p. 108pp). The bifacial tools bear traces of numerous fractures, only a few items are preserved in their entirety. The points are made on flakes or flat raw material nodules (Hopkinson, 2007 p. 57). Freund emphasized the site was a knapping workshop, pointing to the proximity of raw material outcrop and the presence of many preforms on the site (Freund, 1963). While doing the collection analysis, Allsworth-Jones found 145 Kösten artifacts in the collection of the Institute of Archaeology at the University of Erlangen (Allsworth-Jones, 1986 p. 59). According to the statistics made by him, there were 57 leafpoints or their fragments and 30 handaxes. Allsworth-Jones noted the lack of bifacial knives in the inventory (Allsworth-Jones, 1986 p. 59pp).

The inventory of Kösten was interpreted differently by particular researchers. Obermaier and Wernert (1914; 1929) identified the artifacts as being Upper Acheulean. Bohmers placed the site in his own separate Altmühl group (1951 p. 74). Zotz and Freund as well as Birkner, describe it as early Pre-Solutrean industries (Zotz, 1959a p. 119; Freund, 1952; Birkner, 1929 p. 224). Even though Bosinski had no possibility of studying the artifacts themselves, still, based on Zotz's publications, he noticed the similarity to Rörshain

inventories (Bosinski, 1967 p. 47). Allsworth-Jones (1986) analysed the artifacts, placing them in the Middle Palaeolithic assemblages with leafpoints, just like Hopkinson (2007). Hopkinson noted that the tools lack absolute determinants which would justify including them in the Middle Palaeolithic inventories (Hopkinson, 2007, 57).

### 2.1.3.4. Mauern (Weinberhöhlen)

The Weinberhöhlen site (Mauern) consists of several interconnected caves located on the western slope of the Weinberg hill in the Wellheimer Trockental valley, north of the modern Danube River valley. The site faces the southern part of a dry valley which was part of the Danube River valley during the Riss glacial. All the cave chambers (except one), are located on one level and they face the southeast, namely the valley.

Excavations on the site were carried out three times. The first systematic archaeological work began in 1937 with Schmidt, and was later ran by Bohmers (1937–1939). The research results were initially published in reports in 1939 and 1944, as well as in a monograph in 1951 (Bohmers, 1951; Bohmers, 1939). Another study was undertaken by Zotz in 1947 and he led it until 1949. The results were published in a monograph in 1955 (Zotz, 1955). Due to stratigraphy divergences obtained during the first two excavations, a re-exploration began in 1967 and was carried out by Müller-Beck and von Koenigswald. The study was conducted for two seasons in 1969 and 1974. The results were published in 1974 (Koenigswald, Müller-Beck & Pressmar, 1974). The last excavations confirmed the general stratigraphical description made by Bohmers.

#### **Stratigraphy**

Currently, there are three profiles whose correlation was widely discussed in the literature (Koenigswald, Müller-Beck & Pressmar, 1974; Koenigswald & Müller-Beck, 1975; Allsworth-Jones, 1986; Hopkinson, 2007) (Fig.29).

Bohmers in his publication (1951 pp. 6–7) described the following system of layers on the site:

- A.** humus, containing Mesolithic and younger artifacts
- B.** brown loam
- C.** yellow loess with sharp-edged limestone rubble, containing flint artifacts, known as the lower Magdalenian level
- D.** gray clay layer with weathered/smooth limestone rubble, archaeologically sterile
- E.** yellow loess with sharp-edged limestone rubble containing flint artifacts, defined as the Aurignacian level
- F.** layer with highly weathered/smooth limestone rubble traces, containing flint artifacts, defined as Altmühlian level
- G'.** yellow loam layer with sharp-edged limestone rubble, discontinuous, occurring only in certain places in the cave, containing flint artifacts, defined as the Mousterian level
- G.** layer with highly weathered/smooth limestone rubble traces, containing flint artifacts, defined as the Mousterian level
- H.** gray clay with weathered/smooth limestone rubble, archaeologically sterile
- I.** yellow clay.

The two highest layers were completely explored by Bohmers and do not appear in profiles during subsequent excavations. Bohmers correlated subsequent weathering layers with the Vistulian Interstadials: the G and F layers were dated to Early Vistulian Interstadials

(OIS 5c) and the D layer was correlated with a warmer oscillation at the end of Early Glacial–Göttweig (OIS 5a) (Bohmers, 1939 p. 156).

Zotz, in his publication (1955 p. 18) described the following site stratigraphy:

**C1.** 60cm- layer containing sharp-edged limestone rubble

**C2.** 10–20cm- early Magdalenian level

**C3.** 20–40cm- limestone rubble layer

**D.** 20–30cm- grayish-brown layer containing: sharp-edged limestone rubble, only sometimes weathered/smooth, coals *Pinus silvestris* and *Pinus cembra*; defined as Lower Aurignacian level

**E.** 15–30cm- layer containing sharp-edged limestone rubble

**F1.** 30–50cm- reddish-brown layer containing highly weathered limestone rubble, a clear boundary with the overlapping layer; defined as Pre-Solutrean level II

**F2.** 15–25cm- ocher-yellow loam layer with a small amount of weathered/smooth limestone rubble, defined as Pre-Solutrean level II

**G.** 25cm- brown-gray loam layer with weathered/smooth limestone rubble, defined as Pre-Solutrean level I

**H.** 20cm- yellow-brown/dark brown loam layer with weathered/smooth limestone rubble; defined as Pre-Solutrean level I

**I.** 20cm- clay with limestone rubble deposited directly on bedrock.

Two C14 dates were obtained, one for the coal sample from the D layer gave the date of 28,265±325 uncal BP, the second for the C2 layer gave the date of 29,410±470 uncal BP (Koenigswald, Müller-Beck & Pressmar, 1974 p. 10). Zotz correlated the C2 layer with Würm 2–3 (Middle Pleniglacial), the F1 layer with Würm 2 (Lower Pleniglacial ?), the F2 layer with Würm 1–2 (Early Vistulian Interstadial–Brørup ?), the G and H layers with Würm 1 (Early Vistulian stadial) and layer I with the Eemian Interglacial (1955 p. 21).

Von Koenigswald and Müller-Beck (1974; 1975) described the following system of layers (referred to by them as "the zone") (Fig.29).

**0.** humus layer removed by Bohmers, absent during the excavations, contains artifacts from the Bronze Age and younger

**1.** loess with sharp-edged limestone rubble, defined as the "lower younger Upper Palaeolithic" (*Unteres jüngeres Jungpaläolithikum*)–Gravettian level

**2.** highly weathered limestone rubble layer, containing artifacts referred to as the "lower older Upper Palaeolithic" (*Unteres älteres Jungpaläolithikum*)–Aurignacian level

**3.** loess with sharp-edged limestone rubble

**4.** level with highly weathered limestone rubble, including archaeological artifacts, defined as Altmühlian level

**5<sub>1</sub>.** loess layer with sharp-edged limestone rubble

**5<sub>2</sub>.** redeposited layer of heavily weathered limestone rubble, containing artifact, defined as Micoquian level

**5<sub>3</sub>.** clay layer.

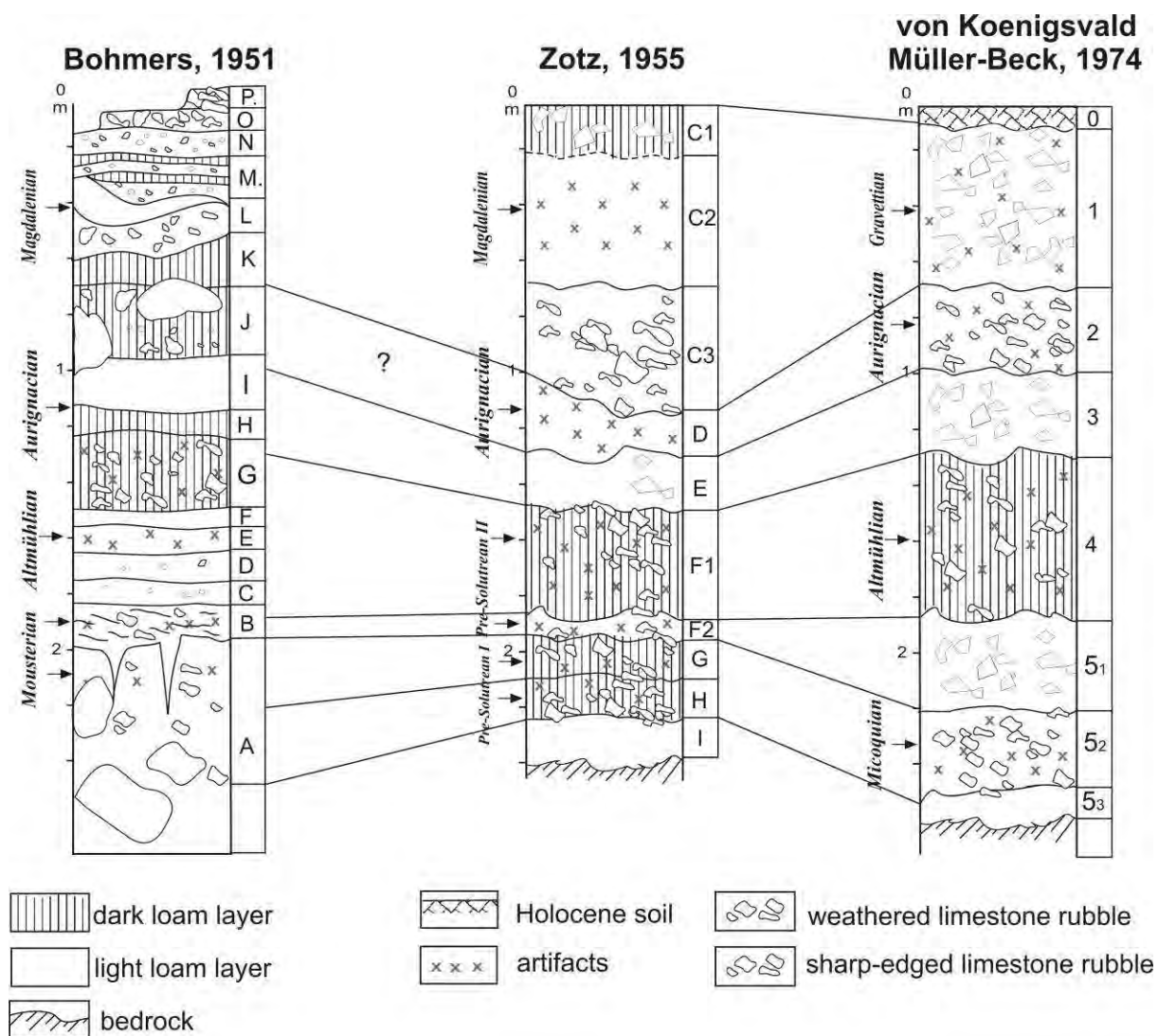


Fig.29 Collective profiles correlation from Bohmers, Zotz and von Koenigswald study.

### Profiles correlation and dating

Müller-Beck made the correlation of all three profiles (Fig.29). As a result, he agreed with the results obtained by Bohmers (Koenigswald, Müller-Beck & Pressmar, 1974). Starting from the oldest layers: in both profiles (of Zotz and Bohmers) at the bottom there is a layer of clay (I) and two overlapping layers (G and H) with smooth (chemically weathered) limestone rubble. According to Müller-Beck, the G layer (his “zone 51”) is a redeposited paleosol. Above them there is a layer defined by Zotz as F2, and by Bohmers as G’, which is characterized by the presence of sharp-edged limestone rubble and Middle Palaeolithic artifacts. Müller-Beck correlated it with temperate climate and dated it to the Lower Pleniglacial (OIS 4).

Hopkinson and Richter have recently put this interpretation under criticism (Hopkinson, 2007 p. 100; J. Richter, 2008 p. 101), noting that in the region there are no sites with signs of settlement during the maximum of the Lower Pleniglacial (OIS 4). Hopkinson suggested that the G layer containing Micoquain artifacts, as well as G’ should be dated to the early phase of OIS 3 by analogy with the layers of Sessefelsgrotte (Complex-G). Over the G layer there was the F layer (defined in the study of Zotz as F1). It was described as a brown layer with weathered limestone rubble and can be dated to OIS 3. In this layer there were flint artifacts,



including leafpoints. Above, there was the layer of loess with sharp-edged limestone rubble (E).

The greatest differences in profiles description are found in the top layers. Bohmers described the D layer as a gray clay sediment interpreted as the equivalent of a warm period. The layer is archaeologically sterile. The study by Zotz showed that at this level there was a layer containing sharp-edged limestone rubble, which would indicate a cold period. At this level, Zotz also found flint artifacts and described them as Lower Aurignacian. The date of C14–28,265±325 uncal BP comes from this layer. Müller-Beck noted that Zotz had described the D layer (equivalent to his “zone 2”) as dark sediment with weathered/smooth limestone rubble (Koenigswald, Müller-Beck & Pressmar, 1974). Thus, Müller-Beck assumed that this layer can be interpreted as a redeposited weathering level. The C14 date would suggest, according to Müller-Beck, a possible correlation of the layer with the Denekamp Interstadial, despite the presence of temperate fauna such as a mammoth or a rhinoceros (Koenigswald & Müller-Beck, 1975 p. 108). As the top two layers (A and B) were completely removed during Bohmers exploration, the C1–C3 layers distinguished by Zotz (1955 pp. 18–19) were correlated by Müller-Beck with the C layer of Bohmers (Fig.29). At the same time, the artifacts of layer C, defined by previous researchers as Magdalenian, according to von Koenigswald (Koenigswald & Müller-Beck, 1975 p. 108), should be included in Gravettian industry, which would also correspond more to the C14 date of 29,410±470 uncal BP.

### **Archaeological inventory**

According to Bohmers, the artifacts were located in six levels. The oldest horizon placed in the G and G' layers was determined by him as Mousterian. It contained numerous side scrapers, including bifacially worked ones, and one handaxe.

In the F layer, Bohmers found 33 bifacially worked leafpoints. Apart from these, he also recovered two handaxes and 61 other tools, among them mainly: side scrapers (also with bifacial retouching), 15 cores and 210 non-retouched artifacts (Bohmers, 1951). This inventory was described as Altmühlian by Bohmers.

Artifacts defined as Aurignacian were excavated from the overlapping E layer. A typical inventory element were the carinated endscrapers and retouched blades. This layer was separated with a sterile D layer from the C layer, in which Upper Palaeolithic artifacts were found. Bohmers described the horizon as Lower Magdalenian (as opposed to Upper Magdalenian, which he had already distinguished in the publication from 1939, but later he himself abandoned this interpretation). In the humus layer there were mixed Mesolithic and younger artifacts.

Zotz believed in the evolutionary link between Acheulean, Central European leafpoint industries up to Solutrean culture. Therefore, he defined the upper layers (F1 and F2) containing leafpoints as Presolutrean level II, and the industries found in lower layers (G and H) as Presolutrean level I (Zotz, 1955).

The F1 layer is equivalent to the Altmühlian level (layer F) of Bohmers. In both the F1 and F2 layers, Zotz found leafpoints, whereas Bohmers did not find any leafpoints in his G' layer (which is an equivalent to Zotz's F2 layer). In total, Zotz's excavations yielded 18 leafpoints (of which 6 were from the F2 level). In addition to that, Zotz found individual artifacts also in the D layer, and defined them as Aurignacian; as well as in the C2 layer, which he described as Magdalenian.

### 2.1.3.5. Rörshain

The site is located in the Landwirt J. Volker sandpit, about 500m from the Reutersruh site and 45km SW of Kassel (Graßkamp, 2001 p. 2). The first stone artifacts were found during sand exploitation already in 1958 (Bosinski, 1973 p. 27). From that time up to 1964, sand mining was supervised by the archaeologist Luttrupp, who recovered more than 9,000 artifacts during this period (Luttrupp, 1970). The first rescue excavations were undertaken in 1965 on the sand outcrop's western wall. They were carried out by Bosinski. and Goldmann (Luttrupp & Bosinski, 1967). The second study on the site was conducted in 1973 by Campen and Hahn (1975). Excavations were also located on the sandpit's western wall.

During their investigation, Bosinski and Goldmann opened the trenches of 30m<sup>2</sup>. In total, about 30,000 artifacts were found on the site (Luttrupp & Bosinski, 1967).

In 1972, the Institute Ur-und Frühgeschichte, University of Cologne resumed the investigations under the supervision of a local archaeologist, Franken. The trenches of 34m<sup>2</sup> were then opened, located to the north from previous excavations (Graßkamp, 2001 p. 7). Since 1973, throughout two seasons, excavations were led by Institut für der Universität Tübingen Urgeschichte, where the experts were Hahn and Campen. The investigation's aim was to determine the exact location of artifacts within the geological strata and possible dating of stone inventories (Campen & Hahn, 1975; Campen & Hahn, 1973) The excavations were located directly next to the excavation of 1972, as well as to the north from earlier excavation. In 1974, testing trenches were opened 24m to NW from earlier excavations. In total, the trenches had a surface of 17m<sup>2</sup> (Graßkamp, 2001 p. 8).

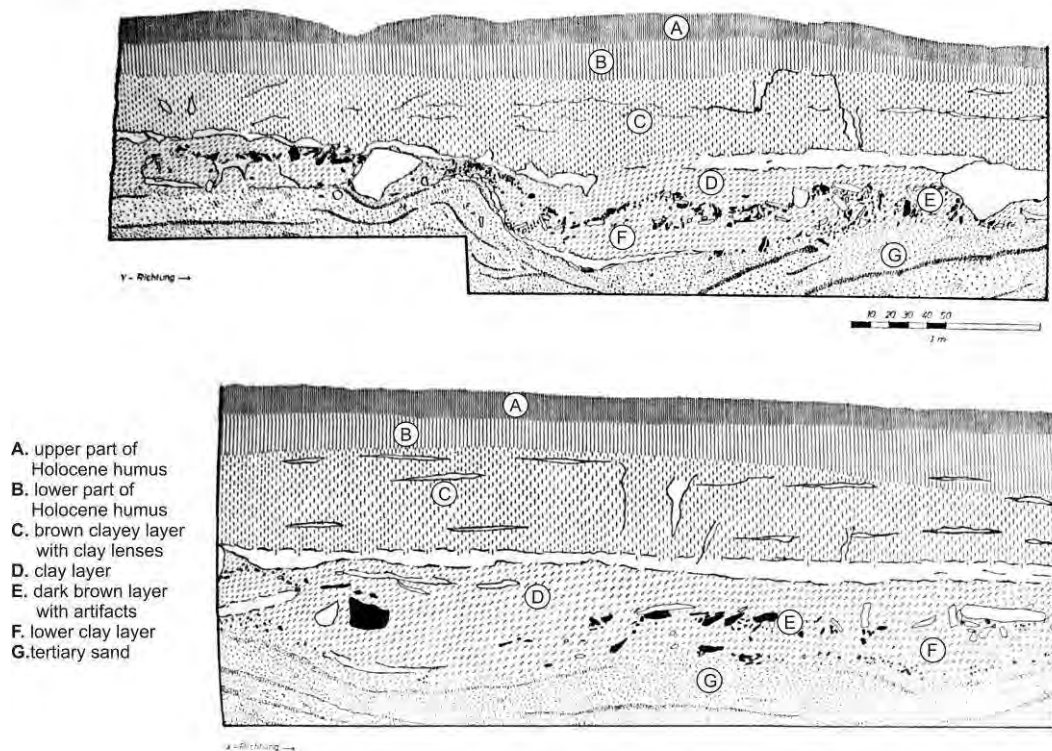


Fig.30 Above: southern profile from 1965 studies (after: Luttrupp & Bosinski, 1967, Abb.2). Below: western profile from 1965 studies (after: Luttrupp & Bosinski, 1967, Abb. 3).

## Stratigraphy

### Profile 1

1965 trench profile (Luttrupp & Bosinski, 1967) (Fig.30)

- A. 15–20cm- upper part of a Holocene humus layer
- B. ca.20cm- lower part of the Holocene humus gradually passing into layer C
- C. 50–70cm- brown clayey layer with a number of horizontal lenses of clay
- D. 10cm- continuous clay layer
- E. 10–50cm- dark brown layer with numerous small stones and large nodules of quartzites. The upper limit/contact is horizontal, the lower limit is irregular and wavy. The layer contains archaeological artifacts.
- F. ca. 5cm- lower clay layer, similar to the clay layer D and clay lenses in layer C; discontinuous
- G. tertiary sand, in some places forming an irregular border with layer E.

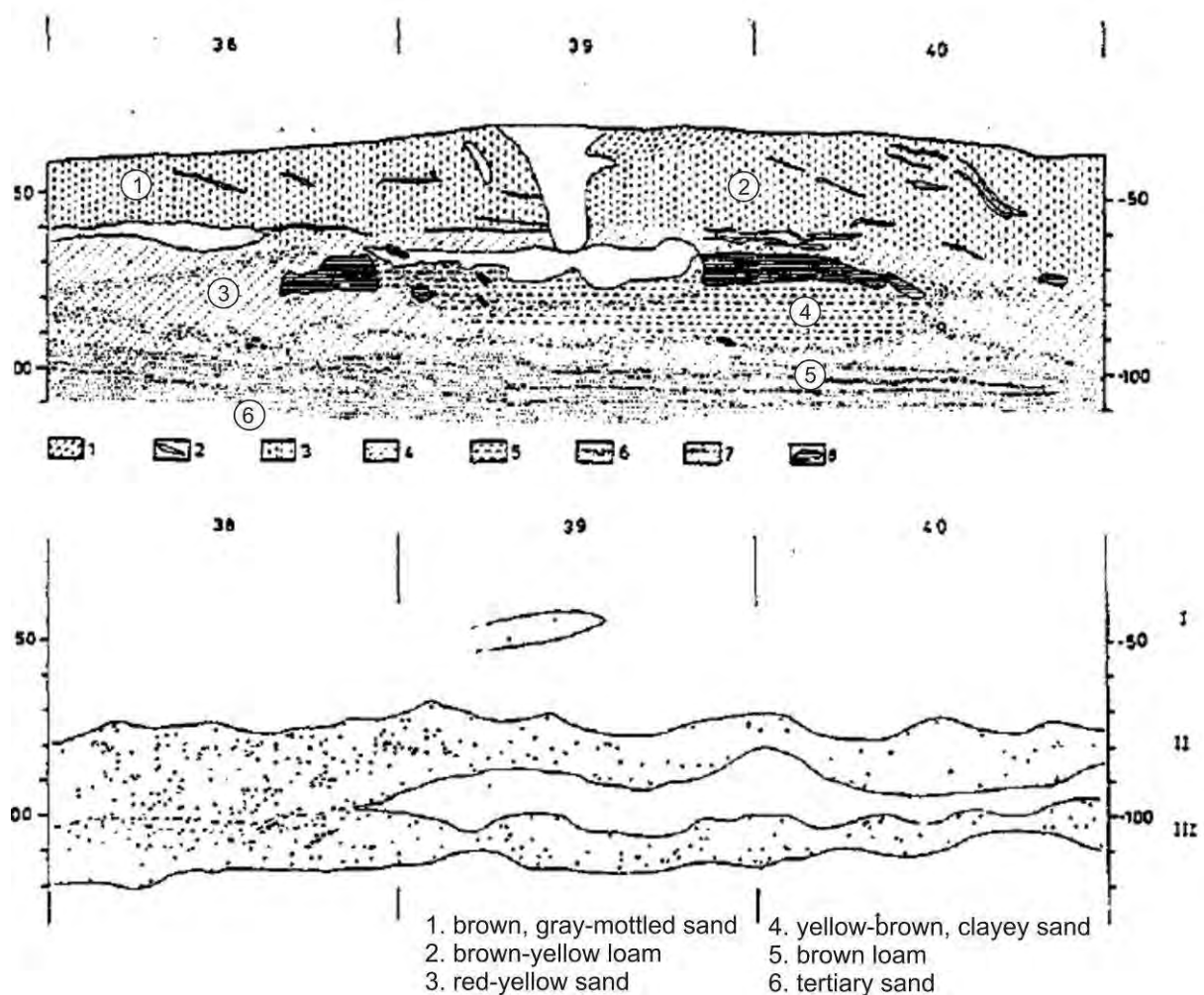


Fig.31 Above: southern profile of 1973 trench. Below: vertical distribution of stone artifacts within 38–40 metres (after: Campen & Hahn, 1973, Abb. 2).

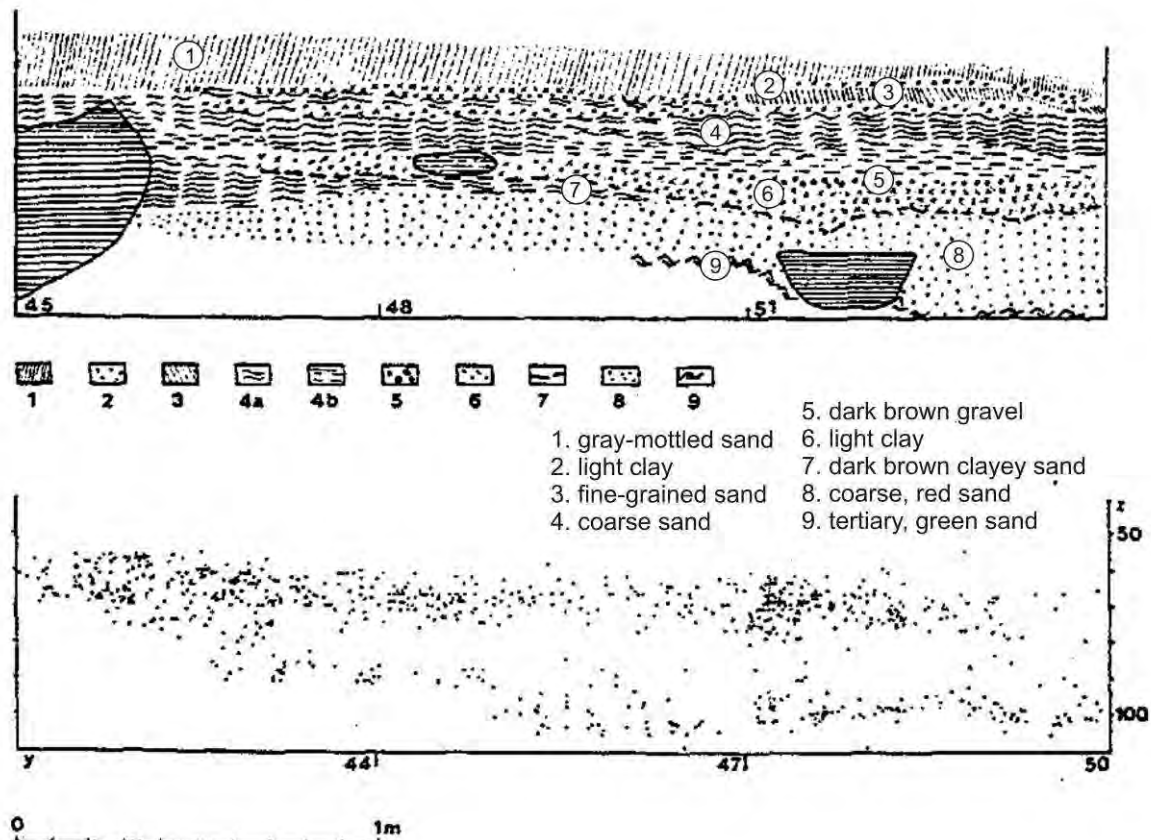


Fig.32 Above: southern profile from 1974 trench. Below: vertical distribution of stone artifacts within 44, 47 and 50 metres (Campen & Hahn, 1975, Abb. 3).

### Profile 2

The 1973 trench profile, from the research of Campen and Hahn (1973) (Fig.31)

- 0. ca.35cm- Holocene humus—previously removed layer
- 1. 0–10cm- finegrained, brown, gray-mottled sand with gravel and lenses of clay; archaeological level I
- 2. 25–35cm- brown-yellow level of loams mixed with finegrained, red-yellow sand and lenses of clay; archaeological level II
- 3. 10–40cm- red-yellow sand with a significant admixture of small gravel and lenses of clay. Contains scarce archaeological artifacts
- 4. 0–20cm- yellow-brown layer of clayey sand with horizontal iron-manganese nodules
- 5. 5–10cm- brown layer of loam sand (similar to layer 2); archaeological level III.
- 6. dark brown horizontally laminated tertiary sand.

### Profile 3

The 1974 trench profile from the research by Campen and Hahn (1975). The trench was located 24m to the NW of the 1973 trench (Fig.32).

- 0. ca.35cm- Holocene humus—previously removed layer

1. 5–18cm- finegrained brown, gray-mottled sand with gravel (7.5YR 5/6) and lenses of clay; archaeological level I
2. 5–4cm- light clay with ferruginous-manganese inclusions
3. 0–5cm- homogeneous, fine-grained sand with small amount of clay and scarce iron-manganese nodules (5YR 5/4); archaeological level I.
4. 20cm- coarse, well-sorted sand with horizontal iron-manganese nodules in the upper part, archaeological level I
5. 2–3cm- compact, dark brown gravel, cemented with iron and manganese compounds
6. 5–10cm- light clay layer with iron-manganese nodules, better developed than in layer 2
7. 2cm- dark brown clayey sand layer, 2.5YR 4/6 at the floor of layer 6
8. 15–28cm- coarse, well-sorted red sand layer, 5YR 5/6, at the base with an admixture of gravel, as in layer 5; archaeological level II.
9. tertiary, coarse, green-coloured sand of green; known as "Kasseler Grün".

### **Profiles correlation**

During the first excavations only one archaeological horizon was distinguished, though the profile published in the 1967 article (Luttrupp & Bosinski, 1967, Abb. 3) (Fig.31) gives rise to the assumption that already back then, the researchers were able to separate at least two separate artifact levels (Graßkamp, 2001 pp. 17–18; Allsworth-Jones, 1986).

Hahn and Campen point out that the artifacts were covered in solifluction layers, so the archaeological levels should be considered as redeposited (Campen & Hahn, 1975). The solifluction can also probably explain the differences between the same layers within different trench profiles. While the D layer of clays from the research excavations in 1965 was a compact, continuous stratum, in the trenches of 1973 and 1974, this layer occurs only in the form of discontinuous clay lenses. Most likely, the E layer from the 1965 excavations should be identified with sand layers 1 to 5 from the research by Campen and Hahn.

### **Archaeological inventory**

The site is located on an outcrop of olive-green tertiary quartzites that occur in this location in the form of clod-shaped nodules and circular or oval plates of 2m in diameter and 20–40cm in thickness. This raw material was the basis for the production of most tools on the site.

During research altogether more than 40,000 artifacts were obtained from the site, most of which is debitage waste. The site is also rich in bifacial tools preforms, incomplete and failed forms. Among the few tools, a specific type are the bifacial tools Faustkeile and Faustkeilblätter, and broken fragments of symmetrical, bifacial tools called "leafpoints" (Blattspitzen), as well as flake side scrapers (Bosinski, 1967 p. 47). The "leafpoints" are usually found in fragments (most of them are broken tips). They are characterized by plano-convex cross-section and not very precise knapping, which is probably connected with the quartzite raw material on which almost all the site's artifacts were made.

The site, due to its workshop nature and the abundance of preforms gives rise to technological analyses. Already in 1977, Hahn conducted the analysis of Rörshain “leafpoints” manufacturing (Hahn, 1990). The artifacts were produced on flakes and thermally fractured fragments. Hahn named two/three (depending on the tool) main stages of points manufacturing, the first (two) of which were based on suitable tool surface thinning and forming, and the last one on edge shaping. Hahn also observed two knapping schemes—edge and surface, starting from the upper face (1990 p. 81). Summarizing the analysis results, Hahn stated that due to the site’s inhomogeneous nature, which stems from wide artifacts dispersion in different layers, as well as due to the nature of raw material used to manufacture bifacial tools, the leafpoints of Rörshain cannot be considered as primitive and transitional forms. Their morphology was entirely determined by the quartzite material which is difficult to knap and has specific knapping characteristics (Hahn, 1990 p. 86).

In 2001, at the University of Cologne, Grasskamp defended his MA thesis devoted to Rörshain “leafpoints” scar pattern analysis. The main objective of this study was to reconstruct the knapping schemes. Grasskamp observed that most of the analysed artifacts were treated in a surface scheme of knapping, where first the upper face was knapped and then the lower one. This allowed him to draw significant conclusions about the standardization of Rörshain “leafpoints” knapping techniques. Grasskamp also noted the absence of correlation between tool cross-section and its adopted knapping scheme (Graßkamp, 2001 p. 108pp).

In this dissertation, it was decided not to use the results of Grasskamp’s detailed analyses as he had used a slightly different description of percussions and did not combine individual scars of removals into sequences. In addition to that, not all of the results concerning the chronology of various artifacts seemed to have been correct, therefore it was decided to re-examine the scar patterns of certain artifacts.

## **Dating**

The site’s chronology is uncertain because of missing absolute dating. At the same, time the site’s stratigraphy and the location of artifacts within sand layers, subjected to large displacements as a result of solifluction, make any specified dating impossible. Only on the basis of archaeological artifacts it was possible to assign the artifacts to the backed knives industries. Bosinski (1967) interpreted the findings from Rörshain as traces of transition from bifacial knives to symmetrical leafpoints which are typical of the Althmühl group and the later Ranis inventories. The Rörshain inventories have been placed by Bosinski into the Micoquian development line: Bockstein–Klausennische–Schambach–Rörshain (Bosinski, 1967 p. 54).

### 2.1.3.6. Wahlen

Open-air surface site located at the northern foothills of Vogelsberg, between the towns of Kirtorf and Neustadt, Hesse, Germany. The artifacts were found mainly on the S and SW slope, which is intensively used for agriculture. The site is located in the area of tertiary quartzites outcrop (Junga, 2009 p. 15).

The site was discovered by private collectors Hermann Schlemmer and Horst Quehl in 1968. Since then, the site has been regularly visited and individual collectors have conducted research while collecting artifacts. Currently, the artifacts are divided into seven collections, two largest of which (Quehl's and Schmeller's) were given to Museumslandschaft Hessen in Kassel (Junga, 2009).

#### Archaeological inventory

The Palaeolithic artifacts were published for the first time in the 1979/80 by Fiedler (Fiedler, Quehl & Schlemmer, 1979). In 2009, a doctoral thesis was written, covering the analysis of the entire available Palaeolithic artifacts collection (Junga, 2009).

The artifacts from the site can be divided into three main chronological horizons—Palaeolithic, Bronze Age and medieval, where the Palaeolithic artifacts prevail. Stone artifacts made of local quartzite can be dated back to the Middle Palaeolithic, although the presence of the Lower Palaeolithic forms cannot be ruled out (Junga, 2009). Among the tools included in the Middle Palaeolithic horizon, the most common ones are “leafpoints” (Blattspitzen), backed knives (Keilmesser), Faustkeile type knives and side scrapers (Fig.33). The consistency of the mechanically separated Middle Palaeolithic inventory can of course be questioned, just as its—chronological nature. The site has not yet been thoroughly dated. The only available dating forms are analogous artifact forms on other sites.



Fig.33 Distribution of artifact types analysed by Junga (after: Junga, 2009, Abb. 12).



## 2.1.4. Greece

### 2.1.4.1. Kokkinopilos

The site, also known as Pantanassa, was discovered in 1962 during surveying conducted in the area of Western Macedonia and Epirus (Greece) by Dakaris and Higgs (Dakaris, Higgs & Hey, 1964). It is located on the eastern slope of the Kokkinopilos Valley near the village of Aghios Giorgios in southern Epirus (Proveza region). The site is located in the place of very intensive erosion, which resulted in the emergence of small, V-shaped gullies, up to 10m deep. Artifacts are found on the surface, though mainly in the lower parts of ravines and inside the eroded red clay layer of *terra rosa* type. This deposit is characterized by lack of stones, deep red colour and the presence of black discolourations inside the layer.

Two artifact concentrations were described as separate sites and received individual marks of  $\alpha$  and  $\beta$ . In 1963, testing trenches were opened on both sites. They were designed to determine the depth of original artifacts deposition as well as the possibility of finding layers and material deposited *in situ* (Dakaris, Higgs & Hey, 1964). During the excavations, three overlapping clay layers were separated, defined as A, B, C zones (Zone A, B, C). Large stone inventory was collected on the  $\beta$  site in the floor of Zone B, and on the  $\alpha$  site in Zone C.

In 1979, studies in Epirus were commenced by Bailey. At that time, he carried out research on the Klitchi site, as well as some testing trenches in Asprochaliko and Kokkinopilos. The aim of this research was to verify prior findings concerning the site's dating and stratigraphy (Bailey, Papaconstantinou & Sturdy, 1992). In 1963–64, Bailey opened testing trenches both  $\alpha$  and  $\beta$  site.

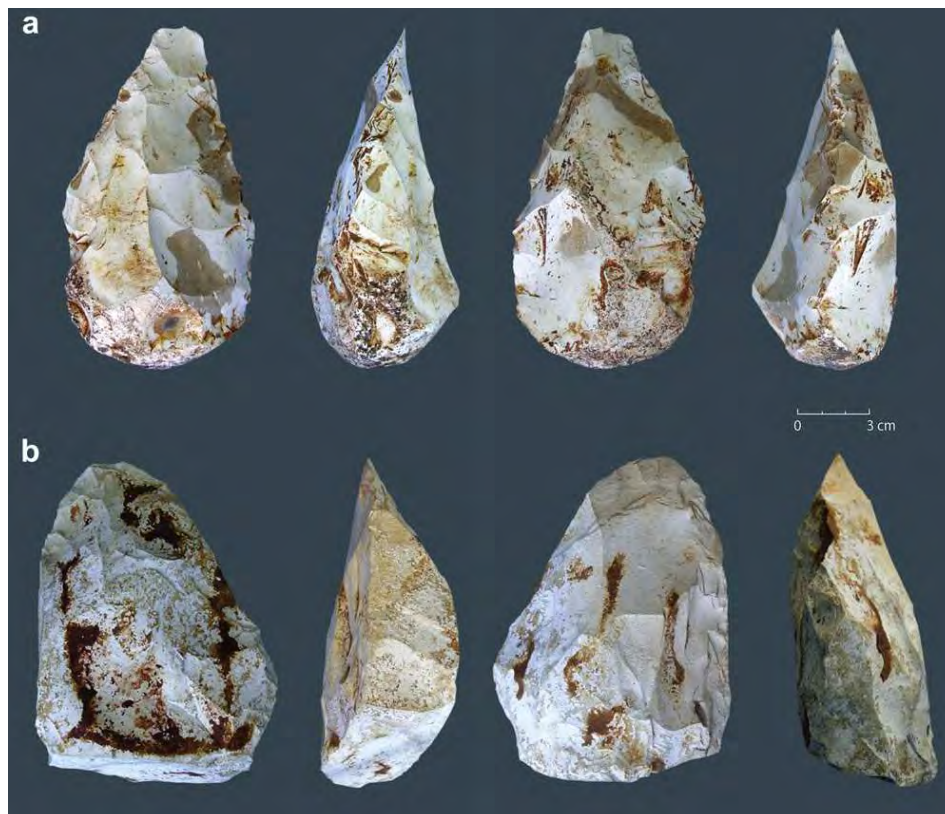


Fig.34 Two bifacial artifacts found by Tourloukis and Karkanas during the most recent studies (Tourloukis & Karkanas, 2012).

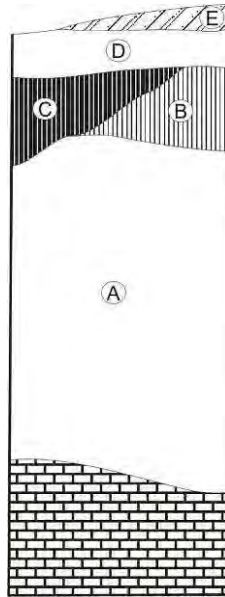


Fig.35 Profile sketch from Bailey's studies (after: Bailey, Papaconstantinou & Sturdy, 1992).  
Numbers of layers correspond to numbers in the text.

A reexamination of the site was performed at the beginning of 90's by Runnels. In 1991, he found a bifacial tool defined by him as a handaxe. The artifact came from a non-reworked deposit of Zone B (Runnels & Van Andel, 1993). The discovery motivated Runnels to conduct further site stratigraphy analyses and to make attempts at its dating.

Since 2007, the site's research has been run by Tourloukis and Karkanas (Tourloukis, 2009; Tourloukis, 2010; Tourloukis & Karkanas, 2012). Their aim is to verify the stratigraphy, identify the nature of artifacts deposition and to date particular site layers. The researchers, during one of their visits, found on the surface of Zone B sediment (a few metres from the bifacial tool found by Runnels), another bifacial tool in a handaxe type (Fig.34a). Tourloukis described it as a "Micoquian handaxe" (Tourloukis, 2009) or "*amygdaloid à talon Acheulean handaxe*" (Tourloukis & Karkanas, 2012 p. 4). During another visit, the second bifacial tool was found on the site (Fig.34b). This artifact, a bifacial tool as well, was described as a "*biface*" (or, a '*bifacial core*'), made on a flake-blank and displaying a flat bifacial retouch" (Tourloukis & Karkanas, 2012 p. 4). The tool, with a poorly exposed tip, was lying horizontally in a non-redeposited clay layer of Zone C (Tourloukis, 2009). Several other artifacts were found in a similar stratigraphic position during TL sampling.

### Stratigraphy

The clay layer in the profile split into three levels of different colours. These levels were specified as zones (Dakaris, Higgs & Hey, 1964) (Fig.36):

**Zone C.** brown-red, discontinuous clay layer, absent in some site parts

**Zone B.** yellow-red clay, brighter than the other levels

**Zone A.** dark red clay.

On the  $\beta$  site, only the existence of Zones A and B was observed, whereas on the  $\alpha$  site all three zones were present. During testing excavations, it was established that Zones A and B (on both sites) are much alike (Dakaris, Higgs & Hey, 1964 p. 215) and the sediment division into three zones was stretched onto the entire site.

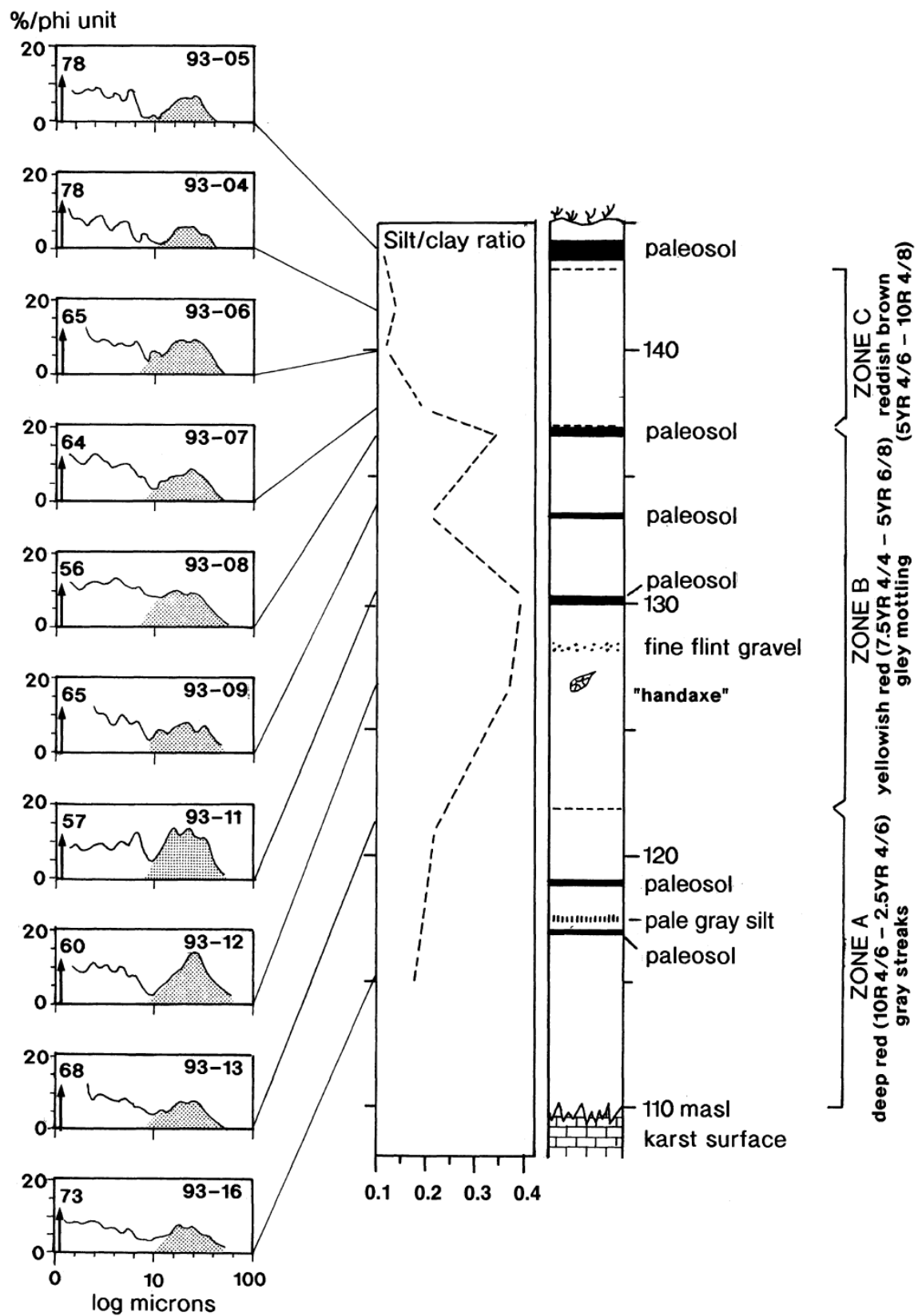


Fig.36 Collective site profile from Runnels' studies (after: Runnels & van Andel, 2003, Fig.3.17).

Bailey gives the following layers description on the site (Bailey, Papaconstantinou & Sturdy, 1992). The researcher retained Higgs' numbering (Fig.35):

- E. red slopewash deposit
- D. yellowish-red or dark red layer of thickness up to 0.5m
- C. red clay with gray veins and darker spotty discolourations containing manganese inclusions and iron nodules (Bailey, 1992 p.140), interpreted as an illuvial paleosol level
- B. orange or red-brown clay, 0.5–3.0m thick, usually laminated and containing silt, sand, and sometimes small gravel lenses, interpreted as a sediment redeposited due to water erosion of lower clay layers
- A. yellowish-red elluvial clay, about 2m thick. In the layer's floor there is a black discolourations level containing ferro-manganese nodules.

In his publication, Runnels presented the following site profile (Fig.36):

- mature paleosol
- **Zone C**—red-brown (5YR 4/6–10YR 4/8) clay “*which locally preserves faint, thin inter-bedding with subhorizontal, gray, bleached layers*” (Runnels & Van Andel, 2003 p. 70), in some places there are gray, vertical fissures which are probably root traces
- immature paleosol
- **Zone B**—yellowish-red clay (7.5YR 4/4–5YR 6/8), subhorizontally laminated, contains gray discolourations—traces of gley processes, interstratified by two poorly developed levels of paleosol located 10 and 14m below ground level. The paleosols are connected with discontinuous gravel lenses, 10 to 30cm thick. Inside the gravel lenses there are flint fragments, including Palaeolithic artifacts
- **Zone A**—dark red (10R 4/6–2, 5YR 4/6) again (like Zone C) with traces of desiccation and erosion in the layer's top; grey-mottled in some places; the floor part has thin (up to 30cm thick) sand layers containing clean, well-formed calcite crystals, precipitated in dry conditions (playa), with dust-fall participation; “*consists of clear, well-firmes calcite crystals with a few percent of quarto, indications precipitation as a playa evaporate combined with a dust fall*” (Runnels & Van Andel, 2003 p. 72).

## Dating

Higgs initially pointed to the eolian origin of the site's sediments (Dakaris, Higgs & Hey, 1964); nonetheless, only two years later he argued in favour of the layers' alluvial character (Higgs & Vita-Finzi, 1966). According to researchers, the artifacts were found *in situ*.

In 1992, Bailey conducted a major criticism of previous results. He stated that the clay layers are older than the artifacts, and perhaps were even deposited in the Pliocene. On this basis, he concluded that the artifacts lying in the layers are redeposited and their age can not be correlated with the age of the very layers (Bailey, Papaconstantinou & Sturdy, 1992).

Runnels mentioned that in addition to the handaxe found within Zone B, also other stone artifacts of non-Levallois morphology were present in the same level. From the profile of paleosol covering Zone B opened by him, he received the TL date of 91 kya BP (Zhou & Lang, 2000), which gave the *terminus ante quem* for the artifacts level. Runnels correlated the



level of the handaxe and other artifacts embeddement with the archaeological horizons (“chipping floors”) discovered by Higgs (Runnels & Van Andel, 2003 p. 99). Runnels dated the level with artifacts to 250 kya BP.

After sedimentological analysis, Runnels concluded that clay deposits with features of *terra rosa* were formed as a result of slow sediment desite in water conditions, in a low-energy depositional environment. This is evidenced by clay layers lamination, fine-grained sediment caliber, and artifacts edges not bearing traces of transport (Runnels & Van Andel, 1993). According to Runnels, the site was created in a tectonic lowering (*polje* type) filled with water, where the material, slowly building-up at the bottom, resulted in the creation of successive clay levels. The sediments show signs of gleying and mottling, which confirms the water nature of sediment desite. Between the clay layers, there are paleosols and desiccation surfaces which point to climate change and temporary reservoir drying. Probably these periods are to be associated with archaeological horizons (Runnels & Van Andel, 1993).

Tourloukis draws attention to the fact that it gives rise to locating such places on the site, where the artifacts will occur *in situ* (2009). The currently developed new research project aims at reexamining the site’s geological aspect and obtaining new absolute dates (Tourloukis, 2009). The results of Tourloukis and Karkanas research published in 2012 confirmed Runnels’ interpretation concerning the low-energy sediment accumulation. Using the dating method of post-IR IRSL (pIRIR), they received the date of >207kya BP for a sample taken from Zone B, a few metres below covering it upper paleosol. The second date >220 kya BP comes from a place not far from the point where Runnels found his handaxe in 1991 (Zone B) (Tourloukis & Karkanas, 2012). Tourloukis also mentions that even the yet unpublished TL dating results also confirm the age of Zone B to be 200–250 kya BP.



Fig.37 Profile revealed during Tourloukis and Karkanas studies. The box shows the first bifacial tool location. In the picture, the desiccation zone is also marked, visible between levels B and C (after: Tourloukis & Karkanas, 2012, Fig.3).

According to researchers, the site was a kind of geological blockage for the sediments washed away from the nearby hills. The sediment deposited at the bottom of water reservoir in the form of laminated clay layers. The periods of climate change and desiccation, associated with soil horizons development, encouraged human settlement. The desiccation zone was found between Zone B and C by investigators (Fig.37). In these points, artifacts accumulation took place. Later, during another climate change, clay accumulation in the aquatic environment started from the beginning, causing the sealing of archaeological material. According to Turloukis one can believe the estimations of Higgs (Turloukis & Karkanas, 2012), who described the age of ravines which cut deeply into the sediment, as coming from late Pleistocene and Holocene. The erosion process would therefore have been recent and artifacts would have been re-exposed relatively recently.

### **Archaeological inventory**

The stone artifacts inventory collected so far includes several thousand of items, excluding the younger age artifacts (ceramics). Most stone artifacts are waste products in the form of flakes and flint blocks.

In a trench on the  $\alpha$  site, the flint artifacts were embedded only within the heavily eroded Zone C (Dakaris, Higgs & Hey, 1964 p. 217). The assemblage contained mainly blade tools, backed blades and high endscrapers which can indicate the inventory's Upper Palaeolithic age.

In a testing trench opened on the  $\beta$  site, the artifacts were embedded in Zone B floor (Dakaris, Higgs & Hey, 1964 p. 215), a few inches above the uneven, eroded border between Zone A and B. A total of 800 artifacts were discovered there, among them two bifacial tools pieces. The inventory is almost entirely made of flint.

What is typical of the Kokkinopilos Middle Palaeolithic inventories is the presence of numerous, flat, small Levallois cores, which provided basis for removing Levallois flakes and blades. Among tools flakes retouched on one edge prevail. Bifacial forms are rare. In the entire collection of Higgs and Runnels only eight bifacially worked artifacts were recovered (including six published). Runnels correlated Higgs' findings (the so called "chipped floors") with the level where the handaxe was discovered. Turloukis relates his findings to the level of handaxe found by Runnels.

Mellars described the assemblage as Mousterian (Runnels & Van Andel, 2003 p. 51). Runnels pointed out, however, that materials derived so far from studies are mostly surface collections and can therefore be mixed. This approach was accepted by Papagianni, who analysed the collection as part of her PhD project (Papagianni, 2000). Her detailed documentation and assemblages analyses led her to the conclusion of mixed Upper and Middle Palaeolithic character of at least the  $\alpha$  site. Also, the surface collections were treated separately by Papagianni, although as a result of her analyses, she found them technologically quite similar to the stratified assemblage from site  $\beta$  (Papagianni, 2000 p. 76). In particular, this applies to leafpoints, of which only two fragments are derived from site  $\beta$  layer (Zone B). The remaining six bifacial leafpoints which were analysed in this paper belong to the surface collection. Nevertheless, it was decided to include them in the analyses for comparative purposes.

Unfortunately, none of the three recently discovered handaxes was found in the Museum of Ioannina collection, hence it was impossible to conduct their analysis.

## 2.1.5. Hungary

### 2.1.5.1. Jankovich Cave

The cave is located on a steep slope of Öregkő hill, in the foothills of Geresce mountains in Hungary. The site is 4–5km to the S of the Danube, in the vicinity of the Bajót village. The cave entrance is 20 metres below the summit and faces the NE. In the course of studies in the early 20<sup>th</sup> century, part of the cave entrance had already been destroyed by quarrying operations, but the main corridor was still about 30m long. The cave consists of two parts, the main passage and the side chamber. The entrance into the side chamber was discovered in the back of the main corridor only after the exploration of a 1.5-metre thick layer of Holocene sediment. In the cave's ceiling, in the middle of the main corridor there is a chimney.

The site's excavations were conducted by Hillebrand between 1913–1917 and in 1925 (Hillebrand, 1935, after: Allsworth-Jones, 1986). The research was started in the main corridor. Only in 1915, the researchers discovered an entrance to a previously unknown cave part called the side chamber. In subsequent years, fieldwork was carried out throughout the cave. During eight seasons of research, Hillebrand explored almost all the cave's sediment, which greatly hindered verifying subsequent site stratigraphy, or obtaining absolute dates. During research, Hillebrand named four geological layers within which he distinguished two archaeological horizons (Magdalenian and early Solutrean). In the side chamber, the researcher distinguished only two layers, but did not reach the bedrock there, though in some places he explored over 7m of sediments.

In 1956, the site's research was led by Vértes. Its aim was to verify the site's stratigraphy, but his actions were very limited as a result of previous major sediment explorations by Hillebrand. Vértes managed to capture the top sediment level in the trench at the cave's entrance, referred to as Magdalenian by Hillebrand.

#### **Stratigraphy**

Hillebrand distinguished four layers in the main cave corridor (Allsworth-Jones, 1986, appendix) (Fig.38):

1. 1–3m (thickness)- Holocene, black and gray-brown humus sediment containing Neolithic and early Bronze Age artifacts
2. 0.5m- yellowish clay with limestone rubble with Upper Palaeolithic artifacts, identified as Magdalenian (Vértes, during his study, distinguished two layers here: the upper level described as brown-yellow and lower as yellowish brown)
3. 0.5m- red clay containing artifacts described as early Solutrean, this layer is missing in the part of the corridor from the entrance to the chimney
4. yellow plastic clay; archaeologically sterile; deposited directly on the rocky ground.

The side chamber profile was described as follows (Allsworth-Jones, 1986, appendix):

1. 1m- yellowish clay containing Magdalenian artifacts, correlated with layer 2 in the main corridor

2. 5m- reddish clay with lighter and darker sub-layers containing artifacts described as early Solutrean, correlated with layer 3 in the main corridor. In the layer's floor Hillebrand discovered two hearths.

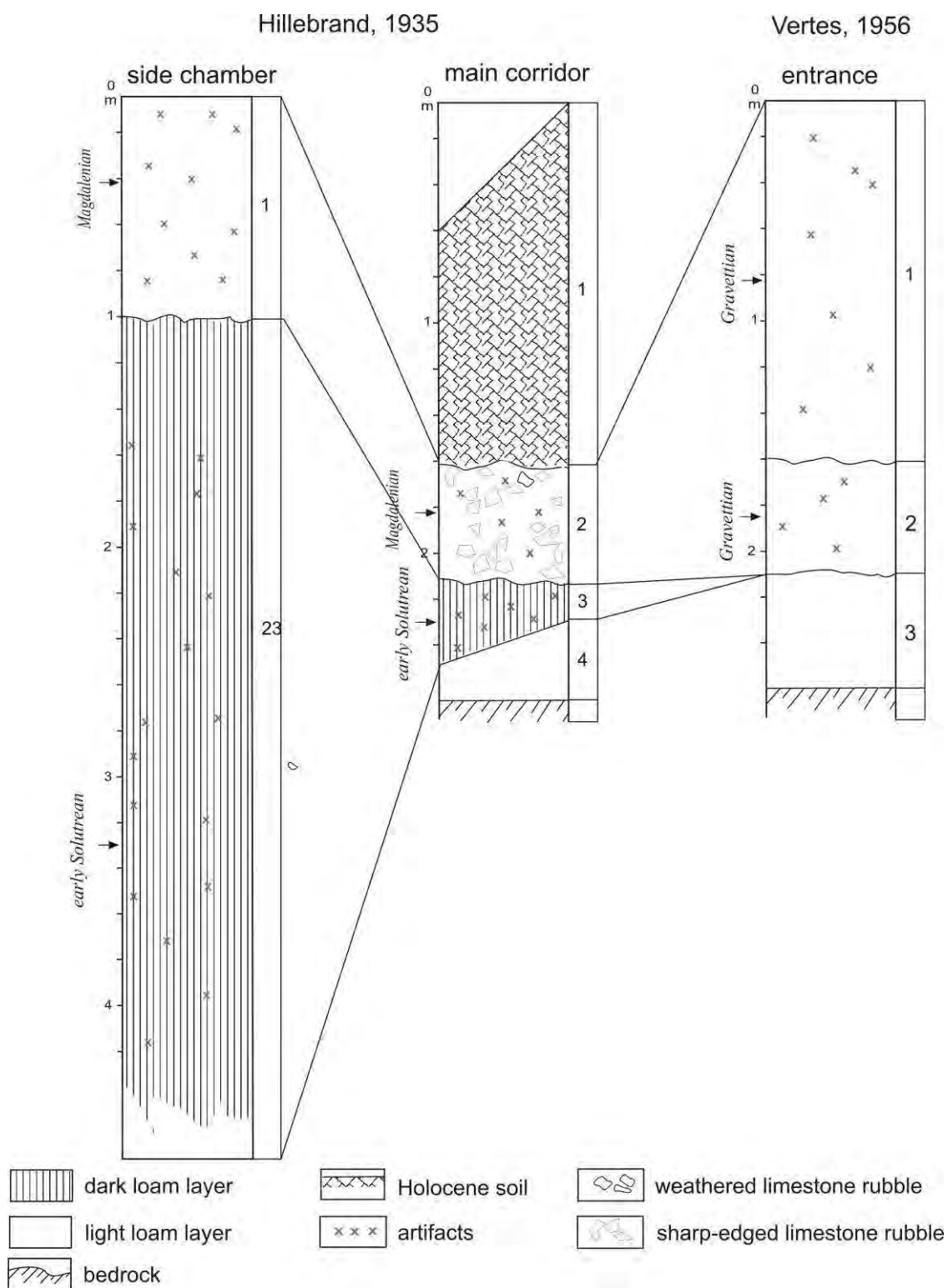


Fig.38 Correlation of Jankovich cave research collective profiles from studies by Hillebrand (main corridor and side chamber) and Vértés (cave entrance).



## Dating

There are no absolute dates available for the site. The only attempt to determine the age of the assemblages were undertaken by Gábori-Csánk, who drew attention to animal bones analysis (Gábori-Csánk, 1993). The results were not conclusive, though. This author suggested that the fauna remains make it possible to correlate the layers with each period of the last glaciation except “Tokod” (Gábori, 1976, Fig.18). At the same time, by analogy to other similar assemblages analysed by Gábori-Csánk, the entire Jankovichian industry was dated to Early Vistulian (OIS 5d–a) on the basis of faunal remains (Gábori-Csánk, 1993). This seems to be confirmed by the archaeological inventory that does not have any Upper Palaeolithic elements or any transitional features found, for example, in the Szeletian inventories.

## Archaeological inventory

The artifacts were highly dispersed and quite rare in the layers. They were, however, accompanied by numerous animal remains, which Hillebrand counted in thousands.

Hillebrand named two culture horizons, of which the upper one was described as an inventory of the Magdalenian period. In the course of his research, Vértes also found the level of Upper Palaeolithic artifacts, but described them as belonging to the Gravettian culture (Jánossy et al., 1957).

From the point of view of this paper, the most interesting is the level determined by Hillebrand as early Solutrean. The Solutrean artifacts were located in layer 3 in the main corridor and layer 2 in the side chamber. Hillebrand did not divide layer 2 in the side chamber into small sub-layers and treated all the collected artifacts as one assemblage. In total, this layer had the thickness of 5m, and here Hillebrand still did not reach the bottom of the cave (Hillebrand, 1935). The researcher stated, however, that the artifacts from different levels of this layer were very similar in terms of morphology and treated the assemblage as coherent.

In total, during the study, Hillebrand obtained less than 150 stone artifacts made mostly from local radiolarites. Their outcrop is located in Dorog village, a few kilometres to the NE of the cave (Hillebrand, 1935). In addition to stone artifacts, in the side chamber Hillebrand found quite a large number of bone points and several other artifacts made of mammoth bones and ivory.(Allsworth-Jones, 1986 p. 113). Vértes, on the basis of the inventory numbers, stated that the bone points come from the top 2 metres of layer 2 in the side chamber (Allsworth-Jones, 1986 p. 114). The archaeological artifacts were accompanied by animal remains, with prevalent cave bear bones.

Among the recovered artifacts there are no cores or debitage flakes, but only tools. Among them Vértes, who performed the inventory’s collective analysis (n=121) as the first one, separated 19 side scrapers, six Levallois flakes or blades, 35 bifacial leafpoints and 17 unifacial leafpoints as well as four Upper Palaeolithic tools, scrapers or burins (Jánossy et al., 1957). Allsworth-Jones, who analysed the Jankovich collection (n=102), found that 15 of the 17 tools identified by Vértes as unifacial leafpoints would be better classified as retouched Levallois points, convergent side scrapers and, in some cases, as Mousterian points (Allsworth-Jones, 1986 p. 114). The results of Allsworth-Jones research increased the Levallois technology input in the assemblage.

Hillebrand described the entire assemblage as early Solutrean (*Frühsolutrees* or *altsolutreen*) (Hillebrand, 1917, 1935 after: Allsworth-Jones, 1986 p. 21) and placed it

chronologically between two archaeological horizons from the Szeleta cave (Hillebrand, 1935).

Prošek was the first who, as early as in 1927 (Allsworth-Jones, 1986 p. 9), suggested to separate leafpoints assemblages in Central Europe as a distinct entity referred to by him as “Szeletian”. Nevertheless, he retained Hillebrand’s division (1935) based on the Szeleta cave stratigraphy. It was Vértes who as the first one noted the difference between the Jankovichian and the Szeletian assemblages. He questioned the set’s placement as a transition between the two archaeological levels in Szeleta cave. He based his assumption on the significant number of bone points in the Jankovich assemblage and, above all, on the leafpoints different morphology and their different manufacturing technology (Vértes, 1956; Vértes, 1955). The researcher emphasized their similarity to the leafpoints from Mauern and the assemblages from the Altmühl Valley. At the same time, he referred to the Jankovich assemblages as “Trans-Danubian Szeletian” (Vértes, 1956).

After the analysis of Jankovich assemblage and other trans-Danubian sites, Gábori-Csánk decided to make it eponymic for the Jankovichian industry distinguished by her (Gábori-Csánk, 1993). According to Gábori-Csánk, and other contemporary researchers (Mester, 2008) what would distinguish the Jankovich industry from other transitional assemblages, and mainly the Szeletian one, was the following:

- lack of typically Upper Palaeolithic tools (such as endscrapers and burins),
- presence of Middle Palaeolithic tools (e.g. side scrapers),
- assemblage made mainly on radiolarite,
- presence of Levallois technology,
- less regularity in the forms of leafpoints (Mester, 2008 p. 67).

Gábori-Csánk referred to leafpoints from Jankovich as “leafscrapers”, so as to emphasize their form different from typical Szeletian points (Gábori-Csánk, 1993; Gábori, 1976).

She concluded that the fauna remains are not distinctive and do not allow for dating the leafpoints horizon, yet, by analogy with other sites analysed by her she determined the general Jankovichian chronology as Early Vistulian (OIS 5d–a) (Gábori-Csánk, 1993).

J.K. Kozłowski drew attention to the Levallois element in the Jankovich assemblages, demonstrating the possibility of a relationship with the Levallois-Mousterian assemblages of Southeastern Europe (Kozłowski, 1975). Following the idea, Allsworth-Jones also emphasized their relationship with the Southern European leafpoints assemblages. Nevertheless, he categorized the Jankovich assemblages as “Central European Szeletian in a wider sense” (Allsworth-Jones, 1986).

### 2.1.5.2. Sajóbábony Méhész-tető

Open-air site located in NE Hungary in the Bükk mountains region. It is located near the Sajóbábony village, about 8km to the N of Miskolc. The site is at a hill top at the confluence of Sajo and Bábony rivers. Its Pleistocene cover is thin, from 1.5 to 3.5m.

As a surface site, the locality has been known since 1927. The artifacts were found in the surface humus layer which is formed by paleosol outgoing on the surface. In the profile below the soil layer, there is a visible loess layer.

First testing trenches on the site were opened in 1974 and aimed at determining its stratigraphy. Research was led by Dobosi (1988). In the study, 182 stone artifacts (including 31 tools) were recovered from the surface, from arable humus layer and from compact red clay layer 50–70cm thick, located just beneath the topsoil (Dobosi, 1988). In the profile's schematic drawing, the arable humus layer was not separated from the underneath humus layer (Dobosi, 1988, Fig.2). Within the arable layer (at a depth of 60cm), a hearth was found, slightly concave in cross-section, square in plan and filled with stones. Dobosi was willing to join the time of its creation with the stone artifacts found in the layer. On the basis of artifacts collected on the site, Árpád Ringer described a separate industry called Babonyian (Ringer, 1983 p. 53). In 1986–1991, research was continued by Ringer, who had identified several artifact deposition horizons (Ringer & Adams, 2000 p. 119). The results have not been fully published so far.

The research on the site was resumed for two seasons in 1997, in order to obtain samples for TL dating and for detailed soil analysis. Trenches with the surface of 26m<sup>2</sup> were opened. The results have not been fully published yet. Stone artifacts were found on the surface, in the humus layer, and in the loess layer below the soil, but Ringer claims that they fell into this layer from the soil level due to post-depositional processes (Ringer, 2000 p. 182).

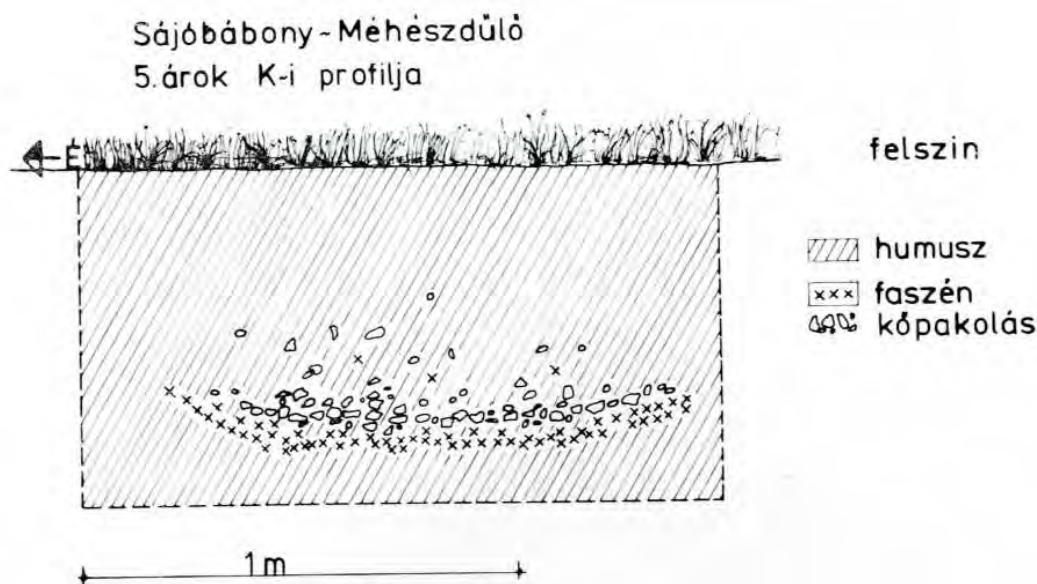


Fig.39 Trench profile with a cross-section through a hearth, explored during the 1988 studies (after: Dobosi, 1988, Fig.2).

## Stratigraphy

For the Sajóbábony site, one does not have any published geological profile. The publication of Dobosi (1988) includes a schematic profile showing the construction of a hearth located in the humus level (Fig.39). The publication by Ringer and Adams (2000, Fig.2) presents a trench profile picture with a visible soil level approximately 1m thick. The publications (Ringer, 2000; Ringer & Adams, 2000) show that the site's layer system is similar to the one presented by Dobosi.

Under the layer of arable soil there is a soil level several centimetres thick (Fig.40). Ringer distinguished two separate paleosol levels within the soil located below the arable soil. The upper one he described as "*pseudogley brown forest soil*" (Ringer & Adams, 2000 p. 117), and the lower one as "*polygenetic gray forest soil-meadow of chernozem character*" (Ringer & Adams, 2000 p. 117). Ringer correlates the upper level with Ma1, and the lower one with level M1 of Eemian paleosol, thus pursuing the regional stratigraphy created by Kordos and Ringer (1991). Bipartite Eemian soil is also found in the profile from Sütto, where the upper level is dark brown paleosol of chernozem type, under which there is a level of red-brown paleosol (Novothy et al., 2009).

In the widely known Hungarian loess profiles such as Mende, Basaharc, Paks, the correlation of levels was extensively discussed for a long time (Oches & McCoy, 1995, for further literature). Currently, on the bases of TL and OSL dating, the forest steppe paleosol MF2 from Mende can be dated to Early Vistulian and Eemian (Novothy, 2002; Oches & McCoy, 1995; Bronger, 2003; Horváth, 2001). In the Basaharc profile, the MF2 paleosol occurs as a redeposited soil layer. The profile of Albertirsa, the MF2 layer is correlated with a bipartite lower soil level, ca 1m thick. Dark brown sediment, darker in the upper part, has traces of numerous bioturbations in the form of crotovinas (Novothy, 2002).



Fig.40 Trench profile photography from the 1997/98 studies by Ringer and Adams. Soil level interpreted as Eemian paleosol (after: Ringer & Adams, 2000, Fig.2).

## Dating

During research, the TL samples were collected from the loess layer lying below the soil level, and gave the dates of  $173.0 \pm 14.2$  kya BP and  $157.9 \pm 7.0$  kya BP (Ringer, 2000). The loess level should therefore be correlated with the Wartanian glaciation (OIS 6) (Ringer, 2000). The dates would correlate with the overlapping interglacial paleosol of Eemian period (Ringer & Adams, 2000 p. 119). In addition to that, Ringer (Ringer, 2002 p. 41) mentions the presence of hornbeam and oak pollen (*Quercus*, *Carpinus*), *Hystrix vinogradovi* and the mollusc–*Helicigona banatica*, which indicate the presence of forest ecosystem and warm climate.

In 1999, a loess profile with paleosol near Sajószentpéter-Margitkapu-dűlő was also submitted to analysis. In the profile one can observe paleosol (M1) correlated with the Eemian Interglacial. For the layer located above the Eemian M1 layer, researchers obtained TL dates:  $85,3 \pm 7,0$  kya BP and  $101,4 \pm 9,0$  kya BP (Ringer & Adams, 2000 p. 119). The dates allowed for extending the dating of paleosol to the end of Early Vistulian. The paleosol can be therefore dated between OIS 5e and OIS 5c. According to Ringer, correlating the two paleosols (from Sajóbáony Mész-tető and Sajószentpéter-Margitkapu-dűlő) allows for estimating the dates  $85.3 \pm 7.0$  kya BP and  $101.4 \pm 9.0$  kya BP as being *terminus ante quem* for the Babonyian (Ringer, 2000; Ringer & Adams, 2000 p. 119).

## Archaeological inventory

The artifacts are made of quartz-porphry or hydro-quartzite coming from the Bükk Mountains. The collected inventory description is not complete, and concerns mainly tools (Ringer, 1983; Ringer & Adams, 2000) The inventory is characterized by lack of Levallois technology. There is a number of forms in the assemblage, including bifacial knives, leafpoints and Babony-type knives (Ringer & Adams, 2000 p. 121; Ringer, 2000). Bifacial artifacts are characterized by the presence of bifacial retouch referred to as "babonyienne" (Ringer, 1983; Ringer, 2001), associated with the *Wechselseitig Gleichgerichtete Kantenbearbeitung* technique defined as a fully alternate knapping scheme (Ringer, 1983, Fig.1.1).

The microscopic analyses of artifacts usewear showed that their edges were postdepositionally modified. Even so, it was possible to recover usewear traces on 6 tools (out of 14 analysed). Five of them show signs of dry hide scraping, and one displays traces of fresco hide scraping. None of the analysed tools has any features of using them as projectile points. This may indicate, as noted by Adams (Ringer & Adams, 2000 p. 123), their use as cutting tools. Among the analysed pieces, there was only one analysed in this thesis (97.2.1970); unfortunately, its usewear analyses show only signs of postdepositional traces (Ringer & Adams, 2000, Tab. 1).

## 2.1.6. Romania

### 2.1.6.1. Ripiceni Izvor

Open-air site placed on the left bank of the Prut river in NE Romania. The site is located in quaternary residue, its thickness approaching 13m, located on a Pleistocene river terrace. The site is located 1.2km from the Ripiceni town in the Botosani municipality. Around 200 metres from the site, in the limestone wall of Stinca Ripiceni hill, there is a small cave of the same name. The cave is also an archaeological site and was excavated in the 1920s by Moroşan. Four Upper Palaeolithic horizons were found there.

The Ripiceni-Izvor site was discovered in 1902. Before World War II, its research was carried out by Morosan, who collected Middle and Upper Palaeolithic artifacts (Paunescu, 1993 p. 9). In 1961 Paunescu started new research on the site, and during the 20 years of excavation he had altogether explored 4000m<sup>2</sup> of the site's surface (Paunescu, 1965, 1993, Fig.13). The fieldworks had an intensive character due to the plans of building a reservoir on the site. With the research terminated, the site was actually flooded, and it is currently under water. During excavations, Paunescu distinguished 16 archaeological horizons dated to Stone Age. The artifacts were accompanied by large amounts of animal bones. In the Middle Palaeolithic levels, 90% of bones belonged to mammoth. Also, in the layers objects specified as dwellings and structured hearths were recovered (Paunescu, 1993 chap. VI).

#### Stratigraphy

Paunescu did not present an exhaustive stratigraphy description, as he mostly focused on separate cultural levels. Therefore, descriptions given below are, in each case, the results of reading and listing the data from profile drawings included in the publication.

The following description was made according to a simplified profile drawing (Paunescu, 1965, Pl. III). The numbers are only arbitrary and ordinal, and have been assumed for the needs of this dissertation. Next to each number there is an approximate layer deposition depth (data taken from a drawing) (Fig.41).

7. 0–1.5m- dark grey humus layer
8. 1.5–2.5m- loess degraded (*dégradé*) by humus
9. 2.5–4.0m- loess
10. 4.0–4.5m- dark red-brown paleosol
11. 4.5–6.5m- loess
12. 6.5–7.0m- dark red-brown paleosol
13. 7.0–7.4m- loess
14. 7.4–7.8m- dark red brown paleosol
15. 7.8–8.5m- loessoid clay
16. 8.5–9.5m- clay
17. 9.5–11.5m- sandy clay, laminated
18. 11.5–12.0m- gravel
19. calcaires sarmatians (limestone rock, sarmat, the Tertiary)

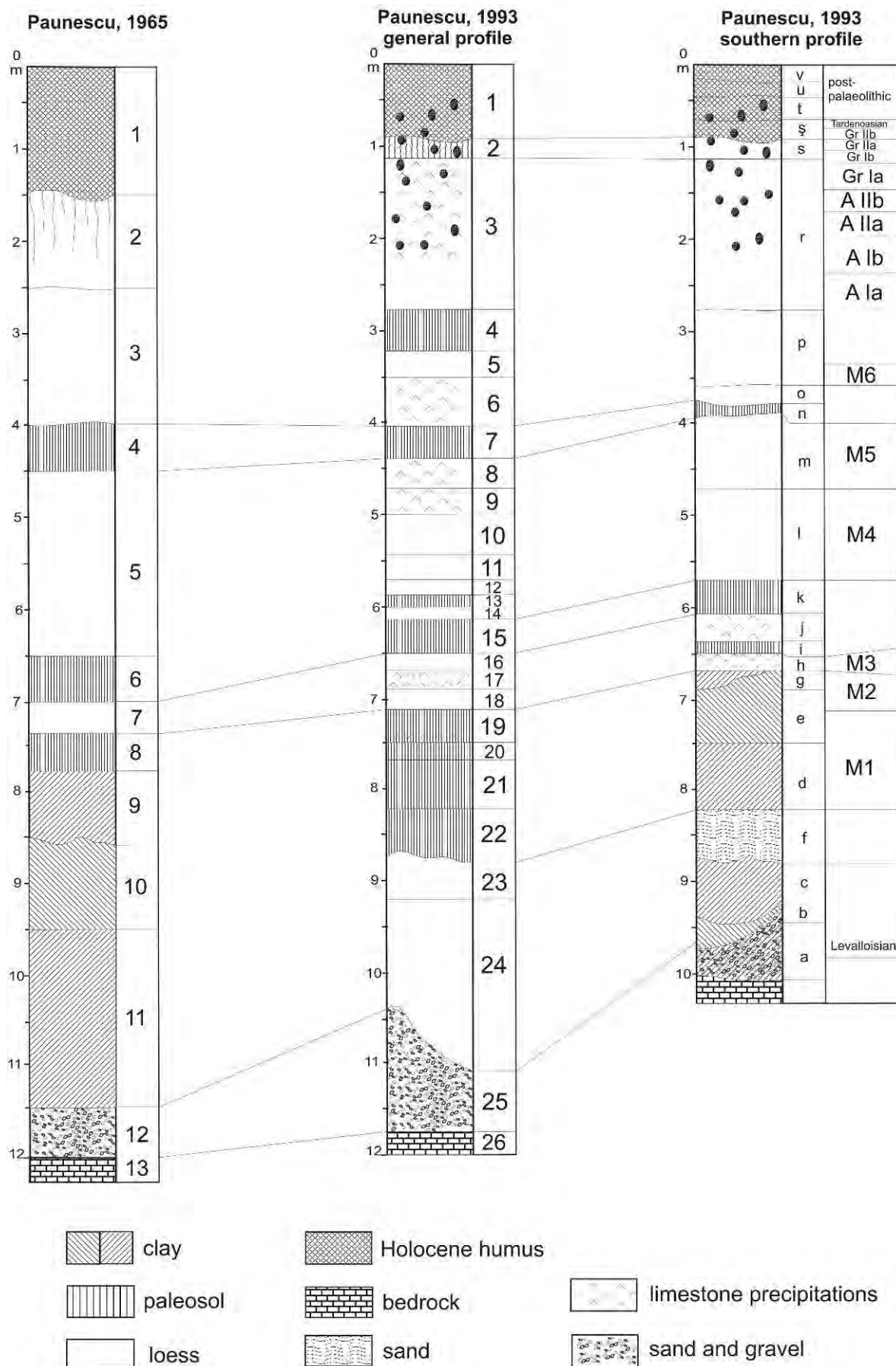


Fig.41. Ripiceni Izvor profiles correlation. Numbers of layers in accordance with description.

Layer description for trench II southern profile. It constitutes the site's only full geological layers description and comes from a profile drawing (Paunescu, 1965, Pl. II, 1993, Fig.4) (Fig.41):

- z)** contemporary deposit
- v)** black humus
- u)** lenses of yellow-grey paleosol with ash
- t)** lenses of dark brown paleosol
- t)** dark red paleosol
- s)** black-grey paleosol
- s)** original loess layer
- r)** yellow loess
- p)** yellow loess with reddish discolourations
- o)** yellow loess with red spots
- n)** dark red-brown paleosol
- m)** yellow loess with red spots
- l)** dark yellow-red loess
- k)** dark red paleosol
- j)** yellow-brown loess with carbonate nodules
- i)** dark red paleosol
- h)** dark brown loess clay with small carbonate nodules
- g)** brown clay with iron nodules
- f)** yellow or red sand
- e)** light brown clay
- d)** clay with red-brown spots
- c)** yellow–brown, horizontally laminated clay
- b)** green-grey laminated sandy clay
- a)** sandy clay and sand with gravel

The following description was prepared on the basis of layers description on a simplified profile, collecting lithological, mineralogical, faunistical, palynological, podologic, granulometric and paleoclimatic data (Paunescu, 1993, Fig.3) The numbers are arbitrary and ordinal; and have been assumed for the purposes of this thesis (Fig.41).

**7.** 0–0.8m- dark brown-black (10YR 2/15) chernozem with bioturbations of animal origin (*taupinée*), containing organic matter

**8.** 0.8–1.0m- dark brown (10YR 3/3) layer containing organic matter and bioturbations

**9.** 1.0–2.8m- brown-olive (2,5Y 4,5/4) loess with carbonate nodules and bioturbations; darker at the bottom, containing root traces



10. 2.8–3.2m- brown-olive (2,5Y 4,5/4) paleosol, poorly developed soil containing organic matter
11. 3.2–3.3m- loess with root traces and organic matter
12. 3.3–4.0m- light brown-olive (2,5Y 5/4) loess with root traces and carbonate nodules
13. 4.0–4.4m- poorly developed soil level with bioturbation traces in the form of roots
14. 4.4–4.7m- brown-olive (2,5Y 4,5/4) loess with carbonate nodules
15. 4.7–5.0m- brown-olive (2,5Y 4,5/4) loess with carbonate nodules
16. 5.0–5.5m- light brown-olive (2,5Y 5/4) loess with root traces
17. 5.5–5.8m- brown-olive (2,5Y 4/4) loess with root traces and organic matter (“*acumulari zoogene*”)
18. 5.8–5.9m- light brown-olive (2,5Y 4,5/4) loess with root traces
19. 5.9–6.0m- poorly developed paleosol
20. 6.0–6.2m- light brown-olive (2,5Y 4,5/4) loess with root traces
21. 6.2–6.5m- brown-olive (2,5Y 4/4), poorly developed paleosol with organic matter
22. 6.5–6.7m- light brown-olive (2,5Y 4,5/4) loess with root traces and organic matter
23. 6.7–6.9m- olive (5Y 5/4) loess with root traces
24. 6.9–7.1m- light brown-olive (2,5Y 5/4) loess with carbonate nodules
25. 7.1–7.5m- brown olive-brown (2,5Y–10Y 4/4) loess changing gradually into paleosol layer
26. 7.5–7.7m- poorly developed paleosol of dark brown-yellow colour (10YR 4/4), containing carbonate nodules in the bottom
27. 7.5–8.3m- light brown-yellow to brown-yellow (10YR–2,5Y) paleosol; illuvial level B
28. 8.3–8.8m- grey-olive (5Y 5/2) paleosol; illuvial level B; red-yellow at the bottom (5YR 4/8)
29. 8.8–9.1m- gley sediment with brown-grey organic substrata (2,5Y 5/2), spotted
30. 9.1–10.3m- marble grey gley sediment with intensive olive-brown discolourations (5Y 5/2 and 7,5YR 5/8), brown at the top (7,5YR 4,5/4)
31. 10.3–11.6m- gravel layer
32. limestone rock

### Profile correlations

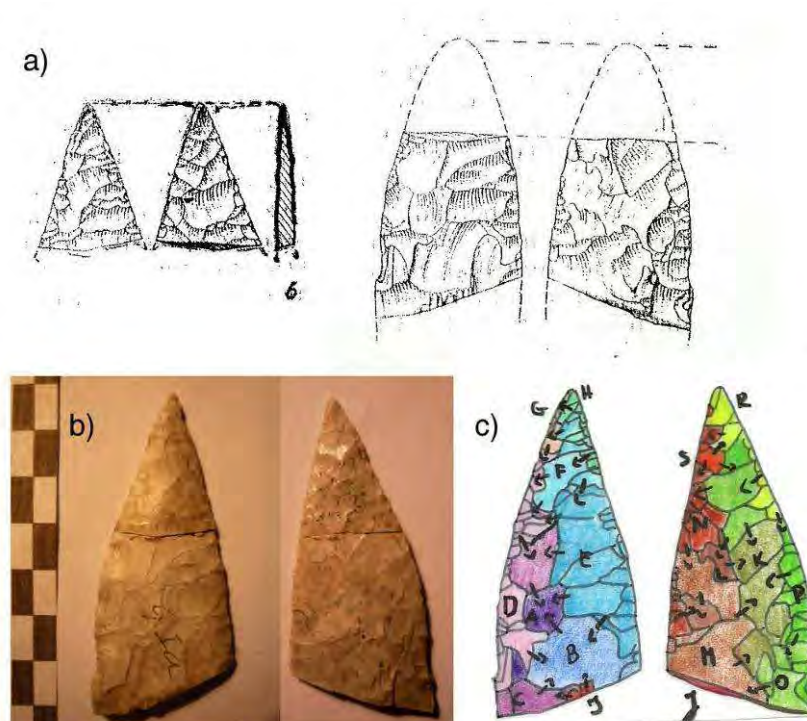
In his 1965 publication, Paunescu presented the site’s preliminary layer description. Nevertheless, in his 1993 publication, two profile drawings were placed, first of which was the drawing of the southern trench profile, the other one being a cumulative, simplified drawing of the site's stratigraphy. On the basis of those two drawings, and the description given in the publication, profile correlations have been produced. . As it seems, the 1965 description of layer arrangement fully corresponds with the layer arrangement presented in

the drawing showing the southern trench profile. The layers division also correlates quite well with the arrangement presented in the cumulative profile. The only biggest discrepancy is the paleosol described in the cumulative profile (layer 4), which does not have its counterpart in the remaining drawings and descriptions (Fig.41). One can also consider the correlations of paleosols lying at a depth of between 6 and 7 metres. Layers 13 and 15 in the general profile do not have a good counterpart in the trench profile. Perhaps they should be correlated with layer "k" and level 6 (Fig.41) or layers "k" and "i" in the trench profile.

As it stems from descriptions and drawings, the Levallois inventory was found in the lowest layer of gravels (a), the oldest Mousterian levels MI and MII were lying in lower paleosols (d, e). The inventory given the name of MIII level, occurred within the limits of thin loess layer (h). The loess and paleosol lying below were archaeologically sterile and separated the Mousterian levels with "leafpoints" (MIV and MV) occurring above in the loess layers (l and m). The paleosol located above (n) was also an archaeologically sterile level separating the highest Mousterian inventories occurring in the loess layer (p). The Aurignacian and Gravettian artifacts were lying in the loess layers (r, s, ş).

### Dating

Three archaeological levels were dated with the aid of C14 analysis. From the Aurignacian level Ib one date was obtained: 28,420±400 uncal BP. For the Mousterian level IV (MIV) 5 dates were obtained, the results being coherent except for one. The dates are: 28,780±2000 uncal BP (which is a false date) (Mertens, 1996), 40,200+1100-1000 uncal BP, 42,500+1300-1100 uncal BP, 43,800+1100-1000 uncal BP, 44,800+1300-1100 uncal BP.



*Fig.42 Two fragments of tools, published separately in Fig.98. 6 and 23 (Paunescu, 1993) appeared to be a refitting of the same leafpoint with a strongly exposed tip; a) published drawings (Paunescu, 1993, Fig.98.6,23); b) picture of the refitted tool; c) scar pattern analysis of the refitted tool.*

For the Mousterian level III five dates were obtained: 38,900±900 uncal BP, >41,000 uncal BP 45,000±1400-1200 uncal BP, 46,200±1100 uncal BP, 46,400±4700-2900 uncal BP. For the Mousterian level II only one date was obtained, because of low carbon level, the result being >36,950 uncal BP.

Paunescu interpreted the whole loess profile as a stratification series originating from the last glacial period. The series of Prut terrace gravel was correlated with OIS 5e. The lower Mousterian level MI was correlated with the Early Vistulian between the Amersfoort and Brørup Interstadials. Level MII, because of its moderate climate, was correlated with Odderade and the beginning of Lower Pleniglacial's later cooling. Mousterian III was correlated with the cooling preceding Moershoofd Interstadial due to the presence of reindeers pointing to a temperate climate. The sterile level above the MIII level, like the MIV archaeological level, due to the presence of cool-resistant fauna such as mammoth and reindeer, was dated to the period of cool oscillation between Moershoofd and Hengelo. On the other hand, level MV was correlated with the warm Hengelo Interstadial. The two lingering sterile layers divided by level MVI were dated to the cold oscillation of Arcy, Stillfried. The Aurignacian levels were correlated with the early phases of Upper Pleniglacial (Tursac), whereas the Gravettian levels with the Lascaux phase and until early Allerod. He correlated the Mesolithic settlements with the pre-Boreal and Boreal period.

J. Hahn proposed to correlate the paleosol layers containing Aurignacian artifacts with warm oscillations of Denekamp Interstadial, before the Upper Pleniglacial (Hahn, 1977, Fig.30).

### **Archaeological inventory**

On the site, 16 archaeological horizons were distinguished (excluding Neolithic artifacts and those of later origin occurring in Holocene soil level.) Among the differentiated levels, there is one Mesolithic, named Tardenoisian, four Gravettian (starting with the oldest—Ia, Ib, IIa, IIb), four Aurignacian (Ia, Ib, IIa, IIb), six Mousterian (from I to VI), two “pre-Mousterian” of Levallois tradition and two lower Palaeolithic (Paunescu, 1993 p. 26). As it can be seen from description and profile drawings, particular archaeological levels did not correlate with the geological layers arrangement. Individual levels were lying directly one over another. Archaeologically sterile layers appeared only among several horizons. The sterile layer occurred below the Aurignacian horizons and separated them from Mousterian levels. The sterile layer also separated level MVI from level MV, and was placed between levels MIII and MIV.

Almost all artifacts were made of good quality local flint coming from the Prut valley, from an outcrop located 20km off the site (Paunescu, 1993).

Owing to the presence of numerous archaeological levels rich in artifacts, the description at hand is limited to levels MV and MIV, which were of the paper's interest with regard to the dissertation's topic. In the Mousterian levels IV and V, symmetrical bifacial tools referred to as leafpoints were found (Paunescu, 1993) Hence, those levels were classified as “leafpoints” industries. Those levels, as it can be seen in Paunescu's stratigraphy, were separated in profile from the remaining ones, both above and below, with archaeologically sterile layers.

Level MIV constituted one of the richest in artifacts (almost 36,000) and bone remains of Ripiceni assemblages. At this level, a few concentrations of animal bones—mostly mammoths—were found, accompanied by numerous flint artifacts (Paunescu, 1993, Fig.38, 54), and also structured hearths with stone constructions (Paunescu, 1993, Fig.50–52), or

separate stone constructions (Paunescu, 1993, Fig.47–48). The existence of such objects points to the site being a base camp. Paunescu interpreted the bones accumulation, and especially mammoth incisors, as the remains of dwellings (1993, Fig.56).

By contrast, level MV was poorer both in artifacts (16,000 only), and in bone remains. Within its limits, there was only one artifacts accumulation connected with an oval stone structure (Paunescu, 1993, Fig.78).

Both inventories are much alike. Paunescu described them both as “*musterien superieures finale*” (Paunescu, 1965 p. 9) Those levels are characterized by considerable contribution of Levallois technology in the form of Levallois cores, points, flakes and blades. However, this technology is accompanied by bifacial artifacts, absent from the remaining, earlier Mousterian levels. The inventory houses backed knives and symmetrical forms named “leafpoints”. Bifacial forms are accompanied by flake side scrapers. Apart from typical Middle Palaeolithic artifacts, there are also endscrapers, burins and borers.

Level MIV, as already mentioned, was given C14 dates in the range of 40,200±1100 to 44,800±1100 uncal BP. Palynological analysis points to a cool period which was accompanied by deforestation and cold steppe ecosystem development (Paunescu, 1993 p. 180; Paunescu et al., 1976). Paunescu correlated it with the Hengelo Interstadial.

In the literature, a discussion was held as to the artifacts’ interpretation and their cultural classification. Bosinski, Mania and Toepfer, and then Allsworth-Jones, were of the opinion that the inventory should be classified as the Central European Micoquian complex (Bosinski, 1967; Allsworth-Jones, 1986; Dietrich Mania & Toepfer, 1973). Gabori (1976) pointed to the presence of Levallois technology in the inventory, which is untypical of assemblages with backed knives. The site’s researchers themselves did not use the term Micoquian for the inventory description (Paunescu, 1965; Paunescu, 1993).

Individual leafpoints also appear on later levels, including all Aurignacian levels, or the Gravettian levels Ia and IIa (Paunescu, 1993, Fig.86, 98, 95, 98, 103). Yet, these artifacts differ significantly from the Middle Palaeolithic leafpoints in terms of morphology. They are mostly distinguished by small thickness, considerable manufacturing precision, and highly significant tip exposure. The analysis of Mousterian forms was accompanied by scar pattern analysis of several leafpoints from the Aurignacian and Gravettian levels. However, the results’ description surpasses the scope of this thesis. Two fragments, 6 and 23, published in Fig.98 (Paunescu, 1993) appeared to be a refitting of the same leafpoint with a strongly exposed tip, resembling the leafpoint from Mitoc Izvorului in the morphological aspect (Fig.42).

## 2.1.7. Ukraine

### 2.1.7.1. Korolevo

Open-air site located in loess deposits up to 14 metres thick, at the top of a volcanic elevation located 80–100m above the modern alluvial terraces on the Tisza river's left bank (Transcarpathian Ukraine). The site encompasses two hills: Gostry Verkh and Beyvar, as well as the area of Vinnyichki terrace below the Vinnyichki hill. Due to its extent, the site is divided into two parts. Korolevo I covers the area of Gostry Verkh and Beyvar, whereas Korolevo II covers the terrace area below the Vinnyichki hill. Both sites are located in the area of active quarry.

The site was discovered by Gladilin in 1974 and has since been subject to several seasons of continued excavation. The works were carried out under the direction of Gladilin of the Ukrainian Academy of Sciences. Owing to the site's substantial extent and the conditions which had to be adjusted for the quarry, the aim was to determine the site's range and its most detailed stratigraphy. The study was continued until the early 90's (Koulakovskaya, 1995).

In total, trenches with the area of 1500m<sup>2</sup> were opened, yielding more than 700 thousand stone artifacts. No animal remains were preserved on the site. The richest in artifacts were the layers placed on the Boyvar hill, though the profile at this point was often of small thickness and different paleosols were preserved only partially. By contrast, the Gostry Verkh area provided few stone artifacts, but the local profile was much more complex and, on its basis it was possible to create full stratigraphy description. In the main profile 7 paleosols and 16 archaeological horizons were distinguished (Gladilin, 1989).

Until today, detailed works on describing all the acquired inventories are still taking place. So far, preliminary results of profiles analyses with palynological and paleoecological analyses have been published in literature, as well as the results of TL, C14 and paleomagnetic datings (Gladilin, 1989). Moreover, preliminary results of the most interesting assemblages analysis, among these assemblages with leafpoints, have been published as well (Gladilin & Demidenko, 1990; Gladilin, 1989; Gladilin & Demidenko, 1989; Gladilin, Slitlvyj & Tkachenko, 1995; Demidenko & Usik, 1995; Koulakovskaya, 1995; Koulakovskaya, 2001).

In 1997, in cooperation with the Belgian and French researchers, excavations were reopened for two seasons. Their aim was to verify different layers' stratigraphy and dating. The trench was located in the area of Gostry Verkh, at a short distance from the earlier trench 18, which served as a reference point for the stratigraphy description by Gladilin (see below).

#### **Stratigraphy**

The most detailed stratigraphy was introduced by Gladilin in 1989 (1989). The author presented the most meticulous profile description of Korolevo I, Gostry Verkh from the trenches 14, 18 and 26, and excavations X and XI. Due to considerable diligence in describing the site, an exact quote is presented below (Fig.43):

*1. Recent brown forest soil that has arisen under deciduous forest. The thickness of the layer is up to 0.5m.*

*2. Loess-like loam, light-yellow, reddish, coarse porous; thickness up to 0.5m.*

3. Loess-like loam, whitish with slight admixtures of manganese-iron nodules; their content is growing downwards, the thickness reaches up to 0.35m.

4. Light-brown loam with light ochre-red hue, and with numerous bean-shaped nodules of iron and manganese hydroxides. The content of these admixtures is growing upwards; it is fragmented by vertical fissures (cavities after the plant roots filled with loam from the higher layer IIIrd fossil soil of the regional section of the Transcarpathian Anthropogene; it is up to 0.40m thick.

5. Light-yellow loamy clay, porous; interrupted by fissures filled with gray-whitish loam; it is up to 0.15m thick.

6. The same loam containing grained and flat iron-manganese concentrations; thickness is up to 0.40m.

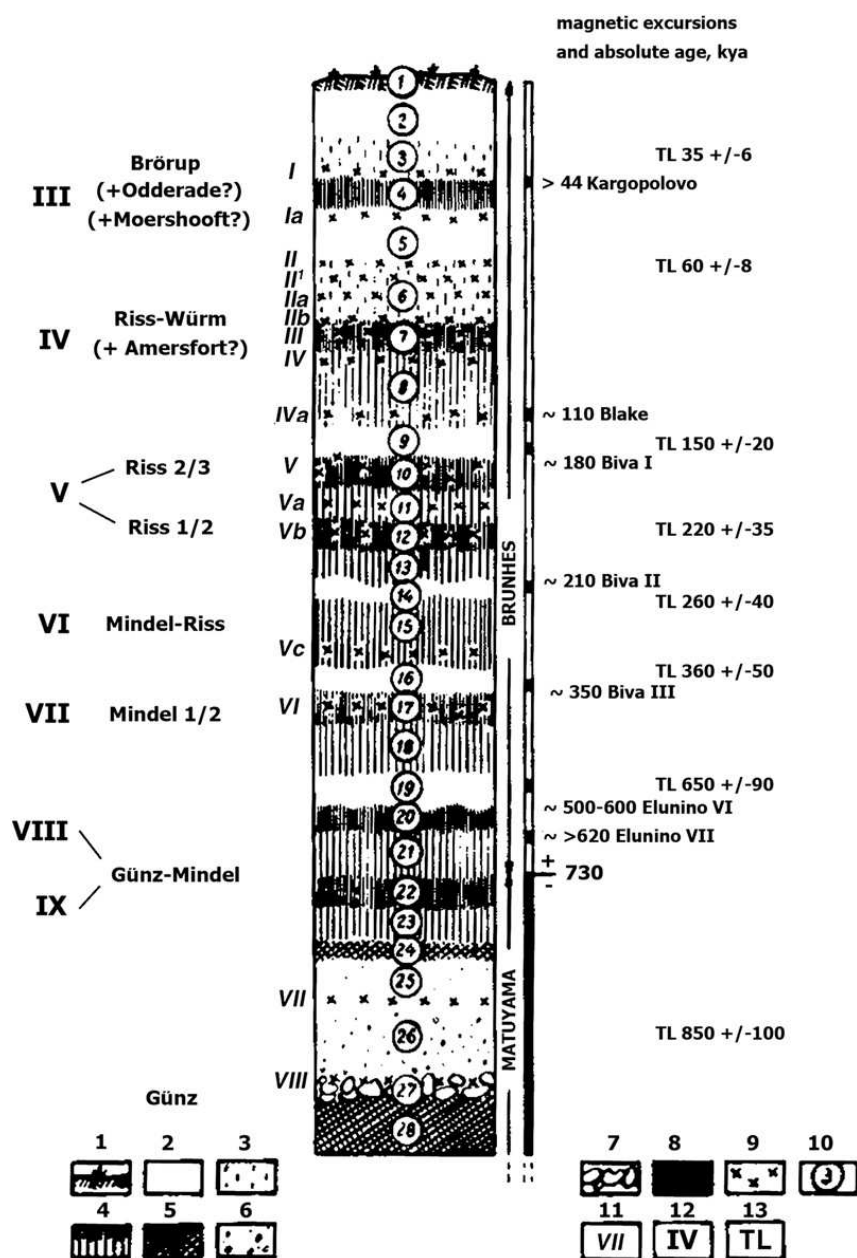


Fig.43 Main Korolevo I profile from Gostriy Verkh. Numbers of layers correspond to numbers in the text (after: Gladilin, 1989, Fig.4).

7. Brown loam with ochre-red hue and with numerous bean-shaped concentrations, of nut-like structure, aggregated; with vertical fissures filled with white loam and with loam of layer 6; the upper horizon of the IVth fossil soil of the anthropogenic section of Transcarpathia; it is up to 0.20cm thick.

8. The same brown loam, but without significant iron-manganese concentrations (the iron content appears in the form of mould in the fissures; with vertical fissures filled with whitish loam and with loam from layer 5: lower horizon of the IVth fossil soil of Transcarpathia; its thickness is up to 1.40m.

9. Light-coloured loam, porous with rare and small iron-manganese concentrations; thickness up to 0.46m.

10. Light-coloured loam with light ochre-red hue and with frequent small and medium-sized bean-shaped and blotchy iron-manganese concentrations: top horizon of the Vth fossil soil of Transcarpathia's general stratigraphic section; thickness up to 0.30m.

11. Yellow-brownish loam of ochre-red hue, grainy, porous, with fissures, with scattered small iron-manganese concentrations in the fissures, looking like mould—the fissures are filled with whitish loam: the second horizon of the Vth fossil soil; thickness up to 0.65m.

12. Light-coloured loam, similar to loam of level 10, but with somewhat less frequent iron-manganese nodules: third horizon of the Vth fossil soil; thickness up to 0.65m.

13. Yellow-reddish loam, similar to layer II, but of more pronounced ochre-red hue, with frequent fissures filled with whitish loam: it is the fourth lower horizon of the Vth fossil soil of the regional section of Transcarpathia; thickness up to 0.50m.

14. Somewhat lighter and less ochre-coloured loam, the higher situated loam (Nr. 13), the fissures filled with whitish loam are less frequent; thickness up to 0.30m.

15. Yellow-brownish loam with rare iron-manganese concentrations in the form of nodules and moulds; numerous fissures, filled with whitish loam; VIth fossil soil of the general Transcarpathian section; thickness up to 1.35m.

16. Light-yellow loam with rare and small iron-manganese concentrations; thickness up to 0.35m.

17. Brown loam with small and medium-sized iron-manganese concentrations, more frequent than in the higher layers (Nr. 16); fragmented by fissures, filled by loam of layer 16; upper horizon of the VIIth fossil soil; thickness of the layer up to 0.60m.

18. Red-brown loam with ochre-red layer; in the upper half there are vertical fissures filled with whitish loam; in the lower half there are horizontal streaks of the same loam (gleyfication); it is the lower horizon of the VIIth fossil ridge soil; thickness up to 0.40m.

19. Yellowish-light loam with thin fissures filled with whitish loam; mould-like traces of iron; thickness up to 0.10m.

20. Loam similar to the above mentioned (Nr. 19), but with ochre-red hue with relatively frequent small iron-manganese concentrations; the upper horizon of the VIIIth fossil soil of the Transcarpathian Anthropogene; thickness up to 0.55m.

21. Gray-brownish loam with ochre-red hue and. with relatively frequent small or medium-sized iron-manganese concentrations; with fissures filled with whitish loam; the lower horizon of the VIIIth fossil soil; thickness up to 1.00m.

22. Greyish loam with frequent small, medium-sized and large iron-manganese concentrations; the upper horizon of the IXth fossil soil; thickness up to 0.10m.

23. Loam analogous to that of layer 21; lower horizon of the IXth fossil soil; thickness up to 0.35m.

24. Ochre-red-loam containing smaller fragments of dacites; deluvium of crust, weathering crust of rocks; thickness up to 0.10m.

25. Multicoloured loam, spotty (spots of yellow, grey, whitish hues); in the upper part horizontal streaks of whitish loam, alluvium of the river terrace; thickness up to 0.35m.

26. The same loam with small pebbles (up to 5cm); alluvium; thickness up to 0.80m.

27. The same loam with marked ochre-red hue and with big pebbles; alluvium; thickness up to 0.30m.

28. The weathering crust of the dacite.” (Gladilin, 1989 pp. 96–97)

The profiles obtained from the trenches in the Boyvar hill were less thick, and their paleosols were not as well developed as in the profiles of Gostriy Verkh. However, correlations were possible due to the presence of paleosol III and IV in Boyvar. Paleosols V and VI are preserved only partially (Fig.44).

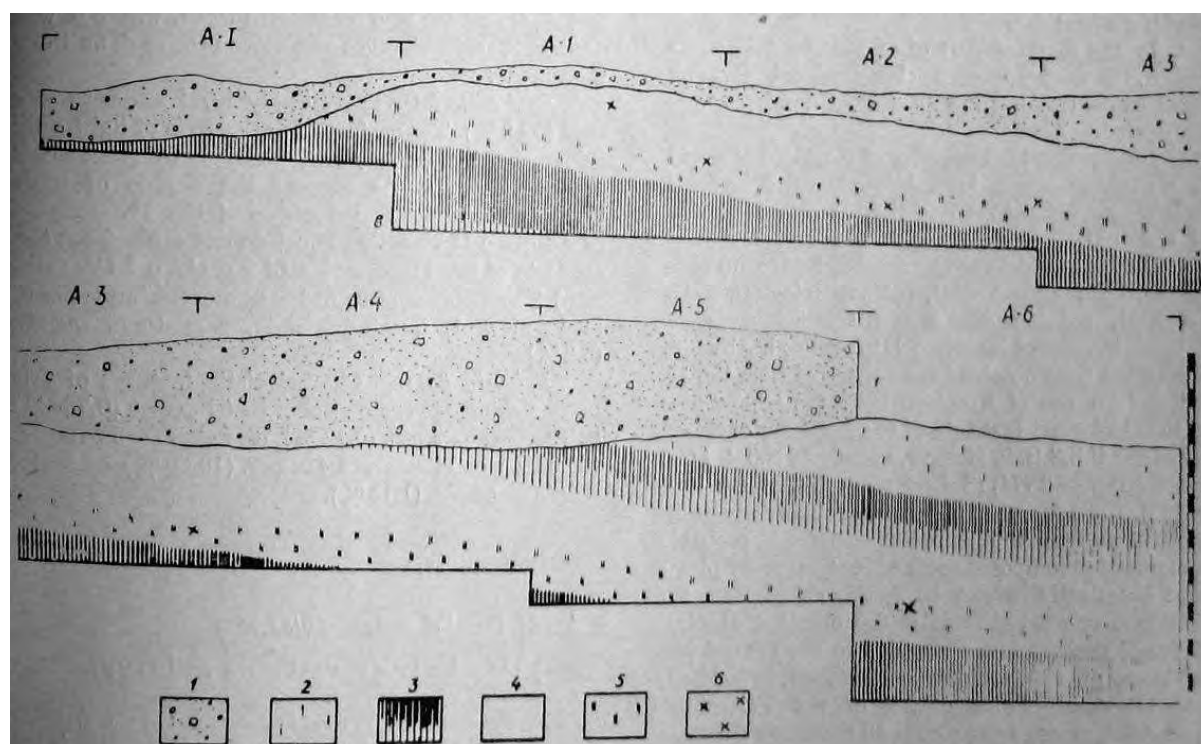


Fig.44 Korolevo II profile, trench I. 1. quarry dump layer, 2. whitish loess-loam level (corresponding to layer 1 in description), 3. paleosol (corresponding to layers 2 and 5 in description), 4. yellow-brown porous clay layer (layer 3 corresponds to description), 5 yellow-brown porous clay layer with ferro-manganese inclusions (corresponding to layer 4 in description). 6. stone artifacts (after: Gladilin & Demidenko, 1989, Fig.2).



On the Korolevo II site three paleosols were preserved, correlated with the main profile's paleosols III, IV and V.

The Korolevo II profile looked as follows:

“ 1. *Loess-loam, whitish with small dispersed 0.00–0.20m iron-manganese nodules, quantitatively growing downwards (layer 3 of general section of Korolevo). 0.00–0.20 m*

2. *Loam of light-brown hue combined with ochre-red hue and with numerous bean-shaped nodules of iron and manganese, quantitatively growing towards the top-III paleosol (Brörup + likely, Odderade and Moershoofd) (layer 4 of general Korolevo section) 0.20–0.70*

3. *Pale-yellow porous loam (layer 5 of the Korolevo general section) 0.70–1.00*

4. *The same loam with dot-and plate-like iron-manganese nodules (layer 6 of the Korolevo general section) 1.00–1.20*

5. *Brown loam with ochre-red hue and with numerous nodules of hut-shaped structure, aggregates–upper horizon of the IV, paleosol (Riss-Würm + likely, Amersfoort) (level 7 of the Korlevo general section) 1.20–1.45.”* (Gladilin & Demidenko, 1989 p. 145)

6. Loess layer

Recent studies have verified the stratigraphy, and thanks to micro-morphological soil analysis, a more precise correlation with particular chronological periods was possible (Haesaerts et al., 2010; Koulakovskaya, Usik & Haesaerts, 2010; Haesaerts & Koulakovskaya, 2006). In the profile, all the previously known paleosol layers were found and described. Paleosols III to IX are characterized, in most cases by a double-layer structure. These paleosols are represented by brown boreal soils up to leached forest soils (Koulakovskaya, Usik & Haesaerts, 2010). For easier results correlation, their prior numbers were retained (Fig.45).

1 and 2. 0–0.20m- forest soil, surface light yellow loess layer

3. 0.2–0.55m- bright fawn loess with iron-manganese nodules

4. 0.55–0.95m- IIIrd paleosol according to Gladilin, silty brown with iron-manganese nodules with bioturbations filled with light brown sediment, humus-eluvial horizon and an illuvial horizon of brown forest soil

5 and 6. 0.95–1.3m- dark yellow silt with small amounts of iron-manganese nodules, the layers' bottom becomes darker

7. 1.3–1.5m- IVth paleosol according to Gladilin, dark yellow, with numerous iron-manganese nodules; humus-eluvial horizon of brown forest soil

8. 1.5–2.9m- IVth paleosol according to Gladilin, clayey, with narrow fissures; an illuvial soil horizon

9. 2.9–3.35m- dark yellow laminated deposit with few iron-manganese nodules

10 and 11. 3.35–4.30m- Vth paleosol according to Gladilin–upper part: dark yellow with iron-manganese nodules (layer 10) passing gradually into dark yellow-reddish-rust laminated layer with carbonate and iron-manganese nodules (layer 11)



**12 and 13.** 4.3–5.0m- Vth paleosol according to Gladilin–the lower part: clayey, bright brown with narrow fissures, in some parts separated from layer 11 with a thin layer of bright gray stone clay (layer 12), gray-yellow layer with traces of gley processes (layer 13)

**14.** 5.0–5.3m- dark yellow and bright yellow loess layer with dark spots

**15.** 5.3–6.65m- VIth paleosol according to Gladilin, humufied, red-brown with small stones, cut by many bright fissures, probably filled with gley

**16.** 6.65–7.0m- straw-yellow deposit with few iron-manganese nodules

**17.** 7.0–7.6m- VIIth paleosol according to Gladilin–the upper part: brown, clayey, with numerous iron-manganese nodules, disturbed by solifluction, mixed with the sediment from layer 16

**18.** 7.6–8.0m- VIIth paleosol according to Gladilin–the lower part–brownish red to reddish rust with iron nodules. The upper part cut by vertical fissures with whitish filling, probably of gley, the lower part with horizontal, whitish intercalations, probably of gley

**19.** 8.0–8.1m- straw-yellow deposit with desiccation fissures, filled with bluish gley

**20.** 8.1–8.65m- VIIIth paleosol according to Gladilin–the upper part: compact, clayey, dark red-brown, with numerous iron-manganese nodules; the forest soil upper part

**21.** 8.65–9.65m- VIIIth paleosol according to Gladilin–the lower part–dark gray with cracks and whitish filling; the lower part of brown forest soil

**22.** 9.65–9.75m- IXth paleosol according to Gladilin–the upper part–dark reddish with plenty of iron-manganese nodules of different sizes

**23.** 9.75–11.1m- IXth paleosol according to Gladilin–the bottom part dark reddish and similar to layer 21

**24.** 10.1–10.2m- red rusty sediment with fragments of dacites

**25.** 10.2–10.55m- spotty sediment with bluish horizontal sediment, probably gley inserts in the upper part; the sediment is alluvial and transformed by the soil processes of IXth paleosol

**26.** 10.55–11.35m- gray-red-rust clayey deposit in the upper part, spotty, laminated in the lower part; the upper part of the Tisza River VIIth terrace (deposit of flood facies)

**27.** 11.35–12.85m- cemented layer of gravel and boulders (deposit of channel facies).

## Dating

The particular levels' dating was performed using several methods. C14 dates were established for Korolevo I layer 5, and gave the result of 25,700±400 uncal BP (Gladilin, 1989 p. 100). The layer 6 of Korolevo II gave the date of 38,500±1000 uncal BP (Gladilin, 1989 p. 100). This layer was located below the loess soil (layer 5 correlated with the IVth paleosol–layer 7 and 8 in the main profile).

For specific Korolevo I layers also seven TL dates were produced (Gladilin, 1989 p. 99):

- layer 2 dated at 36±6 kya BP,
- layer 5–60±8 kya BP,
- layer 9–150±20 kya BP,

- layer 12–220±35 kya BP,
- layer 16–360±50 kya BP,
- layer 19–650±90 kya BP,
- layer 25–850±100 kya BP.

All these dates represent a coherent chronological sequence. They are, however, not consistent with the C14 dates, since layer 5 received two dates TL–60±8 kya BP and C14–25,700±400 BP.

The layers' paleomagnetic analysis was performed separately. The results showed that between the VIIIth and IXth paleosols, and therefore between layers 21 and 22 in the main profile, there is a paleomagnetic boundary B/M (Bruhnes-Matuyama), which can be dated to 730 kya BP<sup>6</sup> (Gladilin, 1989 p. 100). This date matches the results of TL dating and fits into the period between 650–850kya BP for layers 19 and 25 dating.

In addition, 6 paleomagnetic anomalies (events, PMA) were dated:

Layer 3 anomaly–Kargopol PMA dated >44 kya BP,

Layer 8 anomaly–Blake PMA dated 106–114 kya BP,

Layer 9 anomaly–Biva and PMA dated to 180 kya BP,

Layer 14 anomaly–Biva II PMA dated to 210 kya BP,

Layer 19 anomaly–Elunino I dated 500–600 kya BP,

Layer 20 anomaly–Elunino II dated to 620 kya BP (Gladilin, 1989 p. 100).

These dates correlate quite well with the TL results. The discrepancies appear to be within the limits of statistical error (e.g. TL dating of layer 12 and paleomagnetic of layer 14).

Based on datings, and probably different levels of micromorphological analysis, the layers were correlated by Gladilin (1989) with individual interstadial and interglacial periods. It was most difficult to determine the age of IIIrd paleosol. Gladilin, in the end, correlated it with the Brørup Interstadial. The IVth paleosol due to received dates (106–114 kya BP), and the pollen analysis evidencing a climate warmer than today's climate, was defined as Eemian soil. The paleosols located below layer V were correlated with Riss 2/3 and interstadials 1/2. The VIth paleosol was correlated with the Mindel/Riss interglacial and VIIth paleosol with the Intermindel period. The VIIIth and IXth paleosols, between which there is the Matuyama-Bruhnes boundary, were correlated with the Günz-Mindel interglacial. The Kopenski terrace, covered with fluvial deposits was dated, on the basis of rodent remains, to the period between early Pleistocene and the Günz glaciation.

### **Profiles correlation**

Recent research has verified the earlier chronological correlations. The highest paleosol (IIIrd) has been correlated with the period of OIS 3, which is more in line with the early C14 and TL dates. Haesaerts and Koulakovska admitted that the most developed IVth paleosol should be correlated with the Eemian Interglacial, while the upper part of the Vth paleosol (layers 10 and 11) with OIS 7, which would make the Va assemblages equal in age with the Ehringsdorf industries. The lower part of the Vth paleosol was correlated with OIS 9, while

---

<sup>6</sup> The new results obtained by *Ocean Drilling Project Site* suggest that the age of this last reversal is 780kya BP (Shackleton, Berger & Peltier, 1990).

the well-developed VIth paleosol with OIS 11. The paleosols located below (VIIth and VIIIth) were correlated with OIS 13–15 and OIS 17–19. Underneath them, there is the Matuyama-Bruhnes boundary separating the lowest IXth paleosol, correlated with OIS 21 (Koulakovskaya, Usik & Haesaerts, 2010). This interpretation allows for dating the archaeological horizon Va to OIS 7 (ca 220–240 kya BP), and the archaeological horizon II, located in the loess between the IIIrd and IVth paleosols, for the Lower Pleniglacial (OIS 4).

### **Archaeological inventory**

The site allowed for distinguishing 16 archaeological horizons dated between the Lower and the Upper Palaeolithic. Unfortunately, full description of all archaeological horizons was not published yet. Initial publications reveal the fact that among the distinguished horizons, seven levels are known as Acheulean (levels VIII, VII, VI, Vc, Vb, Va, V), seven as Mousterian (IVa, IV, III, IIb, IIa, II, I) and two as Upper Palaeolithic (II' and I) (Gladilin, 1989).

On the Korolevo II site three archaeological levels were discovered, of which levels I and III can be correlated with their counterparts (I and III) within Korolevo I profile. However, level II with its Upper Palaeolithic features did not correlate with the Mousterian level II in Korolevo I profile.

According to the latest stratigraphy verification results (Koulakovskaya, Usik & Haesaerts, 2010), five archaeological levels dated to the Lower Palaeolithic (levels VIII, Vc) and the Middle Palaeolithic (levels IV, IVa, Vb) have been questioned due to their uncertain stratigraphic position.



*Fig.46 Andesite artifact with surface erosion traces, Korolevo level Va.*

Most artifacts found on the site are made of andesites. The artifacts shows signs of very intensive erosion, including patination, and especially cellular leaching (Fig.46) which is the effect of less resistant grains decaying within the andesite mass. As a result of this process, cavities/caverns are formed on tool surface, and in some cases openings near the edges. The artifact has rough surface, and so scar pattern analyses are very difficult then. Andesites surface destruction process is one spanning over a long time period. Hence, older artifacts from the lower layers are more destroyed than the artifacts made later. The state of surface patination helped the researchers to correlate the ages of various archaeological levels. Apart from andesite artifacts, the site also offers some made of obsidian and flint.

From the perspective of this dissertation, the most interesting archaeological levels are Va of Korolevo I and II of Korolevo II.

Level Va was located within layer 11 in the major profile of Korolevo I. Layer 11 is part of the upper horizon of Vth paleosol dated to OIS 7, that is about 220–240 kya BP (Koulakovskaya, Usik & Haesaerts, 2010). The stone inventory of this level is characterized by the use of discoidal and Levallois technology. Among tools symmetrical, thin, bifacial forms defined by researchers as leafpoints make themselves noticeable. These forms, owing to their slenderness, differ from the lower levels' bifacial tools (Gladilin & Demidenko, 1989).

Level II was located within layer 4 in the profile of Korolevo II (correlated with level 6 in the main profile and dated to OIS 4 (Koulakovskaya, Usik & Haesaerts, 2010). It was found in the profile between two Mousterian levels: III and I. The characteristic feature of this assemblage is the parallel presence of Upper and Middle Palaeolithic features. On one hand, the inventory is marked by its characteristic flake knapping of prismatic cores. Nevertheless, these cores have highly faceted striking platforms, which resembles the treatment of platforms in Levallois cores. The Levallois technology, however, is completely absent in the inventory of level II. At the same time, among the tools endscrapers, burins, blade knives, or borers are found. The tools of the Upper Palaeolithic type account for 39.55% of all tools. Nonetheless, the assemblage, also includes numerous tools of the Middle Palaeolithic type (23.88%), such as flake side scrapers. 20% of tools are bifacial forms referred to as leafpoints (Gladilin & Demidenko, 1989).

This inventory contains numerous preforms of both cores and bifacial forms, as well as numerous debitage flakes (also from bifacial tools). Owing to refittings, it was possible to match several flakes with finished bifacial forms (see the assemblage's technological analysis). Numerous artifacts coming from the initial manufacturing stage suggest the workshop character of this inventory (Gladilin & Demidenko, 1989).

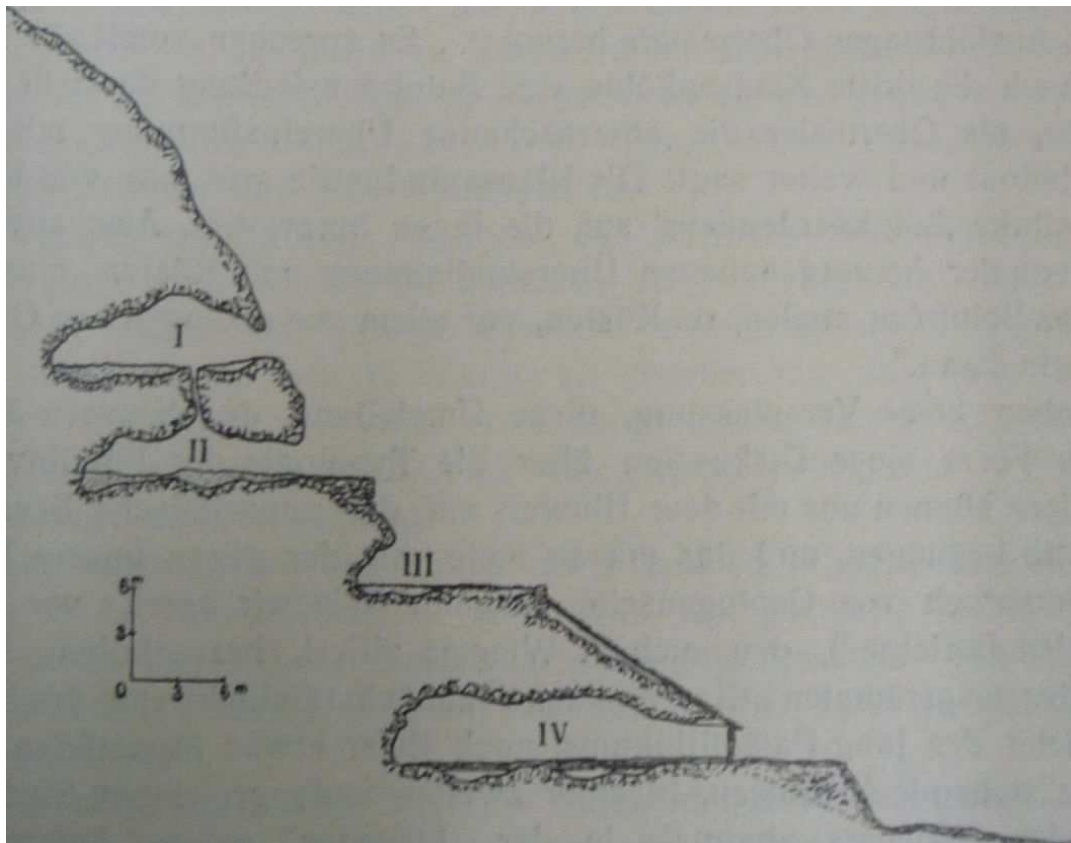
## 2.2. Comparative sites

### 2.2.1. Klausennische

The Klausennische is a shelter located in Altmühl valley, Bavaria, in the Klausen caves placed one over another. It is located between the central (Mittlere Klausen) and lower (Untere Klausen) cave of the complex (Fig.47). The caves are located on the S slope of the valley and lie directly opposite the Sesselfelsgrötte cave (Hopkinson, 2007).

In all the caves, archaeological artifacts were found already in the 19<sup>th</sup> century. The sites exploration began in the early 20<sup>th</sup> century. Excavations in Klausennische were conducted by Obermaier and Wernert in 1912 and 1913 (Obermaier & Wernert, 1929; Obermaier & Wernert, 1914). In the study, they distinguished four layers, top three of which contained archaeological artifacts. Also during this study, an extensive collection of animal bones was obtained, mostly from a mammoth, a rhinoceros and a horse (Obermaier & Wernert, 1914).

During the analysis of bone remains, one human tooth was remarked as well. It is a right deciduous I1 with a broken root (Street, Terberger & Orschiedt, 2006). Abel (1936) described its morphology as being of Neanderthal origin, based on size and especially the shape of the pulp cavity in comparison to the remains from Krapina. The tooth was lost and the verification of its anatomy is currently impossible (Street, Terberger & Orschiedt, 2006).



*Fig.47 Sites arrangement in Klausen cave complex; I–Obere Klausen, II–Mittlere Klausen, III–Klausennische, IV–Untere Klausen (after: Obermaier & Wernert, 1929, Abb. 1).*

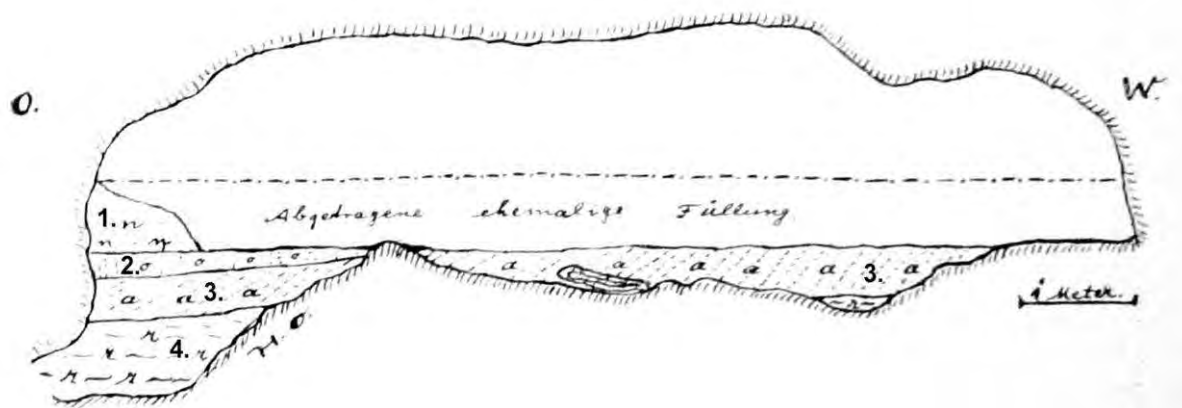


Fig.48 Longitudinal section through Klausennische, from the investigations by Obermaier and Wernert–1912/13 (after: Obermaier & Wernert, 1914, Abb. 18), Numbers correspond to descriptions in the text.

### Stratigraphy

The description of layers is unfortunately very poor, as it dates back only to the preliminary site excavation report published in 1914. The researchers focused more on the layers archaeological content rather than on sediment description. The stratigraphy described by them was as follows (Obermaier & Wernert, 1914) (Fig.48):

- A. clayey layer containing Neolithic artifacts, preserved only partially in the E part of the site, removed on the site's majority
- B. thin layer with Upper Palaeolithic artifacts, preserved in the E part of the site
- C. yellow-grey layer of clay containing Middle Palaeolithic artifacts referred to as “Acheulean”, as well as animal bones (*Elephas primigenius*, *Rhinoceros tictoriformis*, *Equus caballus*); in the upper part, the separate Mousterian-Werkzeuge inventory not distinguished as a separate layer (Obermaier & Wernert, 1914), thickness of 0.25–0.5m
- D. red clay layer located directly on a rocky substrate, archaeologically sterile.

### Dating

For the site, one does not have any absolute dates. Also, the fauna remains assemblages (mammoth, rhinoceros, horse) do not allow for the site's specific time correlation, except specifying the inventories' age as Vistulian (OIS 5d–3).

### Archaeological inventory

A rich Middle Palaeolithic inventory of artifacts, which was the focus of this work, originates from the C layer. As the excavations were conducted on the site in the early 20<sup>th</sup> century, the study was primarily designed to collect interesting artifacts. Therefore, currently a collection of six cores and 280 tools is disposed of, dominated by bifacial forms (76 Faustkeilblätter, nine bifacial knives, 23 pradike style knives, 69 bifacial scrapers, few Faustels and several other bifacially worked tools, Hopkinson, 2007). In the literature, there is no mention of structures, objects, or remains of fireplaces which had accompanied the artifacts.

All bifacial knives are characterized by significant tip exposure, edge line symmetry and a base quite large with regard to the near-the-tip part. The artifacts are made of Plattensilex



(very thin slabs of flint nodules), which, as already noted by Obermaier and Wernert, determined the artifacts shape (1914).

Obermaier and Wernert were initially willing to identify the assemblage as Acheulean (1914). However, in the years that followed, they abandoned that name and created a definition of assemblages with artifacts of Blatt-Typen, which are defined as follows:

*Unter "Blattspitze" versteht man am besten ein oder mehr weniger blattförmiges, gewöhnlich auf beiden Seiten flachmuschelig behauenes, in eine zwei bis Spitzen auslaufendes artifact. verhältnismäßig dünnem Querschnitt myth. Variabler von Grosse (Obermaier & Wernert, 1929 p. 308)*

Based on the Klausennische inventory, Bosinski distinguished a separate type of knives typical of this inventory, and called them "Klausennische" type (Bosinski, 1967 pp. 44–45). This researcher placed the Klausennische type (*Inventartyp Klausennische*) in the development sequences of leafpoint assemblages. This went as follows: Bockstein–Klausennische–Schambach–Rörshain (Bosinski, 1967 pp. 50–51). He even distinguished two leafpoints in the inventory (1967 p. 45). Allsworth-Jones (Allsworth-Jones, 1986) criticized this attribution of the two Klausennische artifacts, stating that these are symmetrical knives. One of them is too short in relation to its width to be classified as a leafpoint, and the other one, preserved partially, might well be a knife tip (Allsworth-Jones, 1986 p. 57). Nonetheless, the two mentioned flint tools were not found in the inventory.

## 2.2.2. Königsau

The Königsau site is located in NE foreland of the Harz Mountains, around 65km NW of Halle (Salle). It is placed within the basin of Pleistocene Aschersleben Lake, drained at the start of 18<sup>th</sup> century. The fossil lake area had an open-pit lignite mine opened in the 19<sup>th</sup> century (Dietrich Mania & Toepfer, 1973).

Fieldworks aimed at reconstructing stratigraphy, climate and searching for artifacts were conducted on the site from 1962 by Mania and Toepfer. In 1963, Middle Palaeolithic flint artifacts were discovered in NW mine wall. This finding pushed Mania and Toepfer to undertake limited rescue excavation (1963–64) (Dietrich Mania & Toepfer, 1973 p. 9). The site was placed inshore the lake, which reinforced organic matter preservation. Flint inventories were accompanied by numerous animal bones such as: *Canis lupus*, *Panthera (Leo) spelaea*, *Crocota spelaea*, *Mammuthus primigenius*, *Equus* cf. *bachensis-abeli* group, *Equus (Asinus) hydruntinus*, *Coelodonta antiquitatis*, *Dicerorhinus hemitoechus*, *Cervus elaphus*, *Rangifer tarandus* (Dietrich Mania & Toepfer, 1973 p. 43). Two oldest fragments of resin, dating back to 75 kya BP, were discovered on the site as well (Koller, Ursula Baumer & Dietrich Mania, 2001).

The site has over 25 metres of sediments which enabled to reconstruct a detailed picture of climatic and environmental changes from the Eemian to the Holocene (Dietrich Mania & Toepfer, 1973).

Artifacts were deposited in three cultural layers, marked with the use of alphabet letters A, B, C (Dietrich Mania & Toepfer, 1973 pp. 65–69). Altogether, the flint inventories counted 5739 artifacts and were defined as Mousterian.

### Stratigraphy

The general profile was 17 metres thick and encompassed 12 layers correlated with consecutive climatic oscillations. The overall layer arrangement on the site looked as follows (Dietrich Mania & Toepfer, 1973 pp. 64–65):

**IX.** shore sediments, peat, limy organic silt, Holocene, FR-44: 10,490±240 uncal BP, FR-32: 8640±125 uncal BP, FR-45: 1750±100 uncal BP

**VIII.** sandy shore sediments/limy organic silt, Older Dryas/Alleröd, FR-25: 12,520 ±180 uncal BP, H-77/54: 12,300 ±260 uncal BP

**VII.** sandy shore sediments/coarse detritus organic silt, Oldest Dryas/Bölling, H-106/89: 13250 ±280 uncal BP, FR-24: 12890 ±190 uncal BP

**VI.** fluviatile sandy organic silt, Interval

**V.** fluviatile sandy organic silt, Interstadial, FR-23: 25,000 ± 750 uncal BP

**IVb.** fluviatile sandy organic silt, Interstadial

**IVa.** fluviatile sandy organic silt, Interstadial, FR-22: 32,500 ± 2600 uncal BP

**III.** fluviatile sandy organic silt, Interstadial, FR-17: 40,000 uncalBP

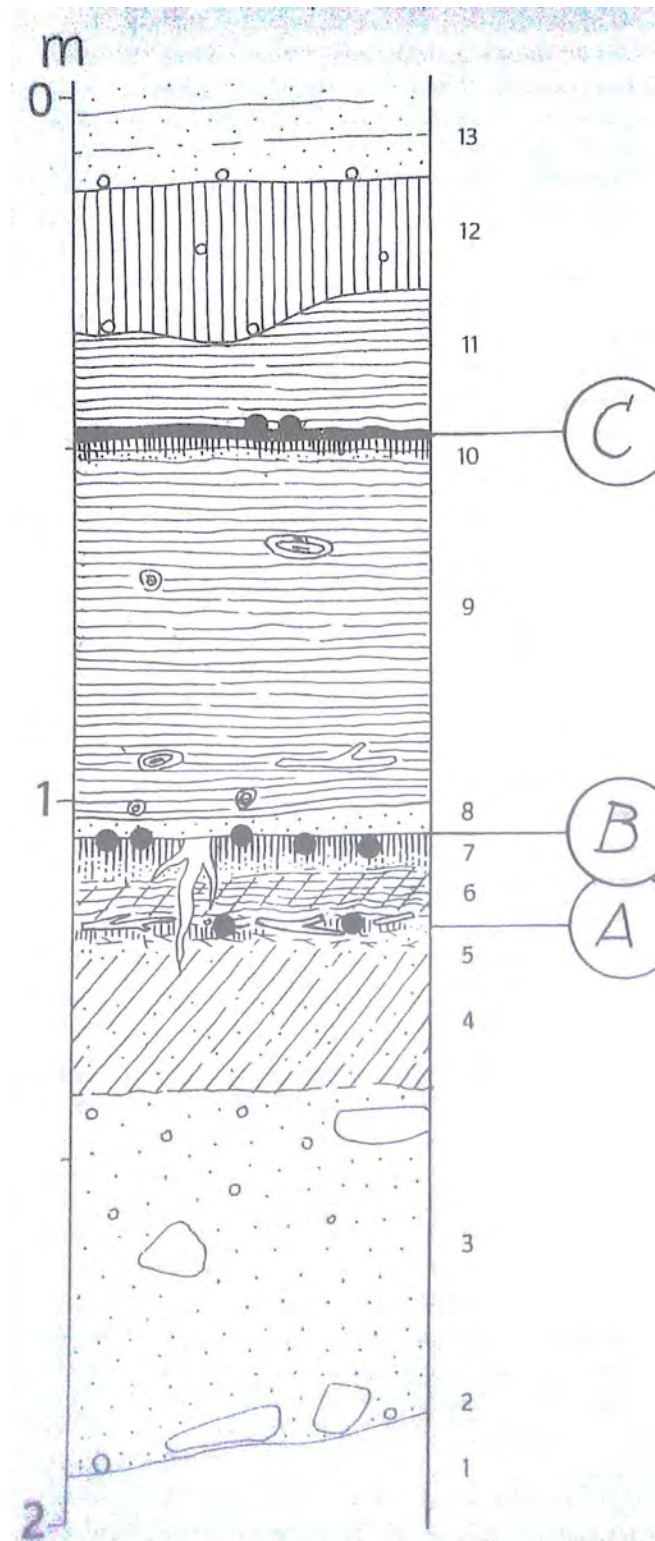
**IIb.** fluviatile sandy organic silt, Interstadial, GrN-5423: 41,000±1275 uncal BP

**Ib.** peat and limy organic silt ("wood-rich Bruchwaldtorf"), Findhorizon of Königsau A, B, C, Interstadial, B-626: >45,000 uncal BP, GrN-5698: 55,800 uncal BP, GrN-5424: >49,800 uncal BP,

**Ia2.** limy organic silt-Interstadial, GrN-5697: >49,800 uncal BP

**Ia1.** limy organic silt, Eemian Interglacial period, no date

fluviatile embeddings, end of the Wartanian glacial period



*Fig.49 Excavation profile with layer arrangement within Ib, where archaeological levels occurred. Layer numbering corresponds with description in the text, scale on the left shows tens of metres (after: Dietrich Mania & Toepfer, 1973, Abb. 26).*

Flint artifacts depository level was divided into a few smaller geological layers. In the site monography, Mania and Toepfer (1973 pp. 64–69) had placed detailed excavation profiles showing an exact arrangement of layers where artifacts occurred. Levels containing flint artifacts were separated with geologically sterile layers. A sample layer stratigraphy in an excavation profile within level Ib looked the following way (Fig.49), (Dietrich Mania & Toepfer, 1973 p. 64):

13. sand
12. sandy clay
11. brown peat layer
10. black paleosol layer of brown peat with thin layers of charcoals, archaeological C level
9. brown peat layer
8. sand
7. sandy Anmoor with traces of plant roots, archaeological B level
6. brown peat layer
5. humified upper part of the sandy organic silt containing plant remains, partly peat-made, archaeological A level
4. sandy organic silt
3. sand with gravel
2. stone layer
1. Tertiary level

### **Dating**

C14 analyses for level Ib ("wood-rich Bruchwaldtorf") with its archaeological levels, yielded the following results >49,800 uncal BP, 55,800 uncal BP (GRN 5424, GRN-5698) and >45,000 uncal BP (B-626) (after: Dietrich Mania & Toepfer, 1973, Abb. 7). Two resin fragments found at levels A and B received the consecutive dates of 43,800±2100 uncal BP (OxA-7124) and 48,400±3700 uncal BP (OxA-7125) (Grünberg et al., 1999).

Altogether, 15 climatic oscillations had been distinguished on the site, starting from OIS 5e. Artifacts were deposited in a layer classified as part of phase Ib, which had been dated to Brørup Interstadial (Dietrich Mania & Toepfer, 1973). Level A was dated back to Interstadial beginning. The site came into existence under the conditions of a boreal open steppe type of habitat, where pollens are determined by grass types (Dietrich Mania & Toepfer, 1973 p. 155). The oldest C inventories are connected with the Interstadial optimum. In pollen profiles, the percentage share of tree pollen rises to 70%, with the dominant species of birch and pine (coincide with the climatic optimum, tree pollen) (Dietrich Mania & Toepfer, 1973 p. 41).

### **Archaeological inventories**

Levels A and C were incorporated into the Micoquian complex ("*central European Micoquian*") due to the presence of numerous bifacial knives forms (Dietrich Mania & Toepfer, 1973).

Among artifacts, bifacial knives made on nodules and flakes were predominant. These tools were accompanied by the Levallois technology; however, represented less richly than at level B. The biggest level B inventory was dominated by the flaking technology of discoid cores, as well as the Levallois technology manifesting itself in the presence of Levallois cores, numerous Levallois points and blades with highly faceted butts. Those artifacts were not accompanied by bifacial treatment. Among level B tools, flake side scrapers prevail. Level B, characterized by lack of bifacial forms, was termed as Mousterian devoid of bifacial treatment traces (*“Mousterian virtually without bifacial working”*) (Dietrich Mania & Toepfer, 1973 chap. 9).

### 2.2.3. Szeleta Cave

Leafpoints from Szeleta cave have been used for comparative purposes. The collection served as a reference point for the core subject, namely “the early assemblages with leafpoints’. Thus, there will be neither an in-depth site stratigraphy analysis nor any direct attempts to correlate it with other sites in the final chapter. The text below presents only the data that seems important from the thesis’ perspective, more precisely the history of site examination, general stratigraphy and flint inventories descriptions, as well as the debate concerning the site’s age and its cultural cohesion.

Szeleta cave, which over the years has constituted a reference point for the examinations of many other sites, is found among the most important Palaeolithic sites in Hungary. It is also an eponymous site for the Middle/Upper Palaeolithic transitional industry which has been first termed “Szeletian culture’ by Prošek (Prošek, 1953). The cave is located in the eastern part of Bükk Mountains (Hungary), 349m above mean sea level.

The site was the object of intensive excavations throughout the entire 20<sup>th</sup> century; first in 1906–1913 when Kadič (1916) performed his work aimed at establishing the site’s stratigraphy. He had originally planned to explore the cave’s full sediment (Mester, 2002) however, he failed to realise his assumptions thus giving the descending excavators a chance to verify the results and estimate the absolute dating of the sediment. Kadič had altogether examined 2,500m<sup>2</sup> (Lengyel & Mester, 2008) of the cave, performing fairly detailed stratigraphic observations available to him at that time.

The profile of the deepest place in the main hall was 12.5m tall (Kadič, 1916). The flint inventory was rather dispersed, artifacts were scarce. The excavation works provided only about 2,000 flint artifacts<sup>7</sup> (Lengyel & Mester, 2008). In the course of his work, Kadič differentiated as many as 11 layers, encompassing four Palaeolithic horizons. The lowest of them, placed within the layer 2, had not been defined as it lacked the diagnostic traits (Kadič, 1916). The remaining three archaeological horizons displaying the presence of symmetrical, bifacially worked leafpoints, had been put under the name of “Solutrean industry” by Kadič. He distinguished three separate horizons: the lowest (in layer 3) was called “early Solutrean” (*Frühsolutrean*), the highest (in layer 6) was called a “developed Solutrean” assemblage (*Hochsolutrean*), and the middle horizon constituting a transition between the two mentioned above. The linear, evolutionary development of leafpoints was noticeable to Kadič, as different horizons presented varied technological advancement of leafpoints production. Lower level was characterized by low-precision in manufacturing, irregular shapes, whereas the highest horizon by high precision in manufacturing and symmetry (Kadič, 1916). The division proposed by Kadič had been introduced in the literature and later adopted by Prošek (1953); which in turn enabled the creation of differentiation between early and developed Szeletian.

After 1913, the site’s examination was resumed seven times by various researchers, e.g. Hillebrand, Saad and Clarke (Cambridge Ethnography Museum, 1928), Maria Mottl (single-season works, 1936), Saad and Nemeskari (1947) (Mester, 2002).

The site’s absolute dating is owed to Vértes and his examination, undertaken in 1966, aimed at verifying the age of archaeological horizons. His three C14 dates, published in 1968, have outlined the discussion axis as to the transition between the Upper and the Middle Palaeolithic for the next 35 years. Later a trench meant to expose the profile for the needs of a

---

<sup>7</sup> Adams and Ringer mention 1603 artifacts of Kadič’s inventories (Adams & Ringer, 2004).

scientific conference (10<sup>th</sup> International Speleology Conference) was opened in 1989 by Ringer.

The datings of Aurignacian and Szeletian sites of the Bükk Mountains had been put under scrutiny by a project undertaken and carried out by the Miskolc University in 1999. The first step was to collect the available materials and submit them to meticulous analysis and critical judgment. The data gathered from earlier examinations enabled the trenches and profiles correlation (Mester, 2002). Then, new trenches were opened in order to acquire new samples for C14 analysis (Adams & Ringer, 2004); altogether, three test trenches were revealed, which made the identification of all the crucial archaeological horizons possible (levels 2–6). As a result, seven C14 dates came into existence, thus sparking a heated debate on the chronology and cultural cohesion of the eponymous Szeletian assemblages.

The deepest cave section, where some fresh digging traces had been found, has been secured in 2007. Further examination allowed a better evaluation of the cave's oldest settling horizon (Lengyel, Szolyák & Pacher, 2009).

### **Stratigraphy**

Kadič's works (1916) gave rise to distinguishing 11 layers. This stratigraphic division was accepted by subsequent researchers who referred to Kadič's numbering and attempted to correlate their excavations with the results of prior analyses (Mester, 2002).

A simplified version of the cave's stratigraphic division proposed by Kadič looked as follows (Fig.50):

- 9.** 0.2m (thickness)- bat guano
- 8.** 0.2m- tuff/calcareous tuff
- 7.** 0.7m- Holocene black humus alluvium containing artifacts dated from the Neolithic up to the Iron Age
- 6.** 0.5–1m- grey clay containing sharp-edged limestone rubble; the upper Szeletian (Solutrean) level
- 6a and 6b.** 1.0–2.0m- bright yellow level with boulders, the upper Szeletian (Solutrean) level
- 5.** 0.2–0.5m- red-brown clay containing sharp-edged limestone rubble (smoothed only at some points), the upper Szeletian (Solutrean) level
- 4.** 0.5m- dark grey clay containing abraded animal bones (50% of them), the Szeletian (Solutrean) transition level
- 3.** 1.5–3.5m- light brown clay containing smoothed limestone rubble and animal bones. Three darker sub-layers (3a, 3b, 3c) with a considerable amount of organic matter; the lower Szeletian (Solutrean) level
- 2.** 2.5–6.0m- dark brown clay with few smoothed animal bones, large amount of phosphoric acid. Two levels of stone rubble present in the layer (2a and 2b); several stone artifacts—an unidentified assemblage
- 1.** 1.0m- red clay (loam) resembling terra rosa deposits; archaeologically sterile level.

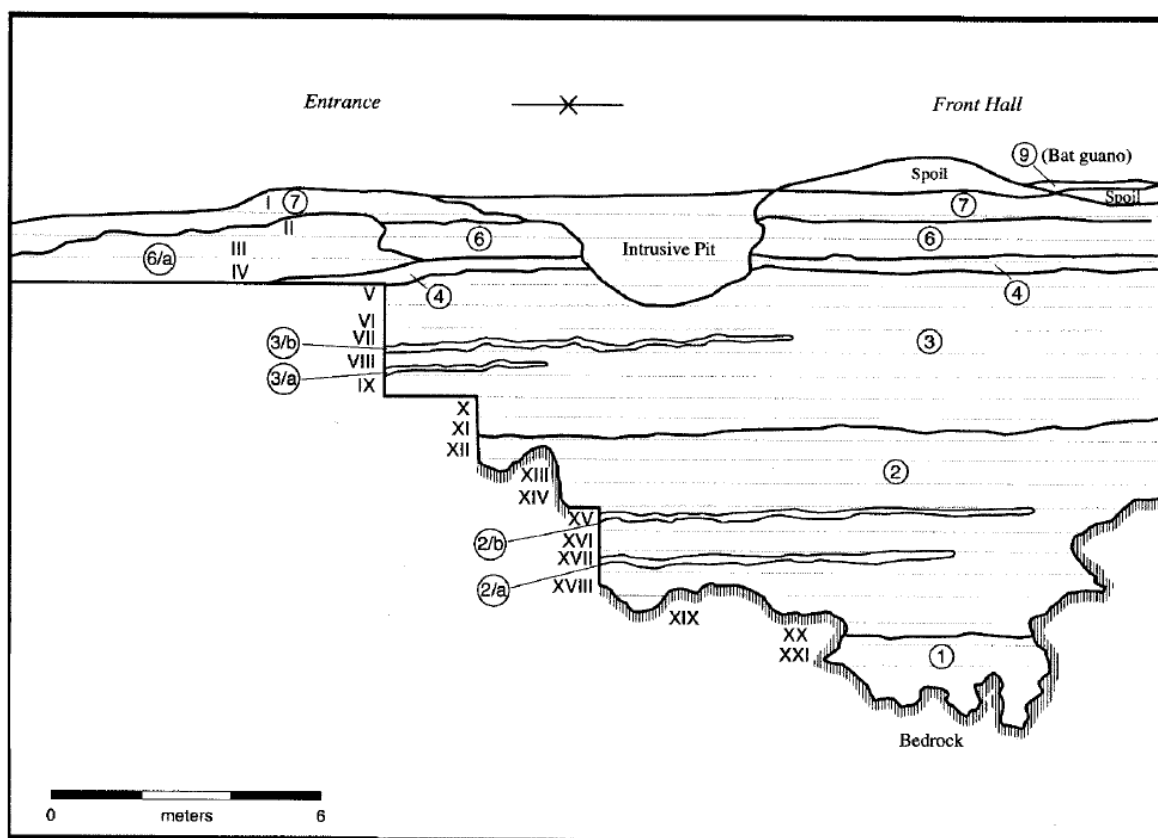


Fig.50 Kadič's longitudinal section between the cave's entrance and its main hall. Numbers are explained in the text. (after: Adams & Ringer, 2004, Fig.2).

## Dating

During his research in Szeleta, Vértes' obtained three C14 dates. The first sample was taken from layer 6 and the result it provided was  $32,620 \pm 400$  uncal BP (Fig.51). The next sample was obtained from a bone found in layer 3 by Kadič; the date it provided was  $>41,700$  uncal BP. The second bone sample was found in layer 2, discovered directly below the early Szeletian horizon (Vértes, 1968). The date it had given was  $43,000 \pm 1100$  uncal BP. Based on those, Vértes established the dating of the Szeletian assemblages to be somewhere between 33 and 43 kya BP.

The excavations were reopened in 1999 with the aim of collecting samples for C14 analysis. As a result of analyses, six samples were found and dated. A bone sample from layer 6, localised near the entrance, produced the following result:  $22,107 \pm 103$  uncal BP (AMS). The main hall excavation exposed the deposits correlated with layers 2 and 3 by Kadič. Within layer 3, a darker sublayer was found, which Adams interpreted as part of the 3b structure observable in Kadič's profiles (Adams & Ringer, 2004). This layer provided a carbon sample and a bone for analysis, the former dated to  $26,002 \pm 182$  uncal BP (AMS) and the latter to  $>25,000$  uncal BP (AMS). Two bones found 10cm above layer 3b gave the dates of  $11,761 \pm 62$  uncal BP (AMS) and  $13,885 \pm 71$  uncal BP (AMS). The bone which was dated similarly to Vértes' result ( $42,960 \pm 860$  uncal BP) had been found on the border between layers 2 and 3.

A date from layer 3 ( $37,260 \pm 260$  uncal BP) was published in 2002 by Ringer; however, there was no reference number or the place of origin attached to the sample he had examined (Lengyel & Mester, 2008).



Lab no	14C age BP	Material	Excavation Area	Layer	Reference
GXO-197	>41,700	bone	unknown	3	Geyh <i>et al.</i> 1969
GrN-6058	43,000 ± 1100	bone	Hall	2	Vogel & Waterbolk 1972
ISGS-4464	42,960 ± 860	bone	Hall	2/3 interface	Adams & Ringer 2004
GrN-5130	32,620 ± 400	bone	Entrance	section collapse	Vogel & Waterbolk 1972
ISGS-A-0131	22,107 ± 130	bone	Entrance	section collapse	Adams & Ringer 2004
ISGS-A-0189	26,002 ± 182	charcoal	Entrance	3	Adams & Ringer 2004
ISGS-4460	>25,200	bone	Entrance	3	Adams & Ringer 2004
ISGS-A-0128	11,761 ± 62	bone	Entrance	3	Adams & Ringer 2004
ISGS-A-0129	13,885 ± 71	bone	Entrance	3	Adams & Ringer 2004
Unknown	37,260 ± 760	unknown	Entrance	3	Ringer 2002b

Fig.51 C14 dates assembled for Szeleta cave (Lengyel & Mester, 2008, Tab. 4).

Since the samples could have been contaminated, Adams and Ringer rejected two earliest datings of layer 3 (Adams & Ringer, 2004). The remaining data was approved, which motivated further discussion concerning the Szeletian horizon's dating. The time boundaries established (btw 26 and 22 kya BP) rejuvenate the Szeletian assemblages by over 10 thousand years. According to the authors, the most ancient date (42,960±860 uncal BP) acquired from the contact zone on the boundary between layers 2 and 3 (and confirmed by Vértes' date 43,000±1100 uncal BP), constitutes a *terminus post quem* for the Szeletian assemblages (Adams & Ringer, 2004). Such dating suggests parallel settling of the Aurignacian and Szeletian people in the Bükk Mountains, as well as confirms Adams' hypothesis on the identity of the Aurignacian and Szeletian assemblages (Adams, 2007).

Nevertheless, Mester has recently reviewed the C14 dates available for Szeleta cave (Lengyel & Mester, 2008). He mainly criticised the layer attribution and correlations made by Vértes, Adams and Ringer, arguing that the levels they correlate with layer 6 actually contained the sediment already explored by Kadič, because the trenches they opened were situated in the very place of Kadič's trenches

Mester (Lengyel & Mester, 2008) also stressed the fact that layer 3 displays significant traces of post-sedimentary modification. The layer's abraded animal bones and artifacts with damaged edges may bear witness to the presence of some postdepositional, e.g. cryoturbation processes. Additionally, a recent hearths analysis within layer 3 (3a–c) has proved that water presence in the cave might have contributed to the layers dispersal over such a large area (Ringer & Szolyák, 2004). Consequently, the artifacts of layer 3 must have migrated as well. This thesis is supported by some refittings found between layers 4 and 6. According to Mester (Lengyel & Mester, 2008), post-sedimentary processes may well account for such considerable discrepancies in datings (37–25 kya uncal BP).

### Archaeological inventory

Regardless of the site size and the exploratory work intensity, Szeleta cave has yielded a scarce artifact inventory, which is best reflected by 2,000 artifacts found by Kadič in the course of his 7-year research. 1364 of them are currently housed by the National Museum in Budapest and the Otto Herman Museum in Miskolc (Lengyel & Mester, 2008). Very few artifacts from the 1928 research can be found in Cambridge (Allsworth-Jones, 1986). Next to flint artifacts, some three pieces of split-base bone points accompanied by animal bones (mainly belonging to cave bear) have been discovered during the research (Adams & Ringer, 2004).

In the lowest archaeological level located in layer 2, only 57 non-specific artifacts were found. Their classifications varied from unidentified (Kadič) through Middle Palaeolithic Mousterian (Vértes, 1968) to partly characteristic of Babonyian (Ringer, 2002; Ringer, 2000; Ringer, 1989; Ringer, 1995; Ringer, 2001). During the most recent research, a single artifact was found termed as a side scraper with La Quina retouch and a faceted butt (Lengyel et al., 2009, Fig.8). The research has not provided a response to the question of classification, though.

At first, the artifacts of layers 3–6 had been termed as Solutrean, later Szeletian. The inventory was generally characterized by a large proportion of leafpoints (n=168), accompanying the Upper Palaeolithic artifacts such as endscrapers, retouched blades, burins and borers, all of which had been mostly made on thin slabs of local felsitic porphyry. Some of the points were made of radiolarite and obsidian. Among those tools, some Middle Palaeolithic artifacts can be found as well, such as side scrapers. Their technology was based on exploiting single-platform blade cores with a plain platform. 10 out of 40 cores recently analysed by Adams (Adams, 1998) are various types of flake cores, with discoidal cores among them. The assemblage does not, however, bear any traces of Levallois technology. Most cores come from the lower Szeletian horizon (n=6).

Kadič's reason for differentiation between the upper and lower Szeletian level was dictated by the leafpoints variable morphology. The tools from the lower horizon were smaller in size, less regular in shape and less precisely shaped. By contrast, the upper level leafpoints were symmetrical and processed in a highly detailed manner. As to the remaining artifacts, the two assemblages differ only slightly, namely the upper level counts more retouched bladelets compared to the number of retouched blades of the lower level (Adams, 1998).

Both levels were separated by layer 4 termed as the transitional level by Kadič. The layer produced only 32 flint artifacts; hence this particular inventory is omitted in current archaeological debates and analyses (Adams, 1998; Adams, 2007).

Archaeological “fossil markers”	6	6a/b	5	4	3 upper	3 lower	2 upper
Gravettian	+	+	+	+	+		
Aurignacian	+	+	+	+	+		
Developed Szeletian	+	+	+	+			
Early Szeletian					+		
Jankovichian	+	+	+	+	+	+	+
Mousterian	+	+	+	+	+	+	+
Taubachien						+	+
Bábonyien						+	+

*Fig.52 The distribution of leading culture-specific artifacts in Szeleta cave's archaeological levels (Lengyel & Mester, 2008, Tab.3).*

As well, the validity of Kadič's interpretations of the early-to-developed Szeletian cultural sequence and evolution has been undermined by contemporary authors. Adams' analysis (Adams, 1998) of the artifacts from both levels has pointed to their technological similarity. Allsworth-Jones (1986) focused on the post-sedimentary processes (e.g. cryoturbation), and their contribution to the inventory's significant dispersal and migration within the layers. Moreover, a refitting of two artifacts originating from layers 4 and 6 has been lately discovered by Mester (Lengyel & Mester, 2008), which is a definite proof of the artifacts' post-depositional movements.

Those disturbances are also supposed to provide explanation for the inventory's heterogenic character which displays features distinctive of various archaeological horizons (Fig.52). On one hand, the literature underlines the presence of leafpoints (Prošek, 1953), which connect the assemblage with the leafpoints industry (Kozłowski, 1995). On the other hand, some researchers claim its affiliation to the Aurignacian assemblages due to the presence of split-end bone points, typical of the Aurignacian inventory (Adams, 1998). Then, some researchers have a tendency to label the site as a Gravettian complex with leafpoints because of the presence of retouched blades and bladelets (Simán, 1995). Finally, Mester's recognition of the assemblage is as being heterogeneous and thus scarcely informative (Lengyel & Mester, 2008).

Regardless of the heated debate around it, Szeleta cave remains one of the very few Szeletian sites with stratification and absolute dating. In spite of all the discrepancies and scientific disagreement on its inventory's cultural affiliation, this site had been chosen in view of creating a point of reference for forms which are termed as leafpoints, despite their chronologically more advanced age. Another factor which weighed in favour of this decision was the availability and quantity of tools in the inventory: this one allowed an unrestricted choice of well-preserved tools, without the necessity of using tool pieces for the analysis.

15 forms under the name of leafpoints were evaluated, all originating from the upper Szeletian level. The analysis was neither about justifying the validity of division into upper and lower level, nor about finding the features distinguishing the leafpoints of both layers. Conversely, the sole idea was to provide a common point for analyses of chronologically earlier leafpoints.



## 3. Scar Pattern Analysis. Techno-functional Approach

### 3.1. Analysis Method

The artifacts analysis method choice was directly linked to the preset goal. The primary idea was to conduct technological analysis of artifacts known as leafpoints. In order to achieve this, it was necessary to reconstruct the production process scheme and the general idea (the ideal type) for particular “leafpoint” assemblages. It had been assumed that comparing the underlying ideas of bifacial tool forms on certain sites would help to answer the question whether it is allowed to combine all the analysed assemblages into one common circle of cultures with leafpoints.

While deciding about the scientific method, however, it had to be considered that in some of the collections only bifacial tools got preserved, or thedebitage products amount was too scarce to utilize the refitting method. At the same time, it was established as proper to use one cohesive analysis for all stone inventories under examination.

Due to such limitations, it was resolved that the so-called scar pattern analysis will be used. Since this method has been utilized for a short time (J. Richter, 2001) and does not have a standardized workshop, a meticulous description of steps taken during analysis is being presented below. All of this resulted in the reconstruction of reduction sequence (*chaîne opératoire*) for particular tools and in consequence, after generalization, for particular artifact assemblages.

#### 3.1.1. Sample choice

Scar pattern analysis requires the work to be done on original tools; hence all the analyses were conducted in locations where particular artifact collections are stored.

For each site, as far as possible, tools most typical of a given assemblage were selected. The only exception are the artifacts from Jankovich, for which there was no access to the most representative bifacial forms, permanently exhibited in The National Museum in Budapest. As to this site, artifacts found in the museum depository were submitted to analysis. A similar situation was encountered in The Landesmuseum für Vorgeschichte Sachsen-Anhalt in Halle, where the artifacts from Königsau are on a permanent exhibition and could not be removed for the sake of examination. The museum, however, disposes of very precise artifact copies made with the use of synthetic material. Thus, it was possible to examine the copies and next, to compare the results with the original tool parts visible on exhibition.

It was attempted to analyse all the artifacts named by the publications as leafpoints, and a few bifacial artifacts such as knives or side scrapers from a given site/layer. Such sample selection enabled to compare production technology and ideas underlying the formation of various bifacial tools coming from the same site. What is more, the examination was extended with two additional bifacial knives assemblages (Klausennische and Königsau), since these knives are characterized by significant vertical axis symmetry.

Not fewer than 10 artifacts per site had been selected for analysis, provided the collection counted at least 10 tools. If the collection was larger, it was resolved to enlarge the

sample in order to eliminate to a maximum errors stemming from the examination of scarce artifact sample.

The best results are provided by examining entirely preserved artifacts, since it is then possible to reconstruct the manufacturing and rejuvenation process of all artifact edges. Nevertheless, due to lack of entire artifacts in some cases (Rörshain), it was quite frequent that fractured tools were submitted to analysis. Such decision proved to be right to the extent where the analyses showed that artifacts termed as point fragments had their base purposefully formed with a transversal breakage (see Chapter 6.5).

Scar pattern analysis is solely possible on tools where interscar ridges can be seen. This is why artifacts with highly eroded surface and tools bearing traces of numerous truncations and post-depositional removals are disqualified from the sample.

### 3.1.2. Artifact construction and positioning, terminology clarification

Because of the fact that the basis for further analysis is a board presenting the artifact in at least two projections (front and back), before commencing it was necessary to give the artifact appropriate positioning. Each time, the tool tip was placed upwards with the upper face on the drawing's left side. The tool tip was established as that end which displayed more precise reduction, was thinner, better exposed. In case of artifacts fractured on both ends, the part closer to the base was the thicker one, unless some other factors witnessed against the rule (e.g. precise retouch of one edge part). The upper face was defined as the more convex one, or as the one having a retouch sequence on it.

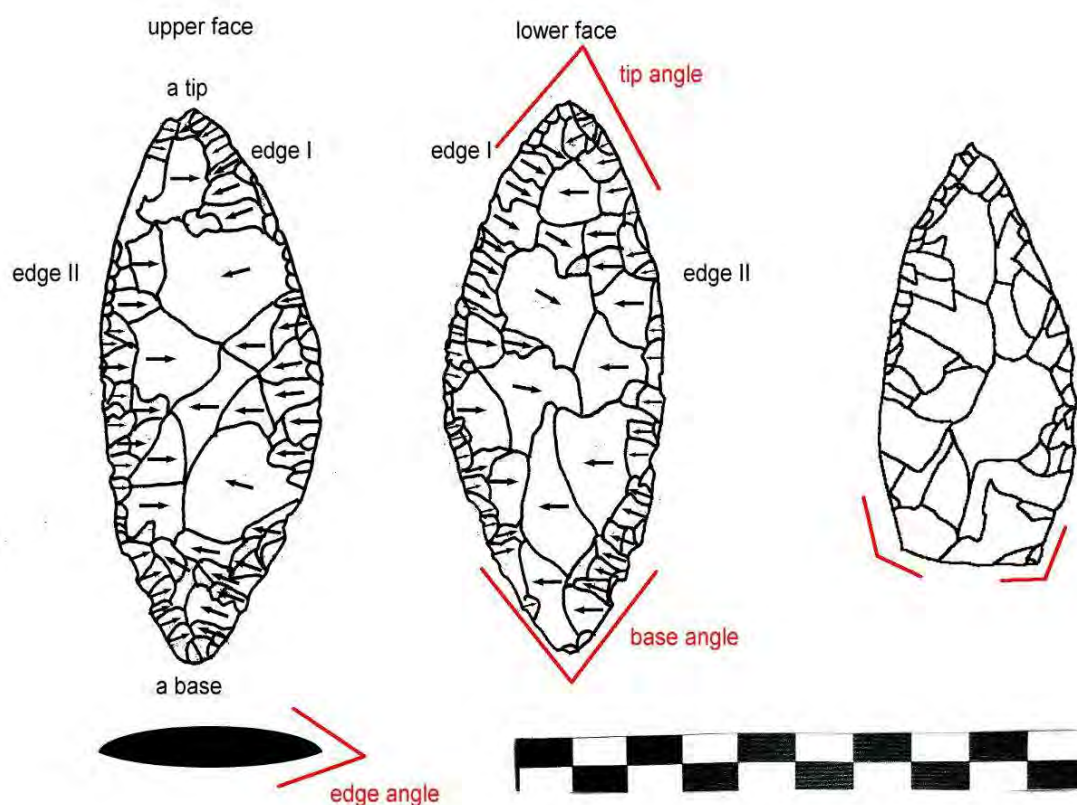


Fig.53 Artifact positioning and terms applied in description.

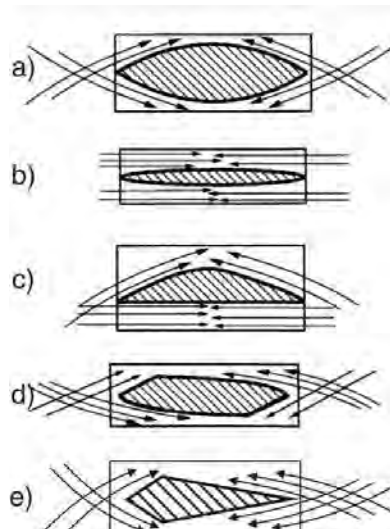


Fig.5.54 Adopted cross-section terminology scheme; a) biconvex, b) biplane, c) plano-convex, d) biconvex plano-steep, e) deltoid (after: Boëda 1995, Fig.2).

After the tool had been positioned, a terminology scheme accorded with the board positioning was adopted (Fig.5.3): **upper face, lower face, tip, base, edge I** (edge on the right of the upper face), **edge II** (edge on the left of the upper face).

As well, four angles were distinguished on the described artifacts (Fig.5.3):

- **tip angle**—angle made by two edges converging at the tip,
- **base angle**—angle made by two edges converging at the base,
- **edge angle**—angle between upper and lower face surfaces, forming a given edge,
- **fracture angle**—angle formed between transversal breakage surface and edge.

For the sake of description, artifacts were positioned in three axes—vertical, which crosses both tool ends and horizontal, which divides the tool in its middle. The third axis is that which divides the tool in its cross-section and defines its plano- or biconvexity (Fig.5.4). According to thus represented three axes, artifact symmetry was considered. Horizontally symmetrical artifacts are characterized by uniform tip and base formation. From the perspective of **cross-section** symmetry, it was determined that the division adapted by Boëda will be utilized, and slightly enlarged (Boëda, 1995, Fig.2). The analysis and description required that the following terms for tool cross-section types would be implemented:

a) **biconvex**—both tool faces formed in a convex manner and symmetrically from both edges (Fig.5.4a),

b) **biplan**—both faces formed with flat removals (Fig.5.4b),

c) **plano-convex**—equipped with one flat and one convex face. It can be symmetrical—both edges on the convex face are formed identically, or asymmetrical (plano-steep), when one of the convex face edges is formed in a semi-abrupt, and the other one in a semi-flat manner (Fig.5.4c)

d) **plano-steep biconvex**—one edge is formed semi-abruptly, the other one is flat. The second face is formed analogically but alternately, which contributes to the tool's biconvex cross-section (Fig.5.4d),

e) **deltoid**—both faces are formed in a convex manner, asymmetrically in a plano-steep scheme, and their cross-sections make one another's mirror reflection (Fig.5.4e).

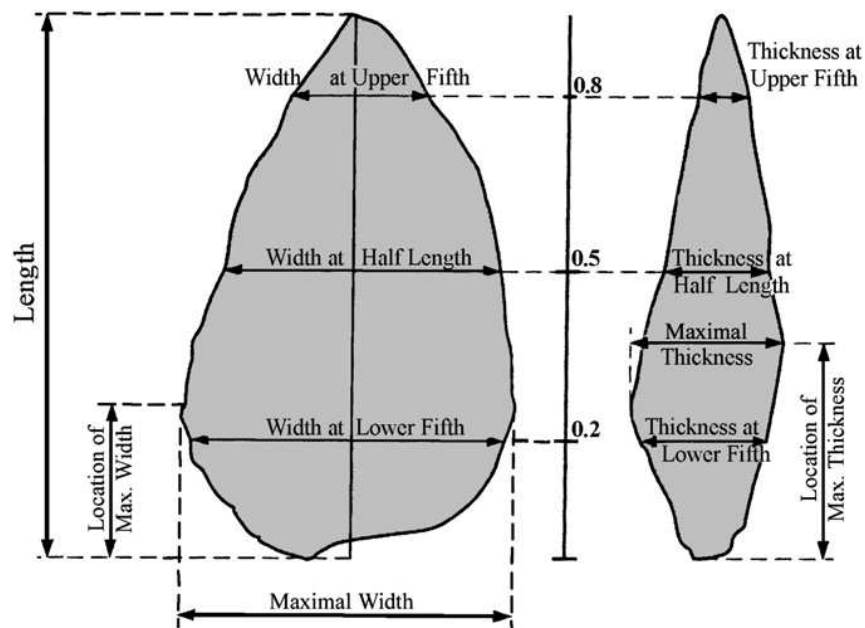


Fig.55 Symmetrical bifacial artifacts orientation according to conventional method (after: Grosman et al. 2008, Fig.2).

It is a much more complicated issue to distinguish tool vertical axis and determine its symmetry in this axis. Traditionally, the vertical axis of symmetrical tools such as handaxes, choppers, cleavers, limaces, leafpoints and other points is designated via inscribing the tool into the smallest possible rectangle (Fig.55) (Roe, 1994). With such positioning, one of the rectangle edges will constitute maximal tool length, whereas the other one its maximal width.

*“Conventional analysis encases the object in the smallest rectangular frame (...), which can be visualized as an enclosing box with paces parallel to the symmetry planes, and whose dimensions can be defined as the length, maximal thickness and maximal width of the object.”* (Fig.55) (Grosman, Smikt & Smilansky, 2008 p. 3102)





In symmetrical tools then, this axis runs near the tool tip. *Technology and Terminology of Knapped Stone* textbook defines bifacial artifacts orientation method in the following way:

*„The morphological axis is the axis of greatest symmetry, in the sense of its greatest length”* (Inizan et al., 1999 p. 105)

This tradition, which originated from the French School, also incorporated other bifacial forms into this drawing scheme and artifact orientation, such as the Micoquian knives. In the recent years, a debate has been held as to determining a better method for vertical axis designation (McNabb, Binyon & Hazelwood, 2004; Archer & Braun, 2010; Grosman, Smikt & Smilansky, 2008; Hardaker & Dunn, 2005; Underhill, 2007; Darmark, 2010). The debate is still being held, while attempts are being made to discover a measure more reliable than the subjective one to estimate bifacial tools symmetry, handaxes in particular. As it has been concluded by Grosman, Smikt, Smilansky:

*“Technically, some observers extract measures while holding the handaxe, others construct a real auxiliary box, and position the handaxe inside it.”* (Grosman, Smikt & Smilansky, 2008 p. 3102)



3. Backed Bifaces / Scraper Bifaces / <i>Keilmesser</i> / <i>Bifaces-racloirs</i> / <i>Faustkeilschaber</i>			
Klausennische	Bockstein	Königsau	Pradnik / Ciemna
 <p>Backed edge parallel to the retouched edge and distal end is oblique to the axis of the piece (Richter 1997: 189)</p>	 <p>Straight backing that extends to the distal extremity (Richter 1997: 189)</p>	 <p>Small backing in the proximal one-third of the piece, while the distal end resembles a leaf point (Richter 1997: 189)</p>	 <p>Rectangular cutting edge (Richter 1997: 189)</p>

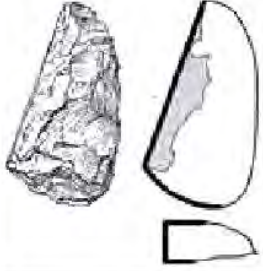

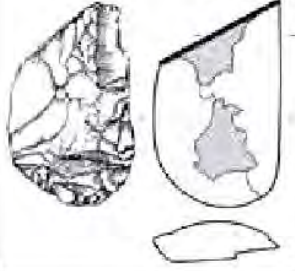
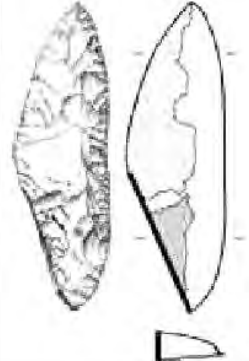
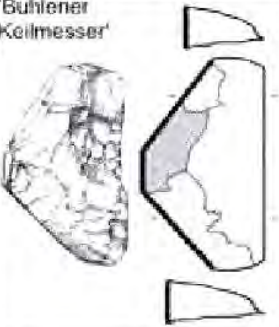
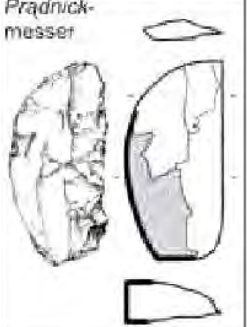

<p>Bockstein-messer</p> 	<p>Klausennische-messer</p> 	<p>'Balver Keilmesser' (-Tata type)</p> 	<p>Keilmesser of Königsau type (-Wolgograd type)</p> 
<p>'Buhlener Keilmesser'</p> 	<p>Pradnick-messer</p> 	<p>Lichtenberger Keilmesser</p> 	

Fig.56 Two backed knives orientation methods; top row—artifacts oriented according to vertical axis designated at the junction of maximal length and width [after: Ruebens 2006, Fig.1] bottom row—artifacts oriented according to perpendicular cutting edge (after: Jöris 2006, Fig.6).

New methods of orientation, axis designation and tool symmetry measurement postulated in recent years are mainly attempting to dispose of the subjectivity element and enhance objectivity through the use of 3D scans or statistic analyses (Underhill, 2007; Grosman, Smikt & Smilansky, 2008; Archer & Braun, 2010; Hardaker & Dunn, 2005; Darmark, 2010).

Asymmetrical tools length is measured, according to this scheme, as the distance between the tool's extremities.

*“If a piece is asymmetrical, then length simple follows the longest axis.”* (Debénath & Dibble, 1994)

Another tradition of bifacial tool orientation is presented by scientists who originate from the German School and the bifacial backed knives collections analyses. Based on technological examination, it is namely assumed that the knife tip in this case is an integral part of cutting edge, which constitutes the tool's main component. Thus, the main tool axis does not have to run through the tip, but it should be designated parallel to cutting edge profile (Fig.56). This is the reason why in literary sources devoted to backed knives, especially the modern ones, tools are arranged in a way so as to position the cutting edge vertically (Jöris, 2006; Jöris, 2001; Urbanowski, 2004; Migal & Urbanowski, 2008). This kind of knives layout was especially welcome in central European literature; nevertheless, English and French scientists still strive in their publications to position knives according to the axis running through the tool tip (Fig.4) (Ruebens, 2010, Debenath & Dibble, 1994).

An interesting fact noticed by researchers is that the artifacts positioning, especially the backed knives or the Micoquian knives, already constitutes a certain interpretation of those:

*“It is important to stress again that the positioning of a highly asymmetric object as the common handaxe is not unique.”* (Grosman, Smikt & Smilansky, 2008 p. 3102)

*“If this is so, the sole artifact positioning in the picture constitutes its interpretation. This is especially well visible in case of some handaxes (e.g. traditional Micoquian-related lanceolate and concave forms). Those handaxes, if they display the edge variability mentioned above (and this is exactly so in the majority of cases), should have their cutting edge positioned perpendicularly, which may well mean they should be included in the asymmetrical knives class. Relating to those observations, a question may be posed whether the division into handaxes and knives concerning the Middle Palaeolithic reflects real differences between tool classes or does it, as a matter of fact, stem from the weaknesses of archaeological classification methods.”* (Urbanowski, 2003, p.29)

As it can be observed, the method adopted for presumably symmetrical knives can as early as at this stage, through an attempt to inscribe every consecutive tool into a scheme, lead to their interpretation as being more symmetrical than they really are.

Backed knives, as opposed to handaxes and leafpoints, had been termed as asymmetrical artifacts from the very beginnings of their analyses (Bosinski, 1967). Recently, three axes of knives asymmetry are being discussed in the literature (vertical, horizontal and cross-section axis) (Jöris, 2006).

However, much as horizontal and cross-section asymmetry descriptions actually refer to edges profile, vertical asymmetry most frequently refers not as much to edges profile as to their formation method. Urbanowski depicted this as an asymmetry: *“between sharp cutting edge and blunted distal posterior edge”* (Urbanowski, 2003, p.28). This fact seems to be pointing to a trend in modern techno-functional analyses which is aimed at discovering an overview closer to the knappers' underlying idea and parametres which are crucial to him, while at the same time avoiding parametres artificially devised for the overview's sake solely.

Bearing in mind the fact that the dissertation concerns leafpoints, it would seem logical with reference to the analysed artifacts, to have accepted the first from among the presented methods of tool vertical axis designation and their symmetry determination. Nevertheless, a thus designated vertical axis is only of use when analysing finished forms, not the entire tool formation process. A leafpoint is, after all, formed as a tool equipped with two symmetrical edges and a tip located in its axis (Ginter & Kozłowski, 1975). Nonetheless, during the nodule reduction sequence, edge shape is formed and both tips are exposed, which results in endless

modifications of tool axis location on various levels of its reduction sequence and, subsequently, rejuvenation. Frequently, the formation process may cause the tip to deviate from the axis, or just the opposite, the reduction sequence may be aimed at placing the tip in the tool axis. Accepting the rule of designating the axis where the largest tool length and width intercross would require the reconstruction of artifact shape at particular reduction sequence stages.

For the purpose of this dissertation, adopting vertical axis is crucial to estimating how much the reduction sequence was focused on achieving tool symmetry. Symmetry is defined on one hand as symmetrical edges profile, on the other hand as tip placement in the axis. However, because of the reduction sequence, edges constitute a more prominent factor since it is their profile that mainly determines the tool shape. Consequently, all retouches, whether of the edges profile or the tip itself, require removals derived on the edge, and it is on the edges that the striving for achieving symmetry will be perceptible or not.

Hence, when it comes to points, it seems more justified to establish vertical axis profile with reference to edges, not tips.

As to the backed knives under examination, German School will be followed and its scheme of tool orienting and vertical axis designating will be pursued. Most commonly, knife tip is then placed outside tool axis. Furthermore, Urbanowski acknowledged this tip-to-knife axis asymmetry as being one of four distinctive asymmetries specific of this tool type (Urbanowski, 2003). It is worth noticing that during intensive cutting edge rejuvenation, tool vertical axis could have been changed not due to tip displacement, but as a result of cutting edge profile modification. Even though this scheme of knives vertical axis determining had been accepted, artifacts positioning was not changed in the dissertation if in other publications they were appearing in a previously predetermined orientation.

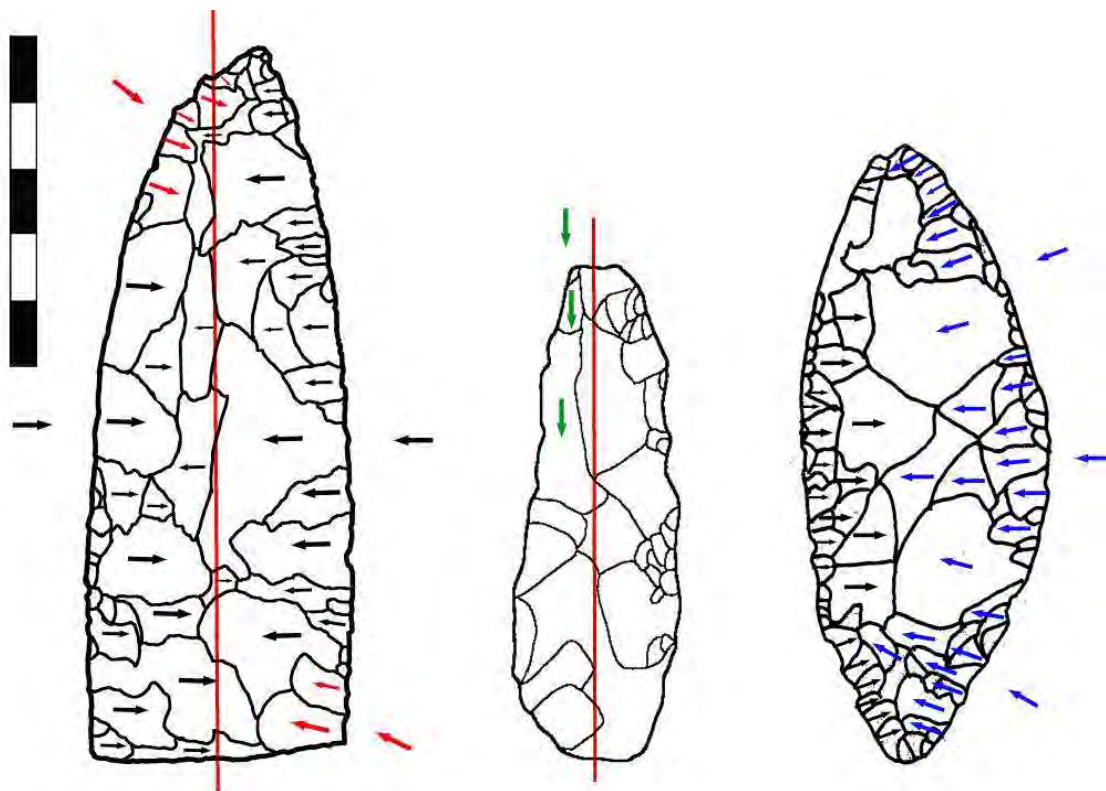
Thus, it can be concluded that much as for knives the vertical axis is designated to be parallel to one cutting edge, for leafpoints this same axis runs parallel to both cutting edges, so it crosses the points located halfway between both edges. With the point's ideal symmetry, the axis runs through its both tips. A similar situation concerns other artifact types, the axis will always be parallel to (one or both—depending on tool construction) cutting edges.

Vertical axis was used in describing the directions of percussions. The following have been distinguished then:

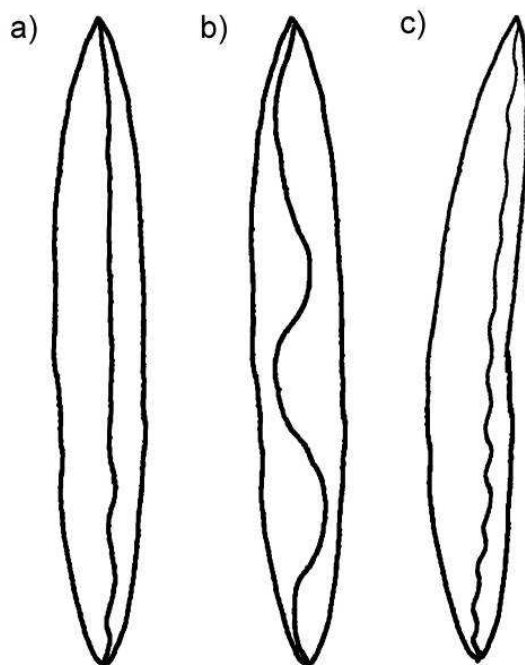
- **axis-transverse** (Fig.57), with vector directed at a straight angle towards vertical axis,
- **axis-oblong** (Fig.57), with vector parallel to vertical axis (most frequently pradnik-like removals),
- **axis-angular** (Fig.57), derived in an angular fashion, most often at tool tip or base.

Sequences derived **transversely to edge** were distinguished as well—in other words removals which, combining into one series, had been derived alongside the entire edge or its fragment, with a vector repeatedly directed transversely to edge profile, regardless of tool vertical axis (Fig.57).

Additionally, for each artifact, edge profile understood as an en face side projection of a given edge profile is a prominent parametre (Fig.58a). Edge profile can be straight or S-shaped, in literary sources also referred to as *edge sinuosity* (Darmark, 2010) (Fig.58b), which had been subject to supplementary analyses (see Chapter 4 and 5).



*Fig.57 Removal directions referred to tool vertical axis; black marks axis-transverse removals, red marks vertical axis-angular removals; green depicts axis-oblong removals; blue marks removal sequences derived transversely to edge.*



*Fig.58 Artifact side projection depicting edge profile; a) straight profile; b) S-shaped profile, c) bent tool.*

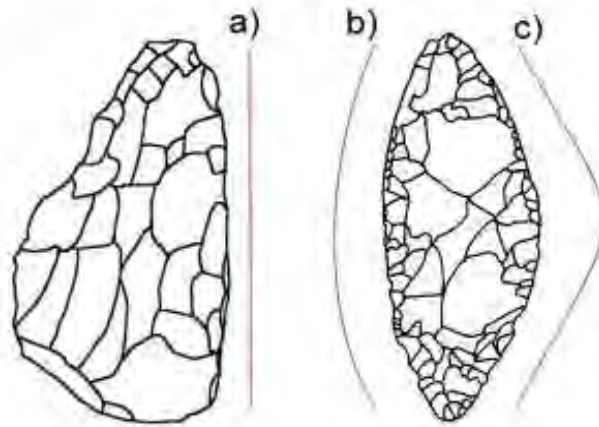


Fig.59 Distinguished edge profile types; a) straight edge; b) convex edge; c) biangular edge.

As well, for each artifact, its side projection bend was determined in a 0,1 system. Bend was understood as the tool's curve in its side projection (Fig.58c).

The artifacts under scrutiny also had their **edge profile** defined, understood as edge shape in its flat projection (en face). The following terminology concerning edge shape was employed:

- **straight edge**—of straight profile in perpendicular projection (Fig.59a),
- **convex edge**—curved edge, most frequently constituting an exposed tip or base (Fig.59b),
- **biangular edge**—prominently curved, which contributes to the formation of an angle in the middle of a given edge (Fig.59c).

### 3.1.3. Analysis progress

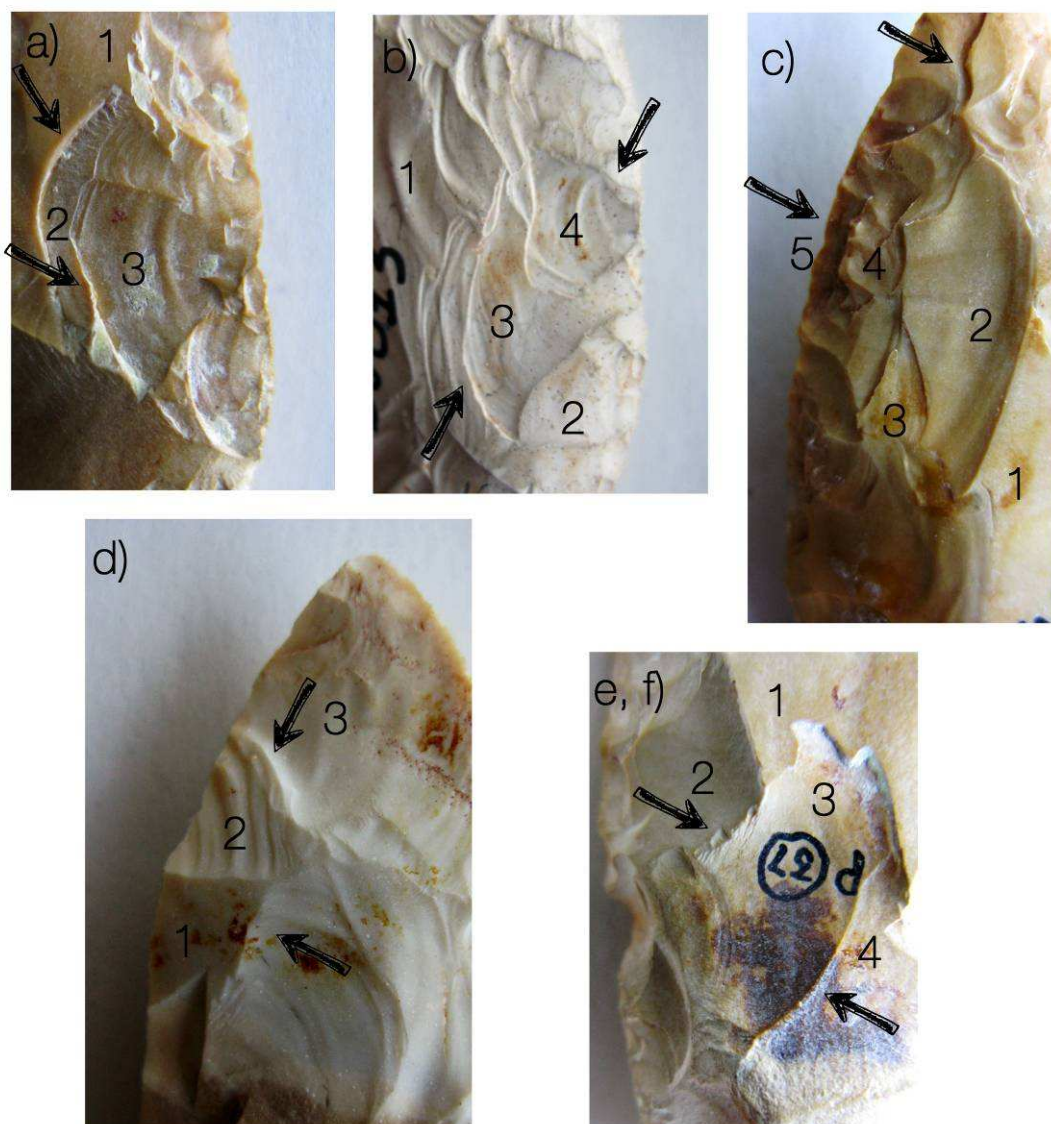
The analysis entailed the following stages:

**1. Determining removal directions.** The initial stage was to define direction and removals characteristics (Fig.61). Separate marking was used for hinged removals, for which it was impossible to determine direction, and for positives of removal. A simplified symbol scheme adopted by Uthmeier was employed (Uthmeier, 2004, Erklärung zu den Tafeln). It ought to be stressed that percussion types were not examined from the perspective of applied removal techniques. The only marginally gathered data was the observation of characteristics of butts and flake bulbs, originating from the formation of bifacial tools from the Musilievo site (see Chapter 3.2.1.1). These results, however, should be treated as observation not supported by statistic analyses, and done on a scarce sample of a few dozen flakes. Apart from this incidental debitage description, there was no instrument available to conduct the percussion technique analysis based on flake scars visible on tools. Transversal breakage surfaces were analysed individually. For each of them, there was an attempt to determine the direction from which force was introduced. It was most often possible via observing negative of fracture bend and the removals chronology. The following rule was applied: a negative of fracture bent on its surface implies a transversal breakage, whereas a flake scar bent or curved



towards the edge points to a breakage resulting from edge percussion. Concurrently, ripples and bend direction often enabled to determine from which side or edge the percussion or force which caused the breakage were introduced (Roche & Tixier, 1982). If the negative of fracture displayed the point of impact, it could be then assumed that the percussion was introduced purposefully. Not all flake scars bore traits allowing to determine all parametres.

**2. Estimating removal chronology.** At that point, reciprocal chronology was estimated among all neighbouring removals (Fig.61b). In the pictures, chronology was marked with arrows, whose vector was directed towards an earlier removal. In some cases, it was possible to establish chronology visually. If distinctive features were not visible on the ridge, magnifying glass enlarging by 5,10,15,20 times was applied. The most useful for chronology estimation was the enlargement by 10. The distinctive features that enable chronology determination entail:



*Fig.60 Distinctive features enabling to determine the chronology of neighbouring negatives of removal; a) flake scar placement height, b) overlapping flake scar, c) hinged removals, d) preserved flake scar contour, e) hinges, f) step. Numbers in particular pictures denote relative chronology of removals.*

a) **flake scar placement height**—flake scar placed lower and intruding into that placed higher is later than the former (Fig.60a),

b) **overlapping flake scar**—flake scar placed entirely on the surface of a bigger one is later than the former (Fig.60b),

c) **hinged removals**—those from among removals, which wedge themselves out on flake scar surface through a hinge are later (Fig.60c),

d) **preserved flake scar contour**—removals wedge themselves out on a tool, usually in a fan-like shape, or in slightly bent ripples near the interscar ridge. The flake scar that is fully preserved alongside a given edge is a later one, that which ends next to the ridge whose ripples are not bent, is an earlier one (Fig.60d),

e) **hinges**—later of the two flake scars contains specific hinges preserved alongside the scar ridge; they are often the ends of interradian defects which wedge out next to the interscar ridge. Hinges are found on the later flake scar's side, and they prove that this exact flake scar created a given interscar ridge (Fig.60e),

f) **step**—when it comes to flake scars with opposite vectors—derived from two opposite edges, whose converging surface is made up by a line at the end of a flake scar, next to a later removal wedge, an insignificant step occurs on the interscar ridge on the side of later removal (Fig.60f).

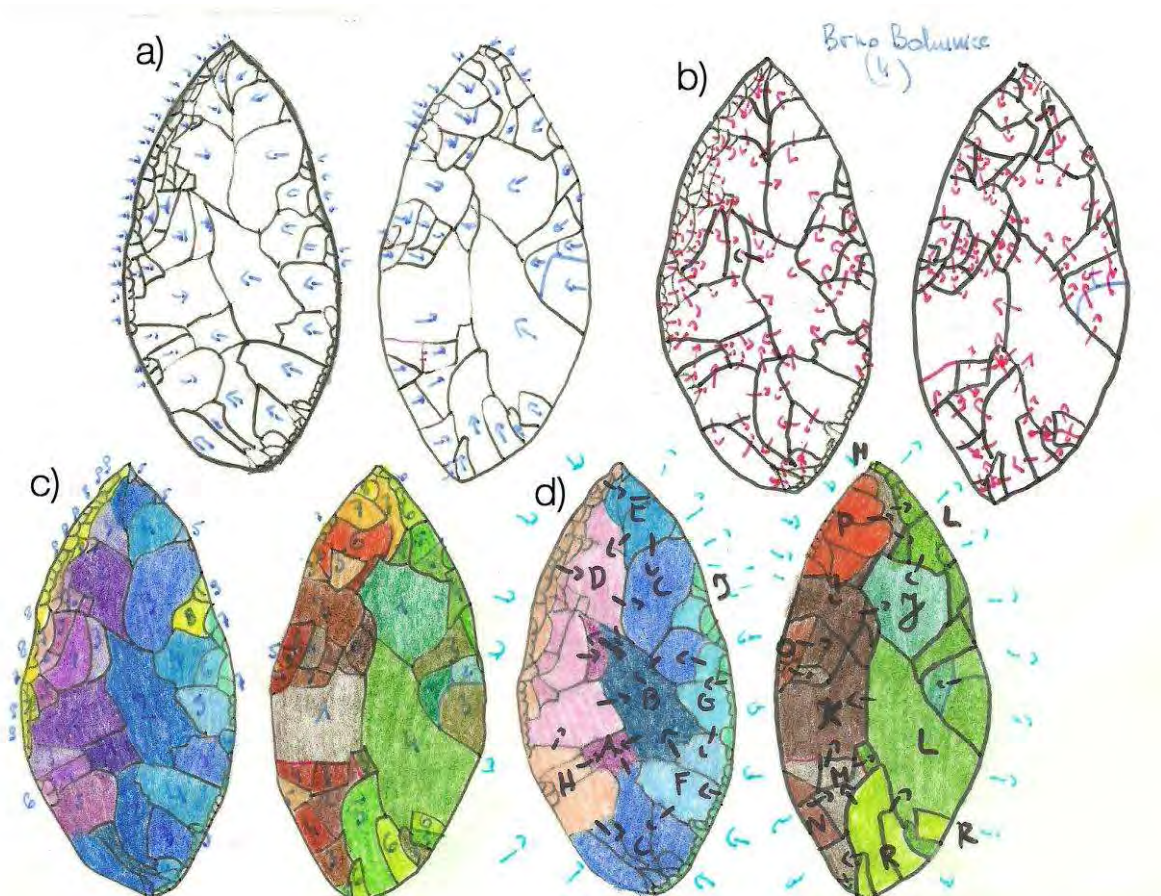


Fig.61 Four initial stages of scar pattern analysis, a) determining removal directions, b) estimating removal chronology, c) estimating removal chronology within edges, d) distinguishing flaking sequence.

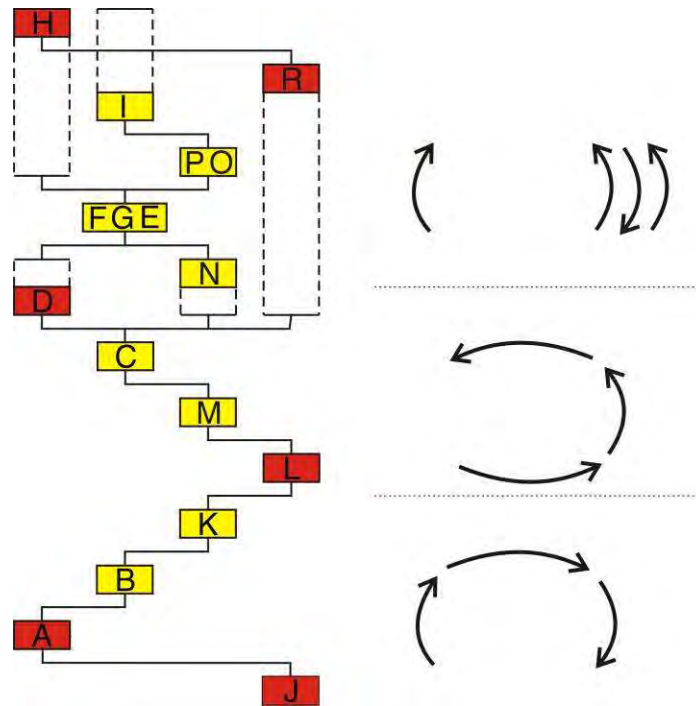


Fig.62 Graph demonstrating reciprocal sequence chronology and division into manufacturing stages. Graph concerning artifact from Fig.61.

**3. Estimating removal chronology within edges.** At this stage, all removals derived from one direction to one tool face were grouped (Fig.61c). It was here that the four tool parts were usually designated, parts which constituted removals derived on each edge and on each face. Separately were treated removals derived from tip or base, but only when they had a prominently different removals direction or character. Within thus designated edges, absolute removals chronology was determined, using numbers to sequence removals from the earliest to the most recent. For the sake of better visualization and further stages simplification, removals were coloured from the darkest being the earliest, to the brightest being the latest. A colour scheme was adopted according to which the right edge (I) on the upper face was marked with blue and its different shades, the left edge (II) on the upper face with purple and its shades, up to pink. The left lower face edge (I) was brown, whereas the right lower face edge (II) was green. An identical colour scheme was retained for further analysis stages. This phase, though it was not crucial, allowed to order the flake scars, and served as an introductory-preparatory stage before combining particular removals into sequences.

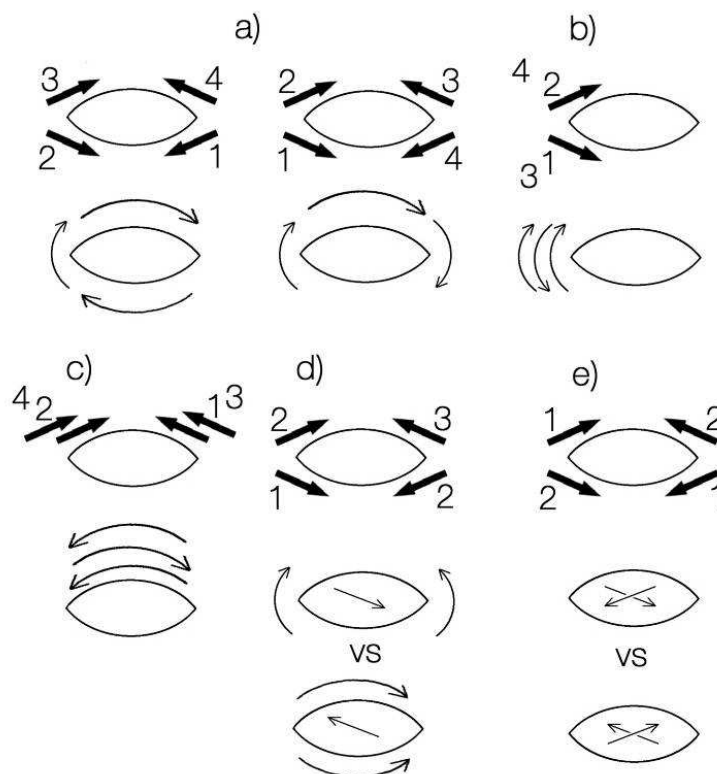
**4. Distinguishing flaking sequences.** Because of the fact that one tool normally contains more than 50 flake scars, estimating and depicting their reciprocal chronology would not bring any informative results. Parallel to that, some flake scars joined together into cohesive flaking sequences which were derived in a uniform time frame at a given manufacturing stage (Fig.61d). This level of analysis was aimed at combining single flake scars into flaking sequences which would, as a whole, reflect a particular action in the tool reduction sequence. Thus, the term “**sequence**” will be applied to denote a few-to-several flake scars designated as a cohesive whole, derived on the tool for a common purpose and bearing similar morphometric characteristics (positioning, angle, size, direction). The indicated sequence has to be chronologically cohesive as well, which means that removals are derived within a certain designated sequence, and that removing is done prior to/following another defined flaking sequence. It is well understood that the examination does not permit to clearly establish the uniform timing of removals combined into each consecutive flaking



sequence. Nonetheless, the examination's focus is on reconstructing the underlying idea of the knapper, and not the sole sequence of actions performed on the artifact. Hence, even if some removals have been joined into one sequence, though for instance they may originate from various artifact rejuvenation phases, it still seems to be a justified procedure if the aim of deriving removals was identical in each case (e.g. edge rejuvenation/sharpening).

**5. Establishing reciprocal sequence chronology, graph.** At this stage, a graph is being created, concerning mutual chronological interrelations of particular tool sequences. To simplify the graph's interpretation, sequences derived from one edge are drawn above one another (Fig.62). If the chronological interrelation of two sequences is not obvious, they are drawn as parallel. Broken lines mark possible chronological span of a given sequence. To simplify interpretation, sequences derived from edge I are marked in yellow, and sequences derived on the left edge (II) are marked in red. Thus, tool rotations by its edge or face are more visible.

**6. Establishing manufacturing stages.** Having drawn the graph, it is now possible to interpret sequences arrangement and to divide the entire manufacturing process into stages (Fig.62). The term manufacturing stage refers to several sequences derived after one another with a common purpose, or to removals creating the sequences, if they are of similar morphometry. One stage includes, for instance, all wide and flat surface-forming removals, usually derived at the very beginning of manufacturing process, or removals forming each one of the edges, even if eventually the edges will serve a different purpose. Tool rejuvenations are also designated as separate stages. Within a particular manufacturing stage, to the highest possible extent, the knapping scheme used in a given tool formation phase is determined.



*Fig.63 General schemes of artifacts knapping illustrated in cross-sections; a) surrounding scheme, b) edge scheme, c) surface scheme, d) surface/edge analogical scheme, e) alternate scheme.*

Several schemes of knapping can be distinguished on a tool:

**a) surrounding scheme**—if removal sequences at a given stage are derived in a surrounding fashion beginning with one edge, an edge surrounding scheme is being tackled; whereas when removals are done on one face first and then on the second face, a surface surrounding scheme is being dealt with (Fig.63a),

**b) edge scheme**—when reduction sequence is performed through deriving removals on one edge, first on one face, next on the second face (Fig.63b),

**c) surface scheme**—when removals are derived on one face from the first, and then from the second edge in turns (Fig.62, 63c),

**d) edge/surface analogical scheme**—when removals are derived from each edge, first on one determined face, next on the second, for example according to the following pattern: bottom–top–bottom–top. Or else, surface scheme, first from one edge, then from the second, identically on both faces. Unfortunately, sequences arrangement does not allow here to establish whether reduction sequence was done with reference to edges or surfaces (Fig.63d),

**e) alternate scheme**—when removals are derived alternately, first on two edges, next on two opposite edges (Fig.63e).

**7. Sequences description.** Here, each sequence is described according to morphometric features of its removal components. Special strain is placed on defining the aim of deriving a particular sequence and finding its analogous sequences.

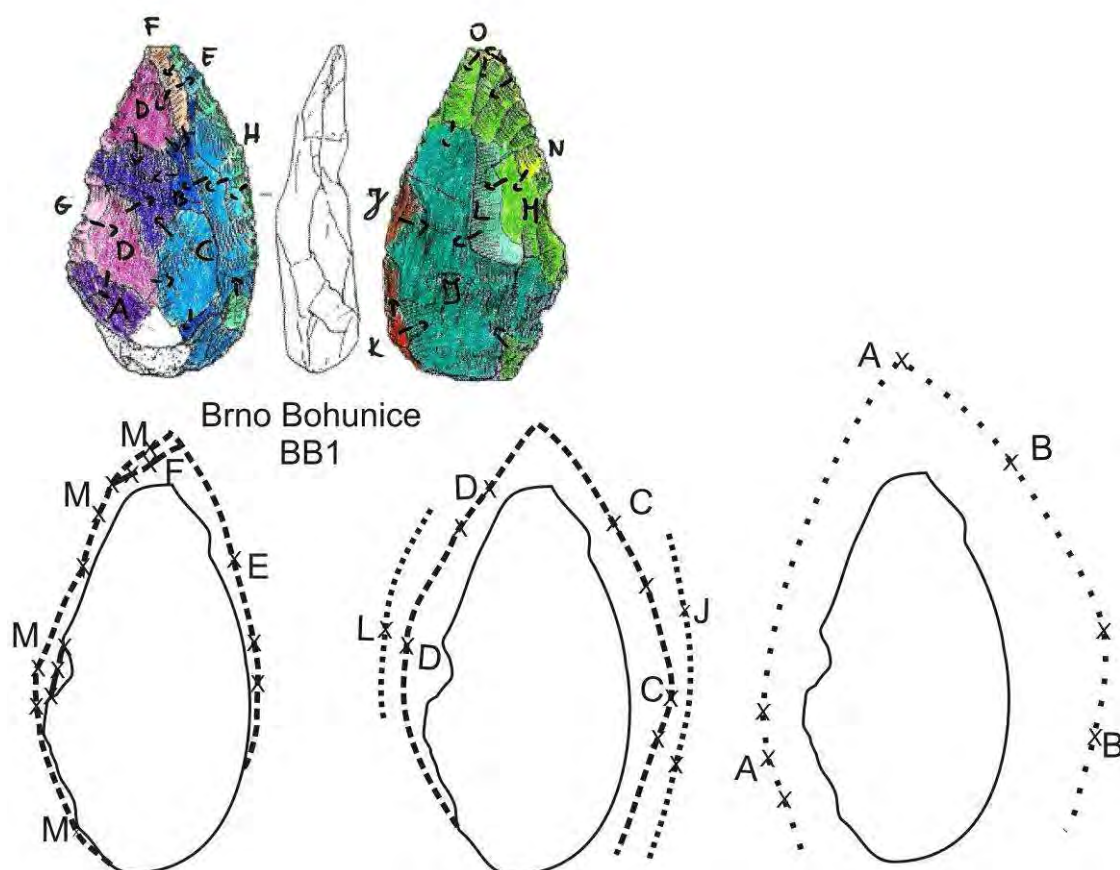


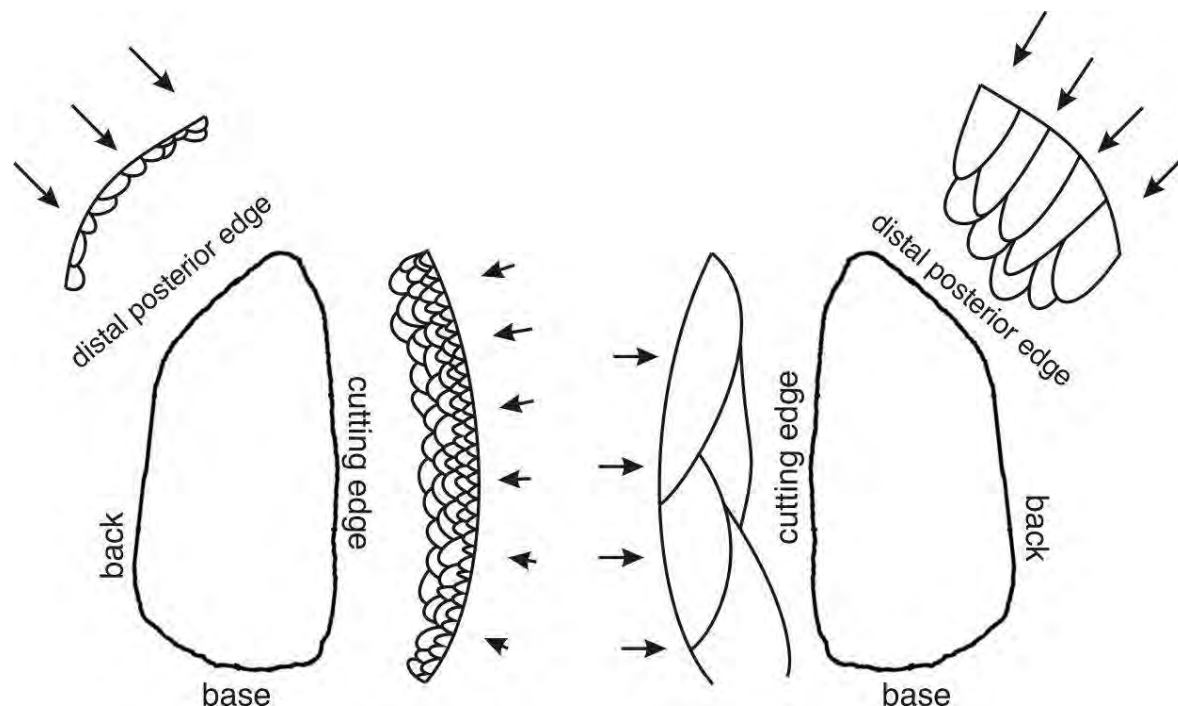
Fig.64 Tool shape reconstruction at particular manufacturing stages, initial stage with marked removal points of certain removals within a sequence.

**8. Reconstructing tool shapes from particular manufacturing stages.** This level is based on estimating tool shape, having taken scars of every removal sequence visible on the tool surface (Fig.64). This process can be done only in approximation, by reconstructing the flake's preliminary shape, prolonging the removal axis and observing the angle of ripples propagation on the removal. This analysis results in creating a map of points, which are then joined together into sequences. Owing to this process, it is possible to estimate what shapes the tool had taken at particular manufacturing stages. This examination also enables to observe gaps in the manufacturing scheme. Those gaps become perceptible when the reconstructed scheme lacks removals that would cause a considerable change in tool shape between two neighbouring sequences; a change that is visible on the reconstructed scheme. Most frequently, such pattern could have been observed on tools bearing traces of repeated cutting edge rejuvenation. Merging edge rejuvenation removals obliterated earlier removals, thus causing the scheme gap to arise.

**9. Designating techno-functional units.** The term “techno-functional units” denotes tool area specified by a different way of knapping. Whole edge, edge fragment or tool surface may all be termed as techno-functional units. These units are designated only when a given tool fragment is formed in a specific, possible to identify and describe manner. This name defines the nature of division which assumes that particular parts are treated as elements formed on purpose. The removals of given features, forming those elements, have a specified aim, either technical—edge/surface formation, thinning, tip exposure; or functional—sharpening and usage.

The following techno-functional units had been designated on tools:

**Cutting edge**—edge straight in profile, with retouch sequences derived on at least one of its faces (Fig.65), from all tool parts, this one received the most precise reduction sequence; may bear traces of rejuvenation, rather devoid of removals with technical functions concerning the remaining tool parts, such as thinning or tip formation. Removals with technical function apply to the formation of cutting edge itself or of its shape.



*Fig.65 Tool division into techno-functional units. The drawing also illustrates specific character of removal directions derived on cutting edge and distal posterior edge.*

**Distal posterior edge**—edge or, most often, fragment of edge opposite to cutting edge, convergent at the tip. Most frequently in angular position towards vertical axis. It is mainly responsible for technical functions connected with tip formation and tool thinning, especially thinning the cutting edge next to the tip. The edge may be retouched and potentially perform functional tasks, mainly near the tip. The edge's functional aspect plays a secondary role. As a result of accepting such distal posterior edge definition, it ought to be underlined that an entire edge placed opposite the cutting edge can be named as distal posterior edge. This may happen on condition that the discussed edge does not bear traces of blunting, but performs the function of correcting tool thickness; moreover, removals derived from this edge on its entire length seem to be performing an identical function as well. According to this definition, it is possible to have a tool with two distal posterior edges convergent near the tip, if both of them possess alternate thinning sequences and both perform parallel technical functions towards one another.

**Back**—edge formed with blunting removals, sometimes in order to form it, breakage surface or natural cortical surface is used.

**Base**—edge shaped with removals parallel or angular towards vertical axis, forming a separate, most often curved edge running crosswise to vertical axis (Fig.65). It may well be formed via retaining natural cortical surface or through the tool's transversal breakage. Base profile may be slightly angular towards vertical axis, which is related to e.g. prolonging the cutting edge at base angle.

**10. Tool comparison within a site.** Here, particular artifacts are being compared among one another in order to distinguish artifact groups within a certain site. Artifacts of the same structure—with designated techno-functional units; or marked by a specific and cohesive manufacturing scheme—are placed in one individual group.

Apart from scar pattern analysis, throughout the course of work done on artifact collections, photographic documentation was gathered and tool measures were taken: length, width, thickness, as well as points of maximum tool thickness and width. Since the measures of most examined tools are well known, widely published and discussed in literary sources (Adams, 1998; Allsworth-Jones, 1986; Allsworth-Jones, 1990; Bosinski, 1967; Hopkinson, 2007), they are not presented in this dissertation. Meanwhile, they had been used during description and considered mainly when site-specific features were investigated, such as insignificant tool thickness or minor width-to-length ratio (slenderness).

For each tool, its symmetry in three axes was determined. Symmetry was expressed on the scale of 0; 0.5; 1, where 0 denotes no symmetry, and 1 denotes full symmetry in a given axis.

Each tool had its morphology overview prepared, as well as the review of characteristic features, its preservation degree and the raw material from which the tool was made.

All additional data that was gathered: measures, symmetries in three axes and extra features description served to compare the artifacts in detail and to make their final overview. Both for measures and symmetry, no meticulous statistic analyses were conducted. First of all, because not entire bifacial artifact collections were examined, but only a selected sample. Secondly, this information did not seem valid in considering the reconstruction of technological idea behind the tools.

### 3.1.4. Scar pattern analysis potential

Scar pattern analysis allows to reconstruct the process of bifacial tools formation. A direct result of each examination is the reconstruction of single tool manufacturing scheme. Much as this outcome is informative in itself, it is the collective and comparative analysis of particular reduction sequences within a chosen sample that may bring the most interesting findings. However, the comparative stage of artifact analysis method examination has, from the very first attempt, posed remarkable problems in using it for bifacial artifacts (J. Richter, 2001; Jöris, 2001; Graßkamp, 2001; Urbanowski, 2004). So far, no uniform concept has been created for comparing the analysis results of single artifacts among one another. The scheme adopted in this dissertation was based on dividing the manufacturing process into stages and comparing artifacts among one another using particular tool formation stages with reference to then applied schemes.

A crucial examination component was to establish the aim of actions undertaken at consecutive manufacturing stages and correlate them with particular techno-functional units. Owing to this, it was possible to determine what the goal of forming certain tool surface/edge was, and consequently, following traits/parameters significant to the tool creator, which decided about the utility of a given form, or its abandonment.

Hence, it was resolved not to underline or distinguish the rejuvenation stage from the manufacturing scheme as completely separate and opposing the tool formation process. For the reconstruction itself was directed at estimating the most important parameters of a given tool, and parameters that could have been discarded by the knapper/user if the situation required to do so (error, failed removal, fracture). These features could have been observed individually at each manufacturing stage. In this respect, analyses of unfinished preforms are equally informative. They provide a presumption for analysing the motivations behind artifact abandonment and learning about the committed errors. In the context of other artifacts from a given site, these examinations also enable to determine parameters which made further tool manufacturing impossible, or led to its impracticality. On the other hand, the rejuvenation stage is important as it is during its course that the tool shape is modified; whereas the creator's intention was to retain crucial functional tool characteristics, e.g. straight in profile edge, exposed tip or symmetrical edges convergent near the tip. For this reason, the observation of rejuvenation stages is valuable, as it allows to trace tool parameters that can be dropped by the knapper, and those that remain important to him in order to keep the artifact functional. Thus, if no significant change can be seen at rejuvenation stage (such as form reorganizing via modifying an edge/a techno-functional unit constituting the main functional interest area, e.g. orientation change, base retouch), it can then be assumed that the tool reflects the creator's original idea. Nonetheless, in many cases, consecutive overlapping rejuvenation sequences make it impossible to discover tool formation stages and this is when the creator's original idea reconstruction becomes unfeasible. The analysis outcome at this point illustrates only the tool's shape at the final stage of rejuvenation phase.

### 3.1.5. Scar pattern analysis limitations

The examination allows to reconstruct only those stages of tool formation and rejuvenation which are visible on artifact surface as removals. In general, consecutive tool rejuvenation series, if they are intrusive, obliterate earlier removals created during former manufacturing stages. Thus, for finished forms, even though they may not bear traces of intensive rejuvenation, lack of removals earlier than the phase of flat, broad tool surface

thinning and forming sequences is a standard. Forms carrying repeated rejuvenation traces and found in exhausted form often carry removals from subsequent rejuvenation phases only. The analyses of those artifacts frequently give scarce information on the manufacturing or even the rejuvenation scheme. This is due to the fact that overlapping sequences, usually of the same parameters and purpose, derived during rejuvenation from the same edges repeatedly, complicate a thorough step-by-step examination of manufacturing schemes. More often than not, intrusive rejuvenation removals from, for example, cutting edge rejuvenation, remove several earlier sharpening removal phases and cause a scheme gap to arise. Those gaps can be noticed while reconstructing tool shape at particular manufacturing stages, but only when the gap is of considerable size since shape reconstruction is marked by large error margin.

To reconstruct earlier artifact manufacturing stages, analyses of preforms and unfinished forms are important. Equally, some artifacts equipped with vestigial removals from early manufacturing phases, preserved owing to hinged removals or failed thinning process, enable the observation of nodule formation scheme at its prior stages.

It is worth stressing that the *chaîne opératoire* recreated on the basis of artifact scar pattern analysis does not encompass all tool formation and rejuvenation stages. Most frequently, it is devoid of the earliest stages concerning decortication and preliminary nodule formation.

## 3.2. Output of Scar Pattern Analysis

### 3.2.1. Key sites

#### 3.2.1.1. Bulgaria

##### 3.2.1.1.1. Musilievo

The analysis included 19 tools from the Musilievo site. The artifacts come from the collection of the National Archaeological Museum in Sofia. Although all examined forms had been described in literature as being examples of leafpoints (Sirakova & Ivanova, 1988; Sirakova, 1990; Sirakova, 2009; Ivanova & Sirakova, 1995 pp. 33–34), yet the analysed artifact collection proved to be technologically and conceptually inconsistent. It would be therefore reasonable to extend the sample with new items so as to verify the results presented below. Due to limited time, it was not possible to proceed with further analysis. For this reason, it was decided to partially extend this group with artifacts whose photographic documentation was done during the stay in Sofia. For this purpose, the photos of artifacts in six projections were used to separate those that have similarly shaped edges, notches and the tip according to the character of forming them removals. On this basis, it was possible to extend the analysed sample to 32 tools.

On the Musilievo site, during archaeological research altogether several thousand of artifacts were excavated, majority of them being debitage. Among the waste products, there are numerous flakes from bifacial tools manufacturing. They have a linear butt with a lip, positioned at an angle of 40–65° towards the exterior platform angle. Some flakes have a bulb and a smaller lip, or they are characterized by lack of a lip. Flakes without lips are generally more massive and have bigger butts. Due to highly limited time, it was not possible to analyse the whole debitage, and only initial observations based on artifacts distinguished as flakes from bifaces' production were written down. For this reason, the description above should be treated only as the result of observations rather than of formal analyses and statistics. However, based on the presented observations, it can be concluded that the bifacial Musilievo tools production made use of soft hammer technique, which left distinctive marks in the form of a lip on the flakes. The presence of more massive flakes with bulbs and without a lip may indicate that at earlier knapping stages, or for the purpose of removing big, extensive flakes hard hammers were used.

The Musilievo artifacts were made on flint nodules, whose outcrop is placed on the slope where the site is located. The site can be therefore treated as a workshop, some artifacts are preforms, broken and unfinished pieces.

The artifacts are characterized by a considerable variety of forms, from long (10cm) and slender (M.56) to small (5cm long) but with significant thickness and width (M.42).

Most artifacts are characterized by edge profile asymmetry, as well as a tendency to leave cortex surfaces on one edge near the base (M.654, M.640, M.55, M.42). The cortical fragment sometimes forms a transversal surface, which is often set angularly to tool axis (M.52, M.648). Such cortical surface placement is associated with specific tool knapping schemes applied (Fig.72, 73).

On the basis of scar pattern analysis and the differences in edges treatment, the tools can be classified into four groups.

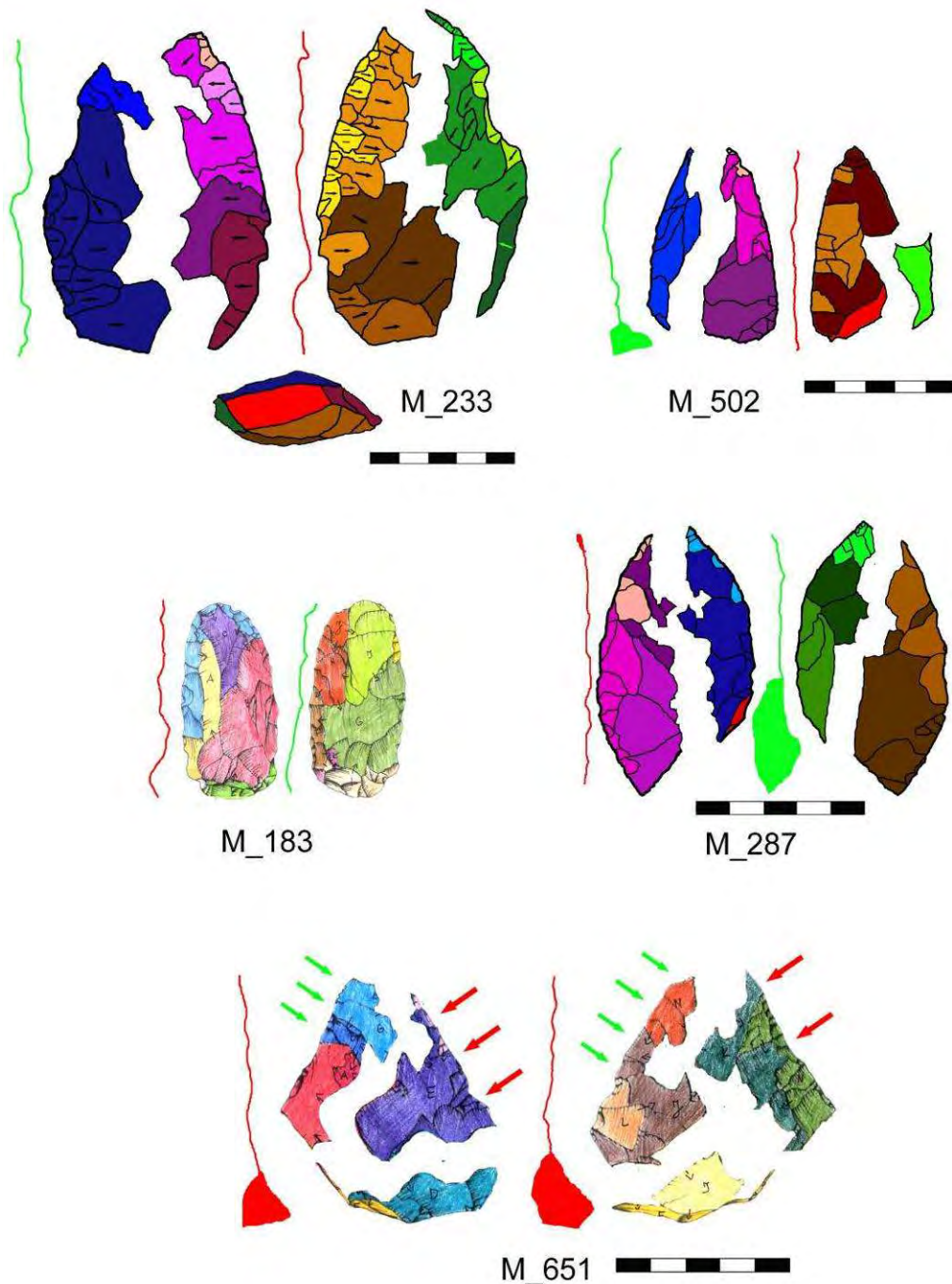


Fig.66 Group I artifacts shape comparison with marked edge profile.

## Group I

It consists of asymmetrical tools, which are characterized by different treatment of edges (each edge is knapped differently). It includes seven artifacts (M.233, M.502, M.287, M.651, M.183, M.480 and M.84). This group is not technologically consistent. The artifacts described below differ from one another in many aspects, from morphology to technology and production schemes (Fig.66). They share, however, **the primacy of care for the edge over care for tool tip and symmetry**. On the other hand, there is the different knapping of both edges, of which one has traces of retouch and rejuvenation, and the other was blunted and left without retouching (M.233, M.502 and M.287). An exception is the triangular flake tool,



M.651, which is characterized by equal knapping of both edges, but a total lack of tip knapping. Most artifacts included in this group also bear rejuvenation and resharpening traces near the tip.

Because of significant differences in morphology, the artifacts will be described separately. On the M.233 artifact the following can be distinguished: a base in the form of a transversal fracture scar, a back's edge formed with abrupt removals, lower face's flat surface, a distal posterior edge running diagonally to tool axis and converging with a long cutting edge at the tip (Fig.66).

The tool was knapped in a plano-steep manner at surface formation stage. This is best visible at the base, where steep removals on the lower face form the back's surface, and semi-abrupt removals on the upper face form the cutting edge near the base. On opposite faces, two series of flat, extensive removals were derived alternately, forming the surface of both tool faces. Closer to the tip, semi-abrupt removals on the cutting edge were replaced by flat, tool thinning removals, while the distal posterior edge was still formed with abrupt removals, which causes the tool to obtain a triangular cross-section at the tip. Tool rejuvenations also deviate from the usually observed schemes since during cutting edge resharpening, the tool was retouched with flat removals on the lower face. Moreover, abrupt removals forming a large notch on the distal posterior edge were introduced. Owing to this, the tool became extremely handy, especially in combination with semi-abrupt removals, partially blunting the cutting edge at the base. Only the last series of fine retouch was introduced at the tip, onto the upper face.

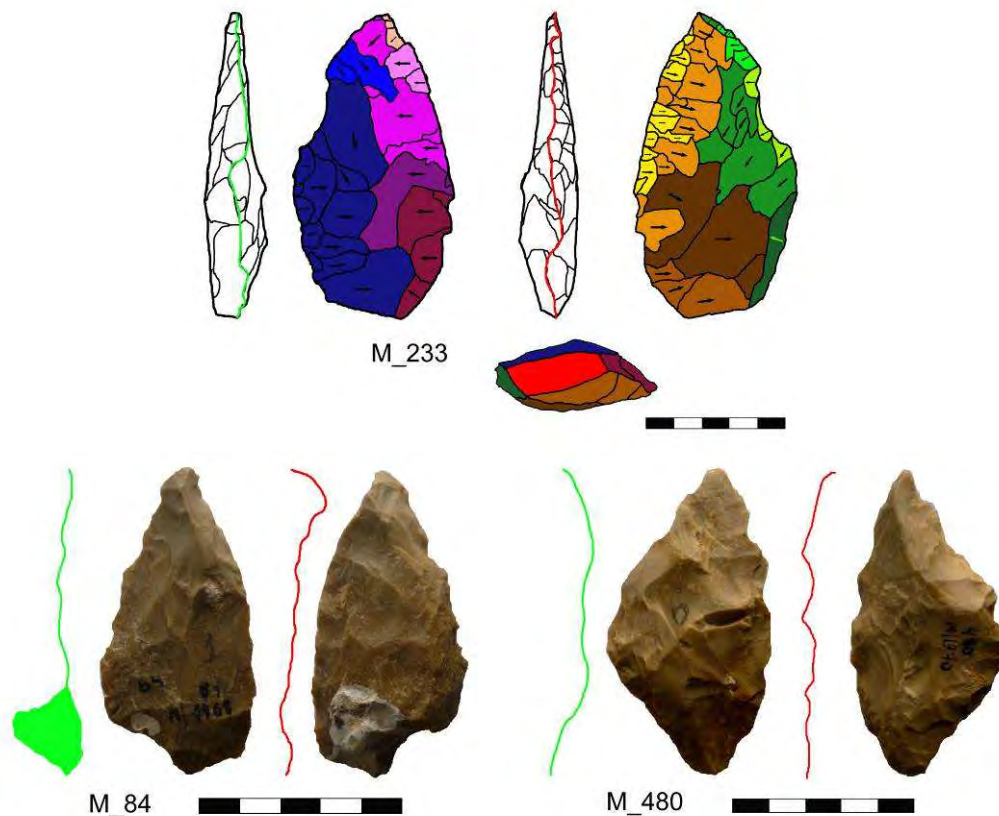


Fig.67 Comparison of analysed M.233 tool and unexamined M.48, M.85 tools, included in group I due to their analogical design. Red marks cutting edge's profile, green marks distal posterior part's and back's profile.

The tool reveals features characteristic of the remaining Musilievo tools, namely a tendency for alternate tool manufacturing schemes, as well as alternately derived retouches, and also the possibility of changing the retouched surface from upper to lower or the opposite during subsequent repairs. The retouch, as it can be seen, could be derived on the upper and the lower tool face equally easily. At the same time one can observe a preference for applying a series of flat, tool thinning removals on its both faces, even at very acute edge angles. Abrupt removal series were performed only at early knapping stages, probably in order to increase the angle, which allowed for larger, more extensive and intrusive removals. At later knapping stages, the steep surfaces were gradually removed.

Analogically to the presented M.233 tool, the unexamined M.480 and M.84 tools were also rejuvenated. Both have traces of numerous repairs on the cutting edge and the distal posterior edge, which resulted in tip exposure (Fig.67). In case of the M.480 tool, the retouch was done on both edges on the upper face, while the lower face has traces of flat percussions thinning the tool at the tip. This rejuvenation scheme has led to tip exposure, but also to it being moved off the axis. It also prolonged the cutting edge. The M.480 tool was rejuvenated with an alternate retouch of both edges. Parallel to that, lack of care for the tip is observable (Fig.67).

The M.502 tool was formed as plano-convex, with an abruptly shaped back on the entire length of its edge (Fig.66–M.502–dark blue). It has a cortical base surface, flat lower face formed with flat removals, crossing the entire tool width, and a straight cutting edge bearing traces of at least two rejuvenations (Fig.66–M.502–brown).

The M.287 tool was formed alike, it has sequences of abrupt percussions blunting the back edge on the upper face (Fig.66–M.287–dark blue). The tool has the cutting edge on its left, which is unusual. The lower face was formed with flat removals introduced axis-angularly at first, and later axis-transversally. Such surface formation was conditioned by the presence of two vertical breakage surfaces positioned diagonally to vertical axis (Fig.66–M.287–red). The fracture scar located near the tip was almost removed in the course of formation and subsequent repairs. However, part of it was preserved as a transversal surface near the very tip. Leaving the remnant of transversal surface at the tip on the cutting edge testifies to the fact that the tip was not important in this tool, but only the very edge, which was repeatedly rejuvenated. The angular breakage at the base could have appeared already during tool formation. It was then abruptly retouched so as to become part of the back.

The M.183 artifact has oval shape, it is characterized by plano-convex cross-section and considerable thickness (2.5cm) in relation to its length (7cm), as well as no exposed tip. The tool was formed in a surface scheme of knapping. First, the convex upper face was formed with semi-flat removal series performed from both tool ends (Fig.66–M.183–purple and red). Then, the lower face was formed with flat, extensive removal series (Fig.66–M.183–yellow and brown). Then, base edge was formed with removal series on both faces (Fig.66–M.183–yellow and green). The back's surface was formed with a steep, edge blunting removal series. At the end, flat removal series on the lower face made it possible to thin the tool at the tip. A series of semi-flat, surrounding percussions along the edge opposite the back and around the tip sharpened the edge and exposed the tip, thus forming a cutting edge (Fig.66–M.183–blue). The poorly regular tool form, the surrounding retouch going along the edge onto the tip, and lack of repairs may suggest that this tool was formed *ad hoc* on a failed preform or a flake (removals on the upper face might have occurred before obtaining the flake).

The M.651 artifact is marked by triangular shape and alternate knapping of both retouched edges, converging at the unexposed tip. The tool was made on a massive flake, whose butt constitutes the tool base. The tool is the widest and the thickest at the base, and

narrows towards the tip. The tip is left without retouching. The tool has an alternate retouch and series of flat, long, thinning removals derived from the angle at the tip on the face opposite to a given retouched edge. Two alternate series of thinning, angular removals formed a separate transversal edge at the tip. The edge is sharp but unretouched (Fig.66–M.651–green arrows). Both edges were also later resharpened (Fig.66–M.651–red arrows) and treated uniformly. The tool was knapped in a surrounding scheme. Knapping began with flat, thinning removals onto the ventral surface, then the upper face was formed. While deriving the last series of edge forming removals, the direction of tool rotation was changed, yet knapping was continued according to the surrounding scheme.

The example of M.651 tool shows that the purpose of production could have been tools with two equally shaped and converging cutting edges, still without an exposed and retouched tip. This tool is a good example of **no attention devoted to the tip**, and **with knapping focused on edges**.

All artifacts of this group were knapped in an edge surrounding scheme, in a bottom-top manner, or in a surface scheme, in a bottom-top manner starting from one face.

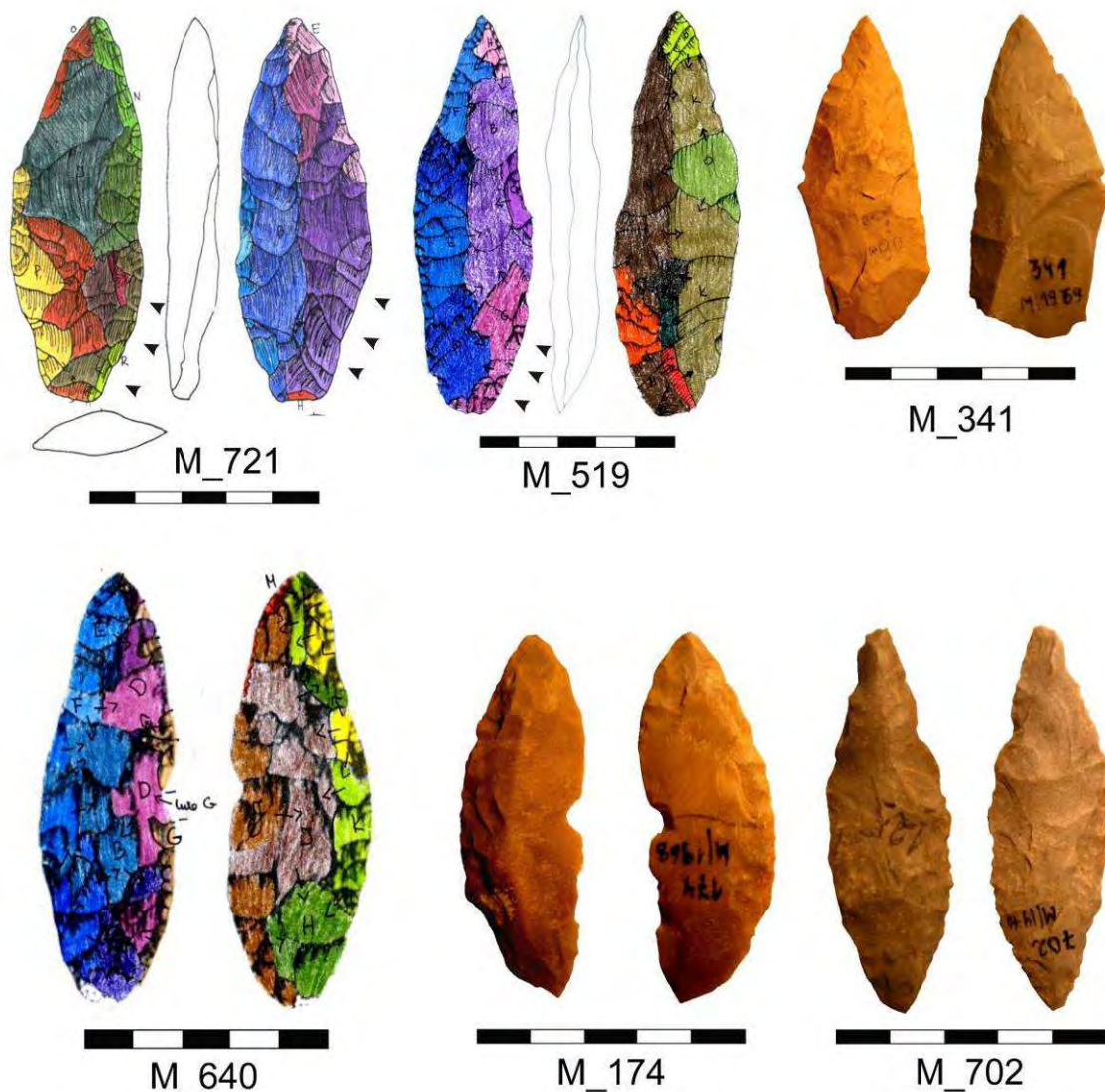


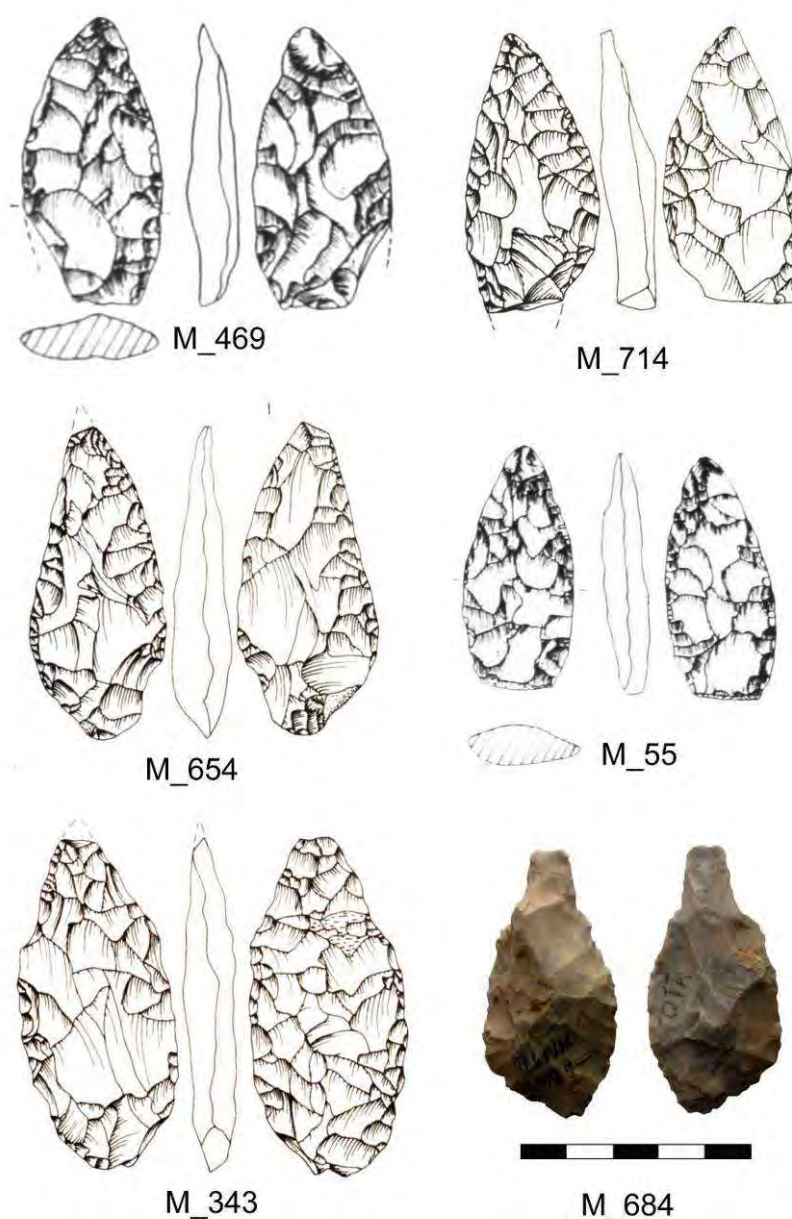
Fig.68 Group II tools comparison, depicting three described characteristic artifact features. Black arrows show sequences of base shaping.



## Group II

The second group included 13 tools, among them M.721, M.55, M.519, M.640, M.469, M.654, M.714, M.341, M.174, M.343, M.684, M.702 and M.354. It consists of slender forms in the shape of a willow leaf, characterized by the symmetry of edges converging at the tip, which is usually well exposed. In three cases, there is a significant change in tool shape at the tip as a result of several rejuvenation sequences (M.343, M.684 and M.702). One of the tools (M.354) is preserved in a heavily exhausted form and bears traces of countless rejuvenation series.

Closer analysis of particular edges morphology showed that the tools were formed so as to have symmetrical shape, and the two edges convergent at the tip have a straight profile and bear traces of marginal retouch. This can be proved by C and L sequences observable on the M.721 tool (Pl.18). They shape the tool near the base. An analogous G sequence can be seen on the M.519 tool (Pl.12).



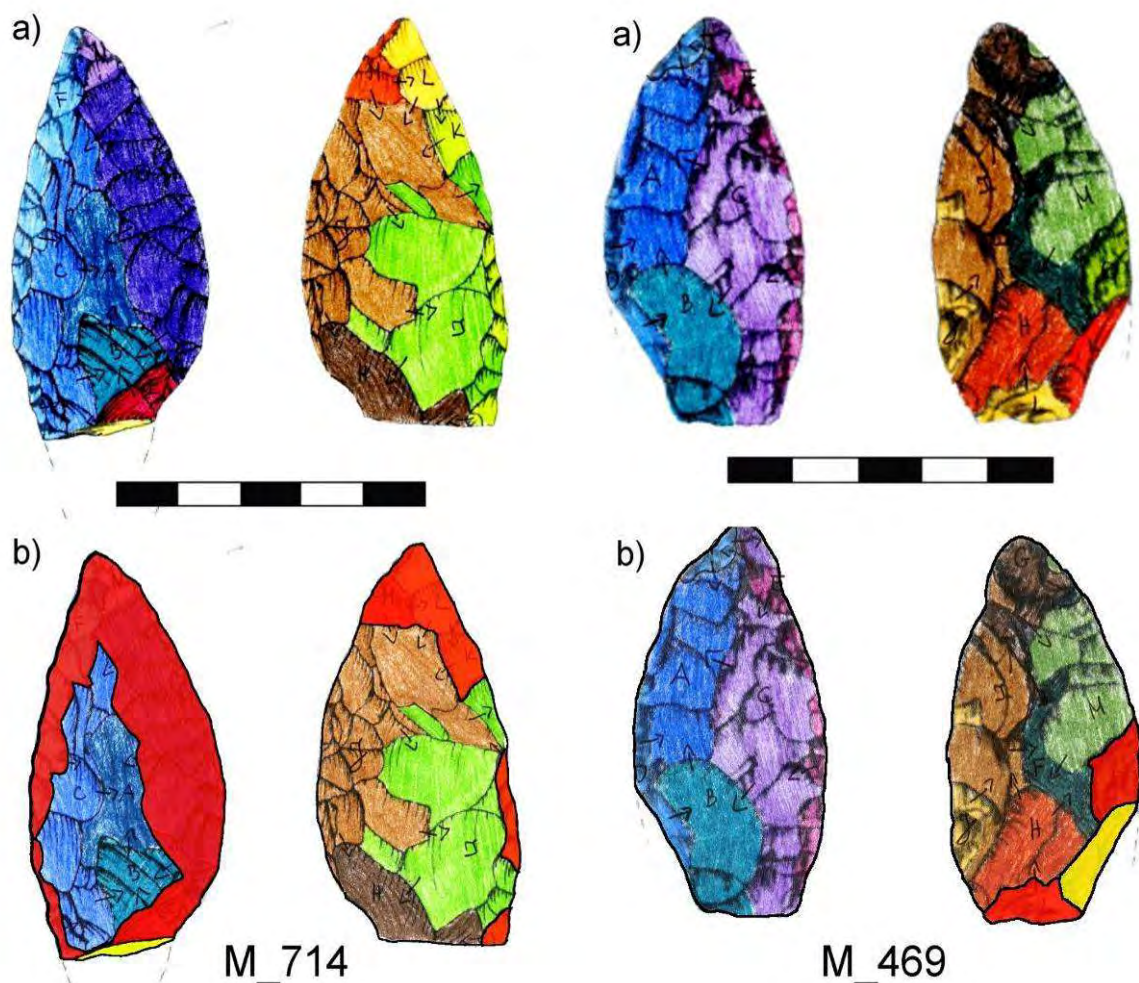
*Fig.69 Group II tools comparison.*

These tools are characterized by similar profile of both edges which are straight near the tip and more S-shaped closer to the base. Three details concerning the described artifacts have still seemed to be worth considering (Fig.68, 69):

1. not very conspicuous, but visible asymmetry of both edges (M.721, M.714, M.654, M.469, M.519),
2. apical part is narrower than base part (M.519, M.721),
3. presence of a deep notch in the middle of one of the edges (M.640, M.174, M.721).

While searching the photo-base of unexamined artifacts, three tools of interesting morphology were found (M.343, M684–Fig.68 and M.702–Fig.69). These have a narrow apical part resulting from multiple rejuvenations of both, close to the tip edges.

Comparing the described features and edges morphology in the examined and unexamined artifacts led to the conclusion that some artifacts must be separated into a group where the willow leaf shaped specimens show signs of greater care and rejuvenation traces on both edges close to the tip only. This indicates that both edges could have been functional units. In addition to that, the previously mentioned notch on the edge may be the remnant of tool hafting system. No back and retouching all the edges at the base, as well as small tool thickness additionally suggest that they were used in hafts.



*Fig.70 The M.714 and M.469 tools sequences comparison, red marks rejuvenation sequences made after transversal base breakage (in yellow).*

Therefore, the following hypothesis is set: these tools were hafted in about half their length, perhaps partly angularly (Fig.74), as indicated by notches morphology on the M.721 tool or the M.341 tool breakage (Fig.74). Moreover, this seems to be confirmed by the M.341 tool morphology, preserved as a broken tip, which also has a notch on one of the edges. At the tip, this tool was formed analogously to the M.519 tool (Fig.68–M.519).

The M.640 tool (Fig.68–M.640), which has a deep notch in the middle of one of its edges, has its analogue in the form of a flake tool M.174 (Fig.68–M.174). The latter had only its tip and both edges shaped. The rest of tool was left unknapped.

Apart from to the tools described above, this group also includes the M.654 tool, which is characterized by concave profile of one edge and convex profile of the other (Fig.69–M.654). Nevertheless, it seems that this is the result of rejuvenation and further resharpening sequences of the concave edge. The tool has a base formed in the shape of a tang, with notches on both sides. Such base formation may be due to a desire to create notches suitable for hafting. This was facilitated by natural morphology of cortical surface which formed one of the notches.

Based on that, also the M.714 and M.469 tools look interesting (Fig.70). Both were broken at the base and were then repaired. For the M.714 tool, the angle of transversal fracture was removed by a semi-abrupt percussion series (Fig.70–M.714.a–dark pink), which caused the occurrence of a notch. At least one of the edges was additionally retouched after breakage (Fig.70–M.714.b–red), which further testifies to the tools being used afterwards.

The M.469 tool was broken angularly (Fig.70–M.469.b–yellow). The rejuvenation consisted of abrupt percussions removing the acute angle near the breakage and forming the transversal base surface (Fig.70–M.469.b–red). This is a procedure which forms surfaces analogical to those in tool M.714. After tool rejuvenation at the base, the edges were most likely retouched again. Both tools, after rejuvenation, have morphology similar to that of the M.654 tool, with one edge straight and one convex, but ending at the base with a notch, or an angular breakage scar (Fig.69, 70).

It is an interesting fact that each of the three tools described was formed (before breakage) in three completely different manufacturing schemes. The M.469 tool was knapped in a surrounding scheme and only at the stage of edge retouching, knapping proceeded in an edge scheme. The M.714 tool was formed in an edge scheme of knapping in a bottom-top manner, whereas each time it was retouched on both edges onto the upper face. Nevertheless, the M.654 tool was formed in an alternate scheme of knapping. The scheme was repeated twice, at two successive stages. Only retouching and rejuvenations were done in an edge scheme. An identical alternate scheme occurred in the analysed tools only once again, namely in the M.237 tool (Pl.7<sup>8</sup>), which was broken transversally, and got abandoned at an initial knapping stage. The tool's initial knapping was performed in an alternate scheme and one of the faces was formed steeply, which facilitated the introduction of flat removals onto the other face of the edge. The alternate scheme was repeated twice. However, the plano-steep manner of surface shaping did not prevent deriving a series of hinged removals on both tool surfaces, removals that hindered further tool knapping.

It seems that alternate knapping was typical of the Musilievo tools at the early stages of manufacturing process, during thinning and surface formation. Such scheme led to creating tools biconvex in cross-section. Specimens of such shape are precisely predominant in Musilievo. Using such a scheme would well explain the morphology of Musilievo tools bases,

---

<sup>8</sup> See the Appendix.

which both at initial knapping stages and later in their highly exhausted forms have remnants of cortical surfaces at their bases, the surfaces being set angularly to tool axis.

This pattern is consistent with the observation of the CII.671 preform from Samuilitsa II cave, and the broken M.123 tip from Musilievo, whose photographic documentation was made in Sofia. The CII.671 form clearly shows the nodule knapping scheme applied at initial surface formation stages. The base is formed with series of alternate abrupt percussions or transversal natural surfaces are used for this purpose. Two alternately formed surfaces allow the introduction of flat, angular, alternate percussions on both tool faces. If steep, alternate surfaces were created on both tool ends, set to each other at an angle of about 90°, then knapping done with angular percussions led to the creation of tools with specific morphology, found both in Samuilitsa and Musilievo. At later nodule thinning stages, the tip was thinned by deriving flat, angular removals from one edge onto both faces (Fig.72, 73 Fig.73). Forms created as a result of such knapping were characterized by the presence of transversal surface residue (Fig.72, 73—red) at the tip and base (more often at the base).

The angular arrangement of cortical surfaces could be also caused by applying the plano-steep manner of knapping. Abrupt percussions on one face and flat on the second face were introduced at initial manufacturing stages. Abrupt removals, being more intrusive, removed cortical fragments on their side, still, it remained on the side of flat percussions, which were so little intrusive that they were unable to remove vertical cortical surfaces (Fig.72, 73). The angularly positioned cortical surface can be observed not only on the M.237 tool, but also on M.654 or M.640.

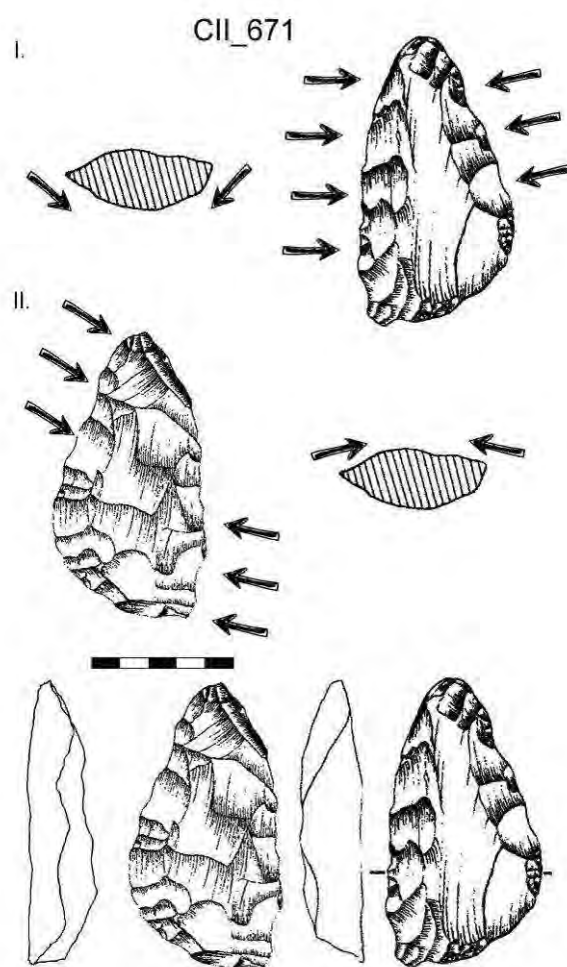
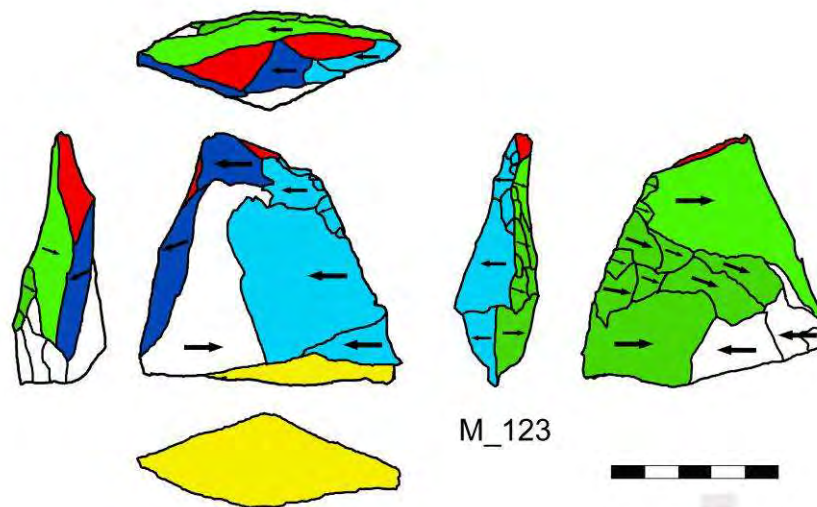


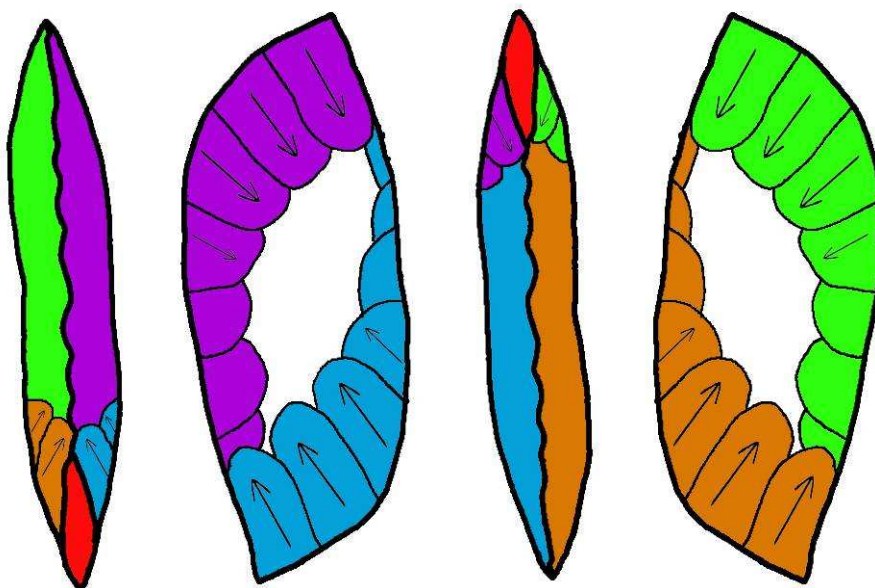
Fig.71 Nodule formation scheme based on the CII.671 tool from Samuilitsa II.



The elements of alternate knapping also appear in the M.55 and M.721 tools, but as they do not occur throughout the entire knapping regimen, but only in two sequences alternate to each other; and they are not repeated, consequently they may be the result of gaps in visible knapping sequences. However, the analogous knapping of both tools may indicate that in fact, at the stage of surface and shape formation these tools were knapped alternately. Further knapping proceeded in an edge scheme. Both tools were retouched alternately near the tip and they have a deep notch on one of the edges. In case of M.721, successive rejuvenations affected only part of the edge closer to the tip (Fig.68–M.721), which made it become narrower in that part, thus creating an angular edge on which the notch was made, perhaps for tool hafting. The notch can also be the trace of chipping as a result of the tool's movement in the haft.



*Fig.72 Tool thinning based on the M.123 artifact, depicting the scheme of performing flat removals from one edge onto both faces (blue and green scars) which encouraged the appearance of angular surface at the tip.*



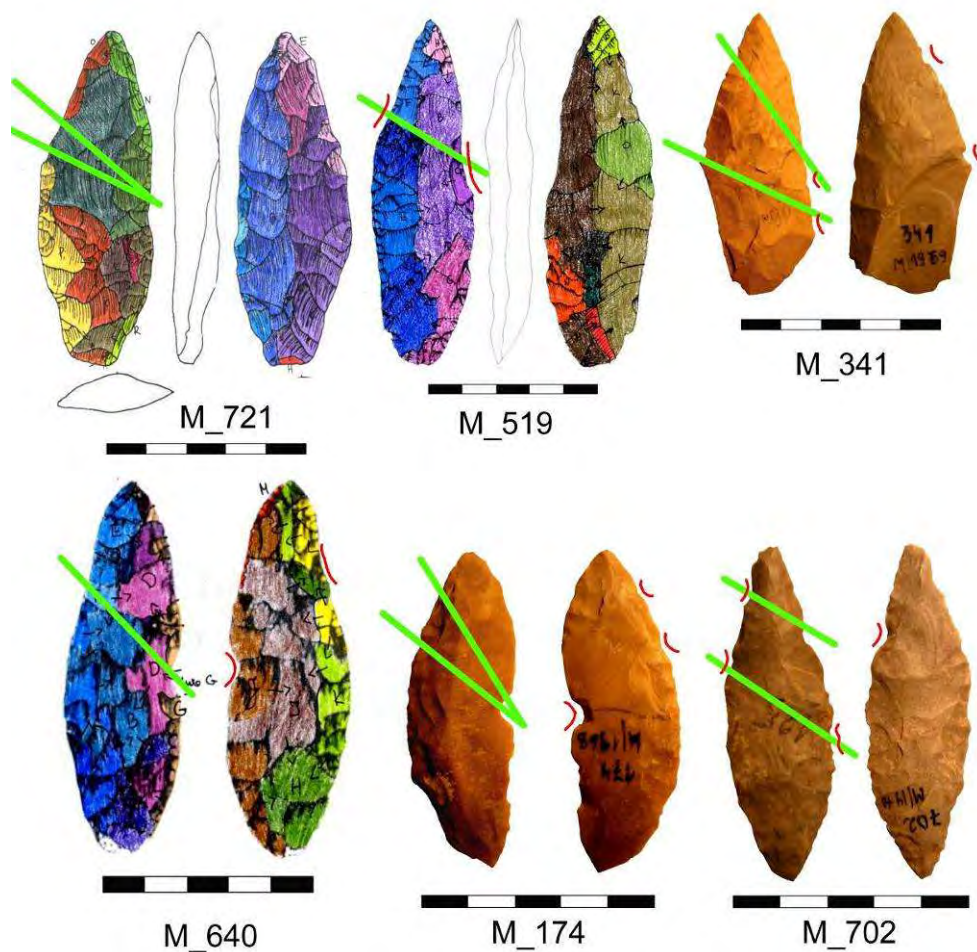
*Fig.73 Musilievo group II tools simplified thinning scheme. Angularly derived percussions resulted in preserving angular surfaces at the tip (from the stage of surface formation).*



The surface formation of M.640 and M.519 tools proceeded in a surface surrounding scheme, while edge formation was done in an edge surrounding scheme. The M.519 tool has a series of flat, small but long removals derived angularly to tool axis near the tip, and thinning the tool near its tip. Analogical series of thinning removals can be seen on the M.651 tool, and perhaps also on M.469 and M.1207. Both described tools have a deep notch in the middle of the edge. Both show rejuvenation signs near the tip.

The M.354 tool, which also received a surrounding knapping scheme, was retained as a heavily exhausted tool. Most likely, all the sequences visible on the tool come from its rejuvenations. The overlapping rejuvenation sequences hinder tool shape reconstruction. Still, the tool has two notches in the middle of both edges.

Only after a detailed description of each tool, a collective description of group II artifacts can be created. These tools are marked by the presence of two cutting edges convergent at the tip. Both edges are retouched, rejuvenation is usually restricted to apical parts. The part closer to the tip is narrower, in some cases, retouch and rejuvenation have transformed the tool's shape and exposed the apical part into a borer. The system of notches, mostly formed in the middle of one of the edges, suggests that the tools were hafted in about half of their length (Fig.74). This is also indicated by the extent of retouches connected with rejuvenation. The tools do not have (except M.654) traces of base knapping, nor is it visibly blunted. Hence it seems that the base should not be treated as a distinct edge/surface.



*Fig.74 Notches arrangement on group II tools. There are visible analogies in notches placement, which may suggest that the notches constitute hafting traces.*

In short, group II artifacts, in at least two cases, bear traces of shaping. The knapping at the tip, however, presents **no care for tool shape**, instead, there is a **focus on edge retouching and resharpening**. Despite the presence of slight edge profile asymmetry, there are no removals aimed at increasing tool symmetry and shaping the edge so as to give it a straight, convex line. On the contrary, sequences at the tip are outlined in such a way, that they lead to tip exposure. Probably this was not intended knapping, but the result of further edge rejuvenations and retouches. The rejuvenations consisted of flat removals onto the lower face and a retouch onto the upper face. This is especially visible on highly repaired tools, such as M.343, M.701 or M.684. During subsequent rejuvenations, though, there was considerable care for keeping the tip in vertical axis.

### Group III

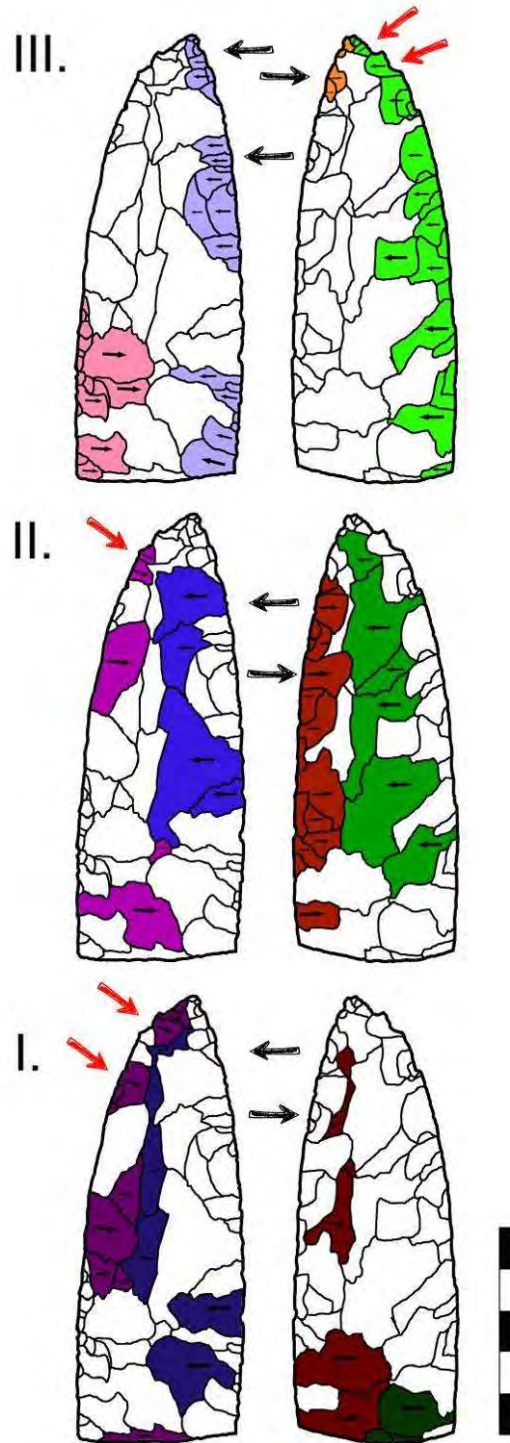
The third group included six artifacts. Only one tool was analysed in terms of scar pattern, which significantly hinders broader discussion on the manufacturing process and the differences in the way of shaping both edges of the described tools. However, the tools seem to be so different from the rest, that it was decided to place them in a separate group. The group incorporated the following artifacts: M.1207, M.66, M.541, M.463, M.311 and M.39. M.1207 was submitted to analysis (Fig.75).

The artifacts of group III are characterized by specific edge shape, one of which is almost straight and parallel to tool vertical axis, while the other is convex at the tip, due to which the tip of these tools is placed off the axis (Fig.75). Moreover, these tools are characterized by parallel profile of both edges in their middle, slenderness, and substantial length compared to tool width and thickness.



*Fig.75 Group III artifacts shape comparison with visible characteristic tip asymmetry.*

Two artifacts are preserved as broken forms (including the analysed M.1207–Fig.75). The breakage appeared after the entire tool had been formed. The other tools are complete pieces, including the M.66 tool which is a refitting of two fragments (the tool was broken near the tip–Fig.75–M.66). In case of four tools preserved as complete pieces, three of them had their base formed quite differently from the tip, but in case of M.66, the tip and base are formed uniformly, and could have been used interchangeably (Fig.75).



*Fig.76 The M.1207 tool knapping scheme. Numbers correspond to subsequent knapping stages described in the text. Arrows mark the directions of tip forming removals, There is visible asymmetry in tool formation, already at its initial shaping stages.*



The M.39, M.541 and M.463 tools are marked by fine, precise, semi-flat and flat knapping at the tip, plano-convex cross-section (Fig.75), retouch, each time derived on the upper face, and blunting removals forming one of the edges near the base. Depending on the tool, back blunting sequences reach 1/3 to 2/3 of tool height. The blunting sequences are derived angularly to vertical axis at the base, and converge with the cutting edge outside the tool axis (Fig.75).

One of the edges has a more straight profile, while the convex edge is more S-shaped, even closer to the tip. An exception is the M.463 tool, where the convex edge profile is more straight, which may be due to the fact that this tool has high hinges in the middle of its “cutting edge”, which prevented further rejuvenation and exploitation of this edge. Similar disparities in edge profile are visible on the M.311 tool. Its edge I has a straight profile, and edge II has an S-shaped line. A very similar morphology is observable on the M.1207 tool, the scar pattern of which was submitted to analysis.

The analysis showed that the tool was knapped in a surrounding scheme at surface and edge formation stages. Only at retouching stage, the knapping scheme was changed into an edge scheme, in bottom-top manner, though at the very tip the retouch is alternate. Based on analogies with fully preserved artifacts, it can be assumed that here one is dealing with a broken tool tip. Interestingly, the characteristic tool shape was attributed mainly at the very end, as a result of semi-abrupt, deep, angular removals within the F sequence (Fig.76.III–red arrows), derived on an edge near the tip. The tool asymmetry, however, must have already existed at earlier stages and must have been accelerated by the introduction of angular removals near the tip onto the convex edge, as well as axis-transversal removals onto the straight edge (Fig.76.III–orange sequence). This points to different treatment of the two edges. Fig.76 shows, with the use of arrows, the direction of removals onto both edges (red arrows–removal directions onto edge II; black arrows–removal directions onto edge I).

The M.1207 tool is precisely knapped and biconvex in cross-section. Both edges have a highly similar, straight profile (Fig.75–M.1207). All the more so, it appears as strange that those semi-abrupt removals were performed near the tip. It is possible that these removals are traces of a failed sequence, which was supposed to be made of flat, long removals thinning the tool near the tip. Similar removals are introduced from the convex edge on the remaining tools included in group III (Fig.75–M.541).

The significant morphological similarity of the described artifacts provokes the assumption that one is here dealing with the purposeful formation of a **straight cutting edge, and a convex distal posterior edge**, from which thinning removals were derived at the tip, and which transformed into a back near the base. Most likely, the back formation enabled to use the tools without the necessity of hafting.

## Group IV

Group IV consists of three tools M.627, M.56 and M.67. One of the tools was broken near the tip in about 1/6 of its length. The tools are characterized by slenderness, cross-section biconvexity, highly regular edge line and its straight profile. The bases of the described tools are either knapped and retouched (as in M.67), or left without separate knapping and partly cortical, like M.627, or M.56.

A characteristic feature, and the most distinctive one, is not only the symmetry of both edges both at the tip and at the base, but also the presence of tool shaping sequences. The location of these sequences depends on where the edge required correction. In case of M.67 the last, small removals are derived on the edge closer to the base, just like in case of M.627,

where the last retouch sequence of one of the edges forms the shape near the base (Fig.77c–yellow).

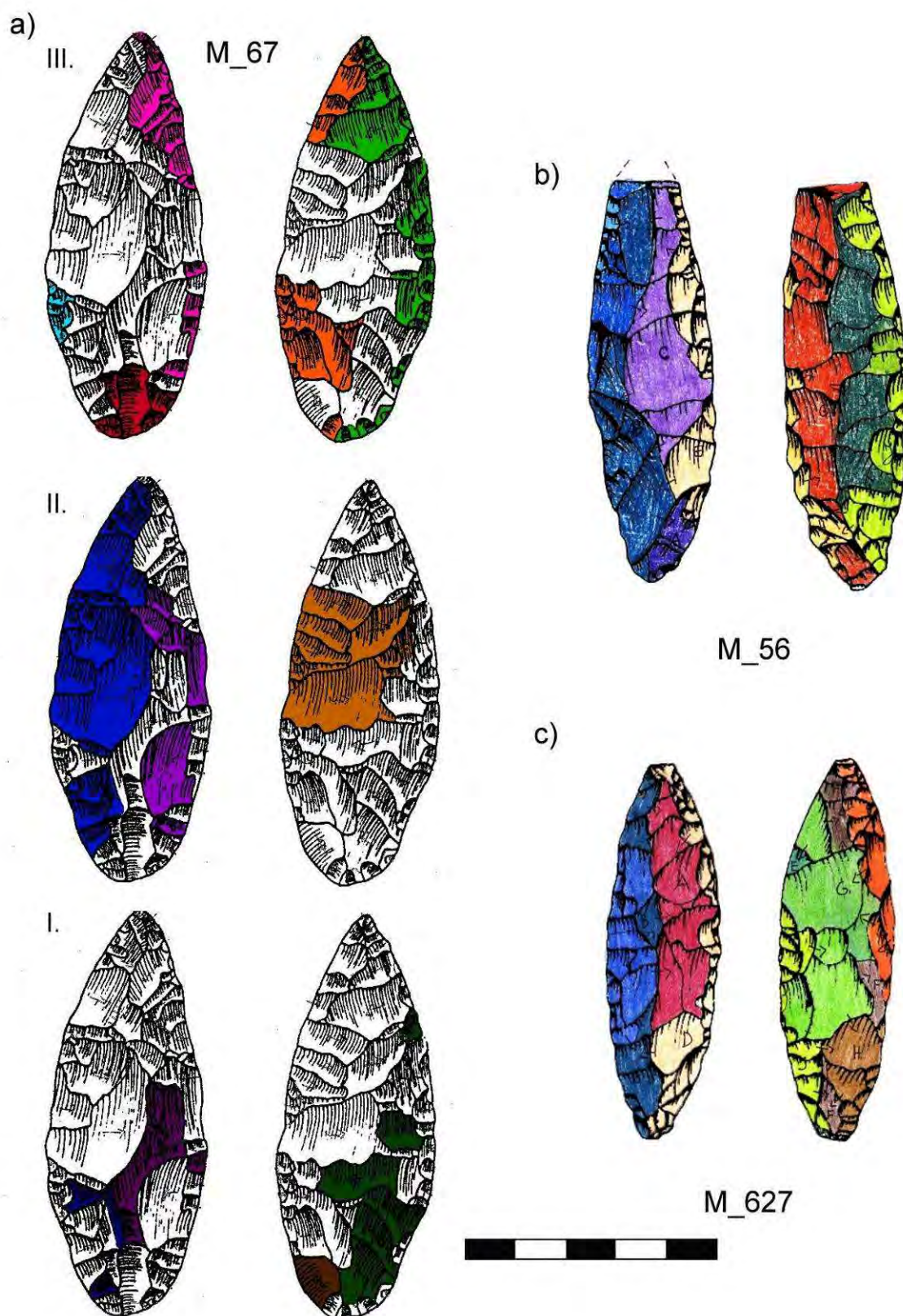


Fig.77 Group IV tools comparison with knapping scheme based on the M\_67 tool. Numbers from I to III correspond to subsequent knapping stages described in the text.

Another characteristic feature is the alternate nature of analogous sequences on both edges, such as the J and D sequences on M.627 (Fig.77c–yellow and orange), the N, M and G sequences on M.67 (Fig.77a, III–green and pink), or J and E on M.56 (Fig.77b–yellow and green). More intensive work is also visible in areas which required greater remodeling, such as the J removals on the base of M.56 (Pl.3), whose aim was to increase base symmetry, which was moved off the axis by earlier sequences. The final retouch at the tip is alternate by nature, which all the more facilitated keeping a symmetrical tool outline. These tools show no signs of rejuvenation, the M.56 tool was neither rejuvenated nor repaired after breakage.

The knapping of group IV tools consisted of three stages (to be seen on tool surface) (Fig.77).

**I. Surface formation/shaping.** At this stage, mainly flat and semi-flat removals were derived. They were not extensive and angular to the axis, especially closer to the base (J and I series on M.67–Pl.4<sup>9</sup>, G and A series on M.56–Pl.3). Only in case of M.56, a full reconstruction of its edge/surface knapping scheme, done in a bottom-top manner was possible. Interestingly, compared with other incomplete schemes for M.67 and M.627 one may risk stating that knapping was done according to a surface scheme, with the lower face formed first and the upper one next.

**II. Shaping and thinning.** At this stage, flat, extensive removals were derived in the tool's middle. Thus, the tool was narrowed (K, E, C sequences on M.67–Fig.77a.II; C, D sequences on M.56–Fig.77b–purple and blue; G sequence on M.627–Fig.77c–green). In case of M.627 this stage was connected with the next one and, simultaneously, edges were shaped and the tool was thinned in a surrounding scheme.

**III. Edge formation, retouch.** At this stage, series of marginal removals were mainly derived, aimed at final edge shaping. Knapping proceeded in an edge scheme, but forming the tool was far more important than applying the schemes. Thus, except for the general knapping scheme, further sequences were adjusted to the needs and goals, hence the J sequence on the M.627 artifact (Fig.77c–light green). It was derived at the end of manufacturing process, near the base, to correct the edge line, which failed to be formed by D sequence (Fig.77c–yellow). Here also minor edge line corrections in the form of H sequence on M.67 can be observed (Fig.77a.III–blue), or F sequence on M.56 (Fig.77b–light blue). At this stage, it was more important to retain the edge outline rather than its profile, which meant that the tool could have even been slightly blunted so as to obtain an appropriate edge line. For instance, this can be seen in G sequence (M.67–Fig.77a.III–pink), which partially blunts the edge with hinged removals.

The tools described above differ significantly from those included in the remaining three groups, both in terms of the aim of knapping, as well as targeting the entire manufacturing process. For it can be seen that the oldest removals visible on these tools are already small and, therefore, they come from the stage of shaping rather than initial knapping and surface formation. Hence all the visible sequences were designed to achieve a particular goal which was obtaining **a symmetrical, slender and thin tool with an exposed tip**. An interesting feature is the presence of phase II sequences which were aimed at not only thinning, but also narrowing the tools. As a result, the Musilievo tools are characterized by considerable slenderness.

---

<sup>9</sup> See the Appendix.

One tool was not assigned to any of the groups. It is the M.42 artifact, which is characterized by small size (5cm of length) and significant thickness as for its size (1.3cm). The tool does not have clearly exposed tip. It is either made on a flake, or was strongly reduced during rejuvenation. This is evidenced by the very extensive removals on the lower face (A and B sequences–Pl.1). The tool has a transversal cortical surface on the base, positioned angularly to tool axis. Even though there are remnants of cortex on the base, the near-the-base part was thinned and therefore the tool is the thickest close to the tip. The upper face is entirely covered with small removals. The removals come from four removal sequences. One of the edges has a straight profile, because on its lower face a broad, old removal scar can be found. The second edge has an S-shaped line, as it was knapped on both faces. Therefore, the artifact is characterized by edge lines disproportion, thus making it possible to find analogies with the M.703 flake tool which has one cutting edge with straight profile and convex line. However, the tool is symmetrical, though sequences providing an irrefutable proof of attempts at increasing symmetry are absent here. At the same time, the location of rejuvenation sequences on the lower face D and F (Pl.1) at the base may bear witness to tool shaping. Nonetheless, retouch and removals on the upper face seem to be quite chaotic, and semi-abrupt on an edge with straight profile, which may stem from rejuvenations.

The Musilievo artifacts are characterized by highly precise knapping and skillful treatment, which are reflected in deriving extensive removals even at very acute removal angles, or maintaining the flat outline of both surfaces. It can be seen that during the manufacturing process, it was not necessary to keep a plano-steep edge formed at initial manufacturing stages. What is more, subsequent flat removal series can be derived even at very acute angles. This is probably why knives lost their back and could be replaced by thinner tools with biconvex cross-section. Quite possibly, group II entails tools used in hafts, which is evidenced by notches and the back edge absence. Whereas groups III and I consist of tools probably used without hafting.



### 3.2.1.1.2. Samuilitsa Cave II

Four artifacts from the Samuilitsa II site were submitted to analysis. These are bifacial tools found in the collection of the Archaeological Museum in Sofia (Fig.78). All were defined as leafpoints (Sirakova, 2009 p. 135; Ivanova & Sirakova, 1995 p. 40).

The tools are made of flint. The CII.1116 artifact was made on a flake, others are probably core tools. The site is not a workshop type of site, but it is the relic of a short-time settlement, which may explain the analysed tools' exhausted stage of preservation. The artifacts bear traces of rejuvenation and repairs, even after breakage. This hinders the understanding of their knapper's original idea.

The CII.1115 artifact is a bifacial tool fragment, broken in about half of its length (Fig.78). The artifact has two parallel edges, both of which are retouched and have a similar profile. There are deep notches made with semi-abrupt, marginal removals on edge I. The tool tip is weakly exposed and located off-axis, which is caused by tool knapping based on deriving angular removals from the tip and shaping convex edge from its very beginning. Moreover, the transversal breakage scar also bears retouch traces. This points to using the tool after breakage.

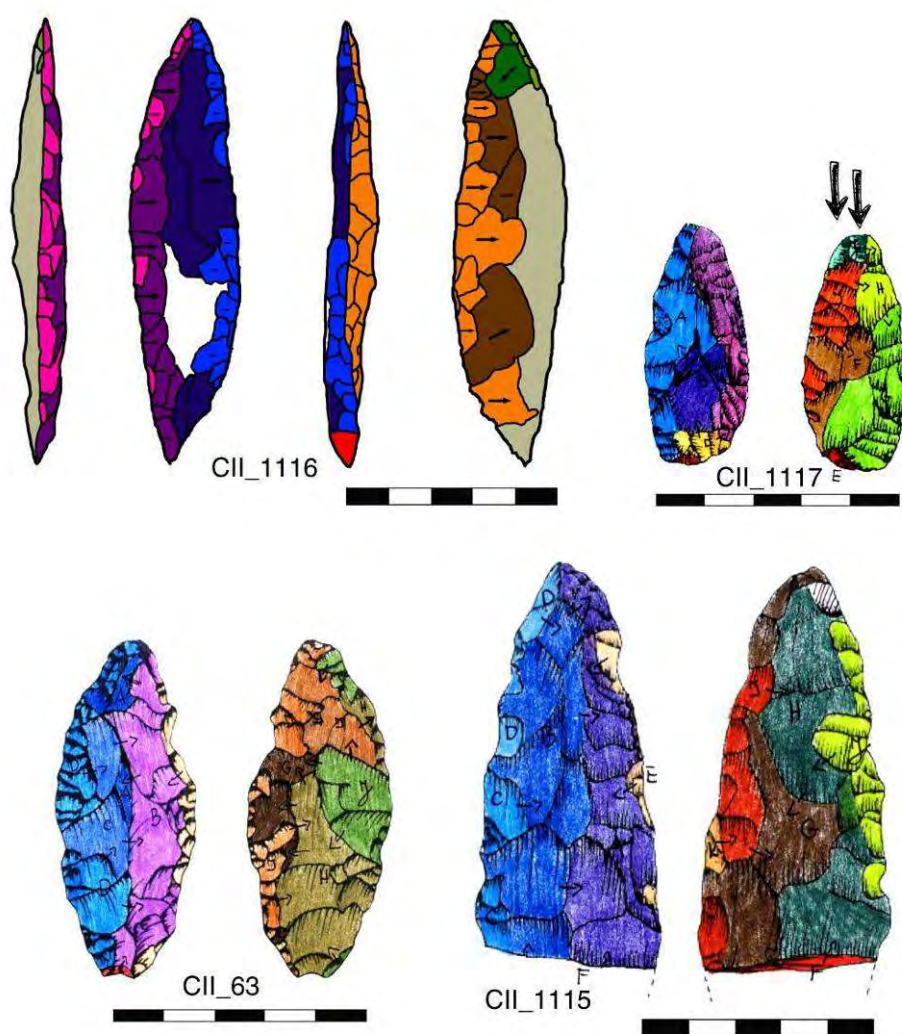


Fig.78 The analysed Samuilitsa II tools comparison. Arrows mark vertical percussions derived from the tip onto the lower face during the CII.1117 tool rejuvenation.

The second of the edges is straight and was retouched already after breakage. The tool was knapped in two phases. During the phase of shaping and surface formation, knapping was done in a surrounding scheme, starting from the lower face (G sequence–Fig.78–brown). The removals on one of the edges overlapped with the tip as well, which formed the convex edge shape and lifted the tip off the axis. The second stage was edge retouch by deriving removals on two faces, probably to correct edge outline. As it had been already mentioned, one of the edges, or maybe both, were retouched soon after tool breakage.

The CII.1117 artifact is an example of symmetrical tool knapped in a surface surrounding scheme, starting from the lower face and ending with the cutting edge formation on the upper face. The tool was then knapped again, also in a surrounding scheme. The process started from thinning the tool near the tip on the distal posterior edge; through a series of percussions correcting the cutting edge angle at the tip on the lower face, up to the entire cutting edge retouch. The tool was resharpened once again with a series of flat removals on the lower face derived from the tip (a pradnik-like percussive–Fig.78–arrows). The base partially consists of a transversal cortical surface. It also has semi-abrupt, blunting removals derived alternately.

The tool is characterized by lack of care for the tip which is formed in a separate transversal edge. At the same time, one can see considerable work applied to the cutting edge and its straight profile in contrast to the other one with an S-shaped profile.

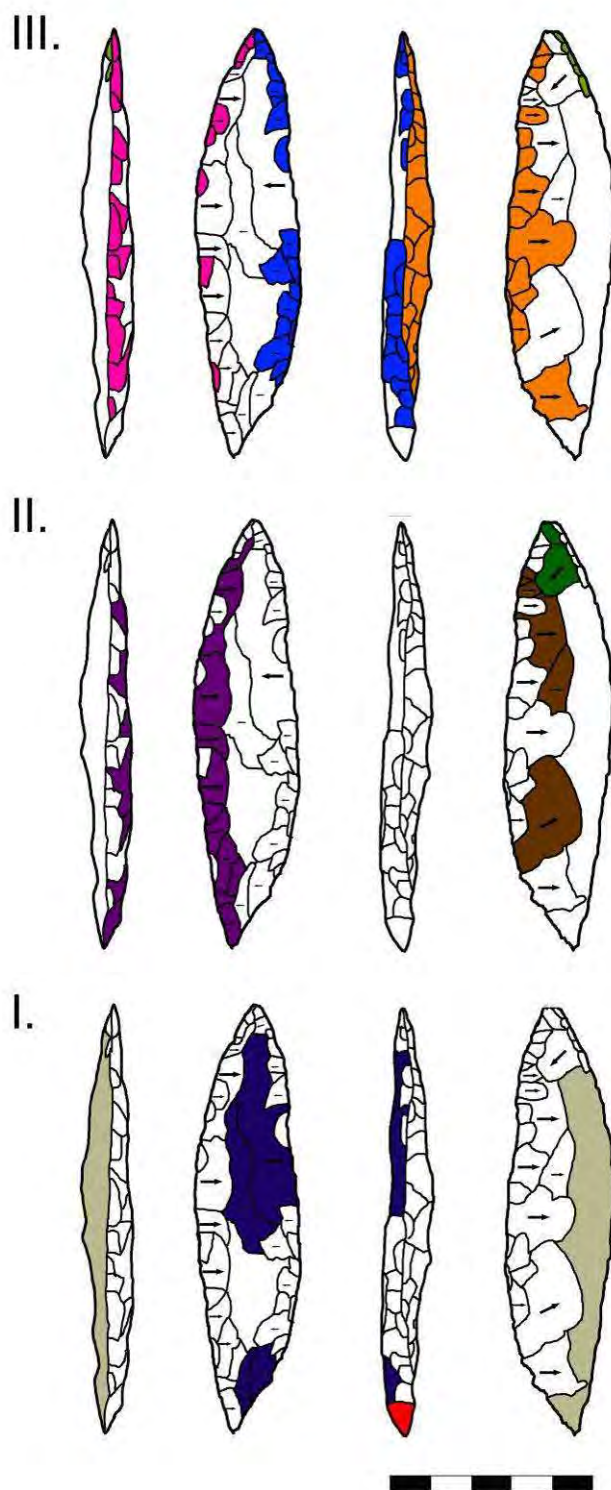
The CII.63 tool is characterized by irregular edges outline. One of which is formed with semi-abrupt, denticulated retouch creating notches along the edge (Fig.78). The tool is plano-convex and has a weakly exposed, rounded tip with a removal series derived from the tip' edge onto the cutting edge, during subsequent rejuvenations. The tool was formed in an alternate scheme of knapping at the first two manufacturing stages. All the visible removal sequences from early knapping stages (before edge retouch) are aimed at tool shaping. Even the oldest observable sequences are derived angularly to tool axis. Parallel to that, the two sequences derived later (J and C–Fig.78–CII.63–green and blue) are extensive, flat removals thinning and narrowing the tool in its middle. Due to significant tool shape modifications resulting from subsequent retouches, an accurate reconstruction of its shape from before rejuvenations is not possible. Even so, the alternately derived sequences were surely supposed to not only prepare the surface, but also to form symmetrical tool shape with an undercut base and curved edges converging at the base and at the tip.

The tool, as mentioned before, has series of retouches enhancing irregular edge outline and creating notches. An additional series of semi-abrupt removals also creates a notch at the base on the upper face (Fig.78–CII.63–red).

The notch arrangement in all three described artifacts is similar. One or two large notches are located on one edge closer to the tip, and the smaller notch on the opposite edge closer to the base (Fig.78). This coincidental notches arrangement may bear evidence to the use of a consistent tool hafting pattern. However, notches may also be the result of heavy edge use.

The fourth of the analysed tools (CII.1116) was made on a flake. The tool is biconvex and almost symmetrical. One of the edges is slightly more concave near the tip, which is associated with the presence of a large, flat scar in that area which probably appeared before

the flake's initial percussion. Both tips are well exposed. At its base, the tool has an angular breakage scar (Fig.79.I-red). The breakage was formed after the removing the flake, but still before tool shaping. The transversal breakage was modeled by semi-abrupt removals at the base so as to fit into the edge shape.



*Fig.79 The CII.1116 tool knapping scheme. Stage I—before flake removal. Stage II—tool thinning from its bulb. Stage III—edge retouch.*

The initial tool formation was based on flattening the lower face first and thinning the flake which had to be considerably thick, as evidenced by the angle of its dorsal surface (Fig.79.II–brown). Deriving flat removals required preparing an appropriate angle through a series of semi-abrupt removals onto the upper face, which preliminarily formed edge outline (C sequences–Fig.79.II–violet). The presence of flat, extensive scars on the upper face (A sequence–Fig.79.I–dark blue), hampered the deriving of flat removals, thus the removals close to the tip are semi-flat and form biconvex tool cross-section.

The last step was retouch and final edge shape formation. This stage began with flat removals on the lower face (Fig.79.III–orange), followed by two marginal retouch series on the upper face (Fig.79.III–blue and pink), and finally, a series of flat, hinged, fine removals near the tip on the lower face (Fig.79.III–green). The location of retouches indicates that in the manufacturing process, care was taken of both edge profile and tool shape. On one hand, a series of flat removals on the lower face (I sequence–Fig.79.III–orange) formed a straight edge profile near large scars (A sequence–Fig.79.I–dark blue), but at the same time it created a concave edge. To correct the edge outline, a semi-steep retouch was applied afterwards onto the upper face. The retouch was not applied onto the lower face to leave the flat dorsal surface untouched (A sequence–Fig.79.I–dark blue), and to keep the straight edge profile. Hence one can conclude that the retouch–B sequence (Fig.79.III–blue) is not a rejuvenation sequence but a shaping sequence, and was done to correct edge outline near the tip and close to the base. A similar situation is encountered on the other edge, where a series of hinges onto the flat lower face near the very tip is derived at the end. Its task is not so much to correct edge profile and symmetry, as it is to sharpen the edge and increase tool symmetry at the tip (Fig.79.III–green). An interesting fact is leaving a transversal breakage scar at the base (Fig.79.I–red). This fact may be surprising as it contradicts the potential desire to maximally thin the tool at its base for easy hafting. Leaving a breakage scar may indicate absence of need for thinning.

These features indicate that the tool was planned as symmetrical; yet, it also exhibits very high attention devoted to both edges' straight profile. Leaving the dorsal surface on the lower face of one of them, and applying fine, marginal retouch onto the upper face enabled the formation of a completely straight edge. The tool has two straight-profiled cutting edges converging at the tip.



### 3.2.1.2. Czech Republic

#### 3.2.1.2.1. Brno Bohunice

The analysis covered 10 artifacts, of which 6 came from excavations conducted in the 70's by Karel Valoch (1976). The other 4 came from the excavations done by Petr Škrdla (Škrdla & Tostevin, 2005; Škrdla & Tostevin, 2003). The artifacts from the Škrdla excavations are stored at the Institute of Archaeology, Czech Academy of Sciences in Brno. The artifacts from Valoch fieldworks are stored in the collection of Moravian Museum in Brno. The artifacts from excavations carried out by Karel Valoch bear inventory numbers that were used in further description (e.g., 64591, 64587). The tools of Škrdla do not have inventory numbers, therefore, in this paper they were given ordinal numbers (BB1, BB2, etc.). It was decided to describe both collections together, due to sample scarcity and similar production technology. All of the analysed tools were described as leafpoints in publications (Škrdla & Tostevin, 2005 p. 47; Valoch, 1976 p. 38). Two artifacts from Valoch's excavations were referred to as leafpoints in the literature.

The tools are made of flint, and are characterized by their small size (average length–6.29cm) and small thickness (average thickness–1.42cm).

Based on the conducted analysis, the artifacts can be divided into two major groups.

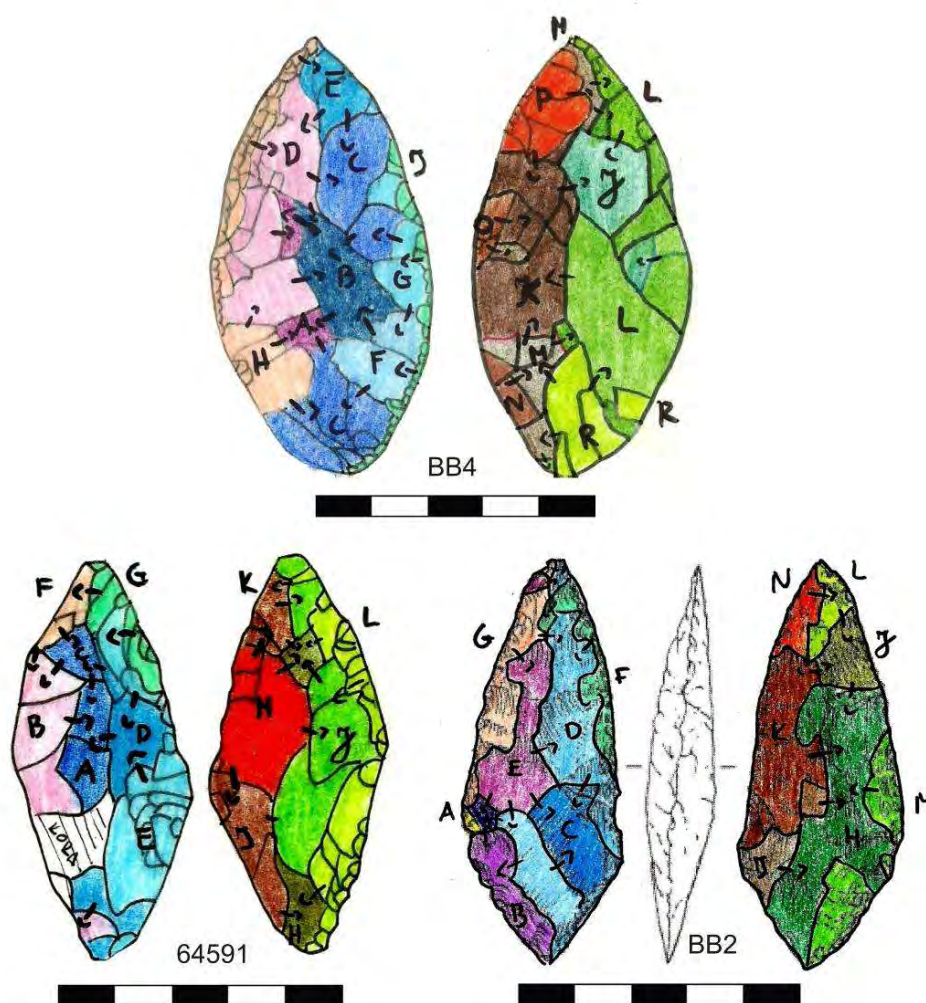


Fig.80 The analysed Brno Bohunice group I tools comparison.

## Group I

The group consists of three artifacts (64591, BB2 and BB4) (Fig.80). These have biconvex cross-section, symmetrical shape, similar profile of both edges, exposed tip and precisely knapped, slightly exposed base. The 64591 artifact is the example of unfinished tool, abandoned at the stage of its shaping/thinning. On the other two artifacts, all manufacturing stages are visible, including marginal retouching. Group I artifacts are specific for their lack of tool repair or edge re-sharpening traces.

The tools have two convex and reciprocally symmetrical edges. Both edges are treated in the same way during manufacturing process. The final retouch is derived onto both edges on the upper face; yet, it is preceded by flat, tiny removals near the tip, derived onto the lower face (N and L sequences in BB2–Fig.80, as well as P and L sequences in BB4–Fig.80). Both the apical part and the part located closer to the base are formed in the same manner, and the final retouch may also refer to the near-the-base parts (BB4–sequence I–Fig.80), which points to the purpose of retouch being different than edge sharpening only.

The artifacts are marked for their coherent knapping technology in which three main stages can be identified:

**I. Surface formation, thinning.** At this stage, flat or semi-flat removals are derived, thinning and forming both tool surfaces (Fig.81). The 64591 (Fig.80) artifact and, to a lesser extent, the BB2 (Fig.80) tool display a tendency for performing alternate removals in a plano-abrupt manner. The first series of flat removals was applied to one surface, then semi-abrupt onto the other edge surface. The knapping scheme is not clear, because one has to deal with sequences which are almost totally removed by subsequent removal series. Semi-abrupt removals, in case of the 64591 artifact, were to create an angle convenient for deriving further flat, thinning removals onto the opposite face (J and D sequences–Fig.80). Only the BB4 artifact has no traces of semi-abrupt removals. In this case, surface formation proceeded in an edge surrounding scheme, and the derived thinning removals were extensive and flat. This tool is characterized by highly precise knapping. This may explain the application of additional series of thinning and flattening removals aimed at removing semi-abrupt alternate surfaces. The oldest extensive removal scars visible on the artifacts, and left after the surface formation stage, are obviously not the oldest steps of manufacturing process. Prior thinning stages, as well as the stages forming tool surface and its preliminary dimensions are not visible because they were removed by subsequent removals. Thus, scar pattern analysis serves as no base for their description.

**II. Shape formation, further thinning.** At this stage, the tools were knapped in a surrounding scheme by deriving flat removals angular to vertical axis, reaching far into the tool surface (Fig.81.II). Knapping at this stage was mainly focused on near-the-base and near-the-tip parts, causing their exposure.

In case of the 64591 tool, at this stage the flat, thinning removals derived onto the lower face wedged themselves out in the form of hinges in the middle of the lower faces' surface (J sequence–Fig.80). Further undertaken steps aimed at removing hinges by preparing an angle for removing and deriving semi-flat, thinning removals. These were performed from the second edge and reached far into the surface (M sequence–Fig.80). This action did not address the intended result and the artifact was abandoned at this knapping stage.

Also, in case of the BB2 artifact an error occurred. One of the hinged removals of D sequence (Fig.80) blunted the tool's edge. Knapping was continued, but the blunting removal could not be obliterated. That is why the tool has, in its widest point, a completely blunted edge (suggesting the priority of edges shape over their sharpness).

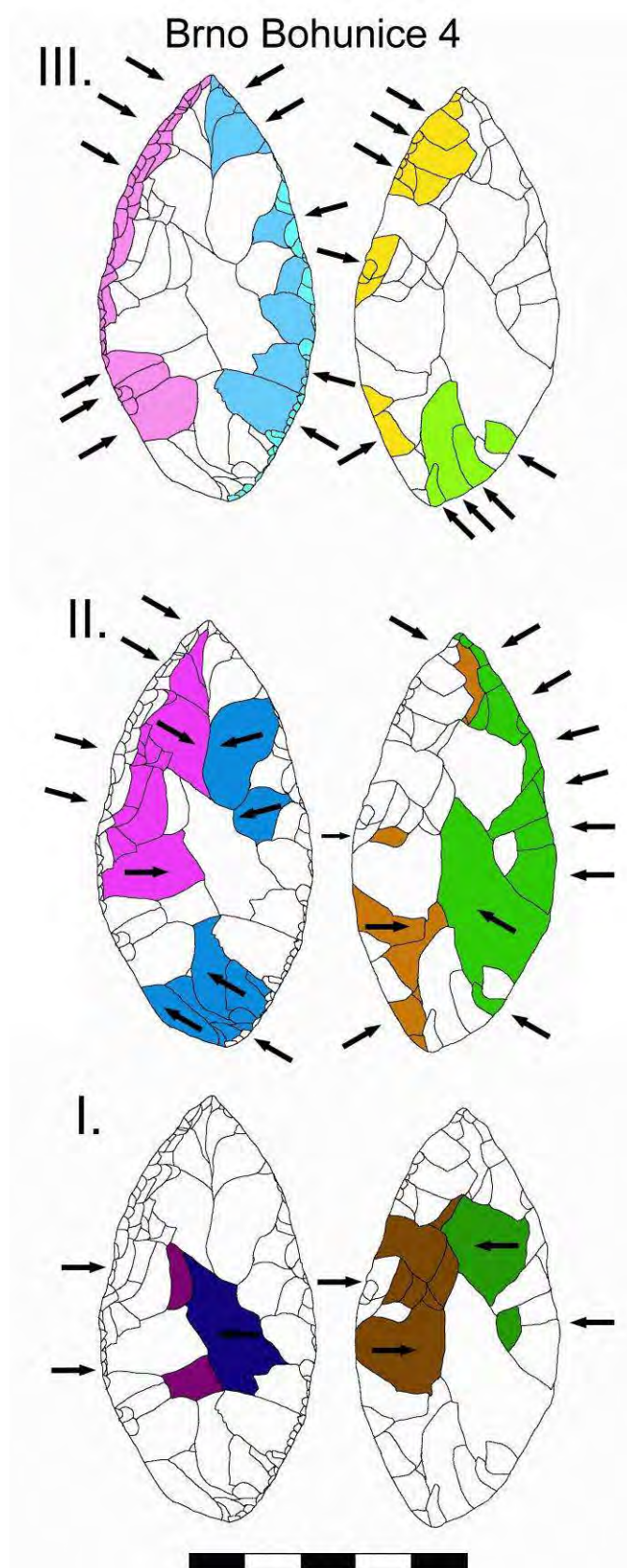


Fig.81 Brno Bohunice group I artifacts' knapping scheme on the example of BB4 tool with marked removal directions. Numbers I to III correspond to subsequent knapping stages described in the text.



**III. Edge profile correction.** Removal series, in its range and form adjusted to the main objective which was the formation of a straight, symmetrical edge. The BB4 tool has visible removal series derived onto both surfaces, correcting the entire edge length (Fig.81.III). The final marginal retouch is performed at the base onto the upper face (Fig.81.II–blue). The second edge is first slightly thinned with a series of far-going, angular, flat removals performed at the base angle (Fig.81.III–green). Then, it is intensively retouched with a steep, marginal retouch to the upper face (Fig.81.II–pink). In case of the BB3 tool, edge correction was applied only to the near-the-tip part. The correction consists of flat removals derived onto the lower face and marginal retouch onto the upper face.

Based on the analysis it can be stated that group I artifacts are characterized by:

- **care for tool shape** (separate, shaping-oriented knapping phase),
- **care for obtaining tools of small thickness** (the 64591 tool which was abandoned as a result of failed thinning),
- **uniform treatment of both edges,**
- **care for tip exposure.**

Despite their different shape, these artifacts were produced according to the same original idea, and the production's purpose was the same for each tool.

## Group II

The second group included seven artifacts (BB1, BB3, 64587, 64588, 64590, 64592, 64593) (Fig.82). They all are plano-convex in cross-section. Both edges are formed semi-abruptly onto the upper face. One can see the difference in the base's manufacturing process and in the edges near the base. Some of the tools included in group II show considerable symmetry in vertical axis (64590, 64592, 64593, BB1, BB3) (Fig.82), however, almost all of them have on at least one edge repair and re-sharpening traces (except for 64588–Fig.82). One artifact has a transversely broken base as a result of percussion derived into the middle of the upper face. One can not rule out the fracture's intentional nature. After fracture, the tool was repaired and edges near the fracture were retouched again. The BB1 artifact is a flake tool. Other forms are core forms probably.

The tools can be divided into three main techno-functional units:

**A) Cutting edge.** Formed with semi-abrupt removals on the upper face and flat on the lower face. The lower face only serves to derive flat removals aimed at correcting edge angle and profile. The edge is retouched onto the upper face. On the edge, there are visible repair sequences in the form of repeated flat removal series onto the lower face, and semi-steep removals onto the upper face. During rejuvenation, the edge was maintained as nearly vertical, converging with the opposite edge, more inclined at the tip. The tip was most frequently well-exposed and thinned. In case of BB1 and 64587 (Fig.82) it was broken and repaired. The only exception is the BB3 tool, which, apart from edges retouch, has a semi-abrupt retouch on the rounded tip's edge, which gives it the form of an endscraper. However, the BB3 tool shape reconstruction at subsequent knapping/repair stages shows that earlier it could have had an exposed tip and shape close to the 64688 tool.

**B) Distal posterior edge.** Encompasses part of or entire edge opposite to cutting edge. It is characterized by, just like the cutting edge, semi-abrupt knapping onto the upper face and flat onto the lower face. Its characteristic feature, though, is greater inclination to vertical axis than that of cutting edge. That makes the generally symmetrical group II artifacts

asymmetrical at this point. During the repair process, from this edge flat, angular, far reaching into the tool's surface removals were derived, their removal series sometimes even running parallel to cutting edge (BB1, 64593, 64592, 64590) (Fig.82). They caused the tip and the cutting edge near the tip thinning without the necessity of performing percussions from the cutting edge onto the lower face. Due to this procedure, the cutting edge remained straight in profile and could be resharpener onto the upper face. The distal posterior edge was also retouched onto the upper face, thus becoming a functional edge on one face, whereas on the other face retouch allowed to keep the tip exposed. In some cases, distal posterior edge's repair entailed the entire edge; in other, it was confined to apical parts, which caused the edge to have a biangular profile (64592, 64587) (Fig.82).

**C) Base.** One can not see consistency in the formation scheme of base. In one case left as a cortical surface (BB1), in two other cases formed with abrupt blunting removals onto the upper face (64588, 64592) (Fig.82). In 64587 formed with a transversal fracture scar. Finally, left without knapping from the earliest tool formation/repair stages (64590, 64593), or retouched semi-abruptly and probably used afterwards (BB3) (Fig.82).

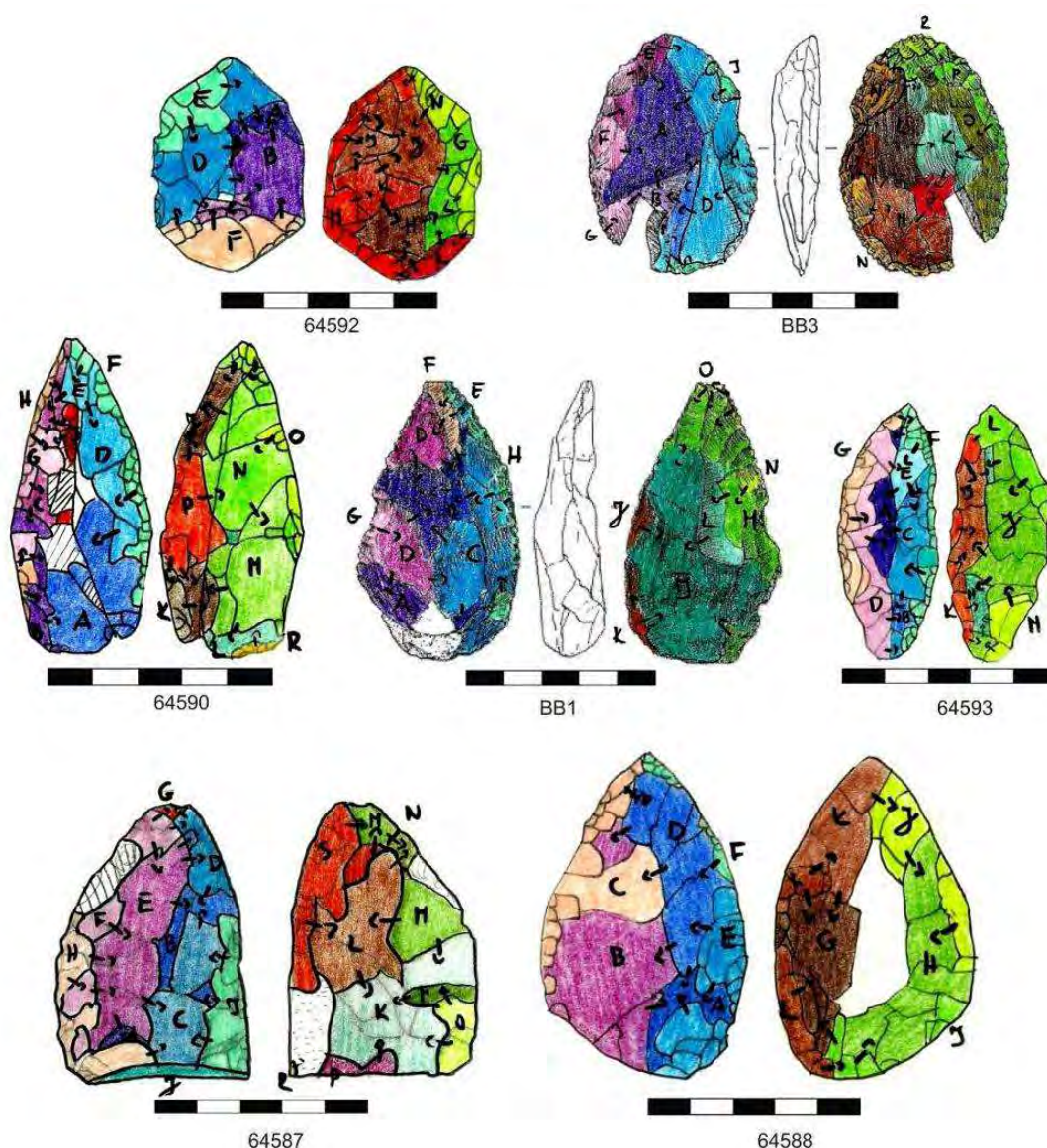
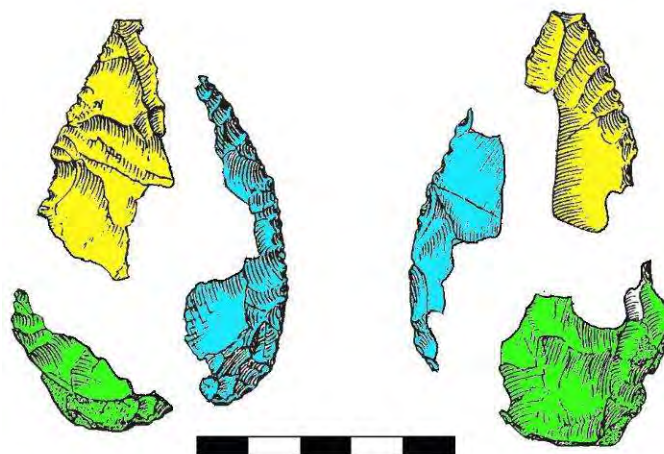


Fig.82 The analysed Brno Bohunice group II tools comparison.



*Fig.83. Brno Bohunice group II tools' techno-functional units arrangement on the example of BB1 artifact. Blue marks–cutting edge, green–base, yellow–distal posterior edge.*

Numerous repair series visible on the tools surface hinder their production technology analysis. Certainly, one can say that the production was not as coherent as in group I tools. Based on the analysis, only two stages can be distinguished:

**I. Surface and edges formation.** Visible on two tools only, tools which do not bear traces of intensive repair (64587) or, like the 64588 tool (Fig.82), do not display any repair traces and were likely abandoned before the final edge formation stage. The most interesting artifact seems to be 64588, which from the very beginning is formed as a tool with plano-abrupt cross-section. The lower face is formed to be completely flat, with sequences of extensive removals derived from both edges. By contrast, the upper face was formed with semi-abrupt removals derived from both edges and the base. At the initial stage such nodule shape was needed in order to decorticate the tool and create favourable angles for percussions. However, at a later stage, when the tool was supposed to be thinned and the semi-steep removals on both edges should be flattened, the action was not successful and the removal sequences of K and L wedged themselves out as hinges, not quite thinning the tool near the tip (Fig.82). It was probably the reason why further tool exploitation was dropped.

What is interesting, though, is the shape reconstruction of other group II tools, where trace of several repair series are visible. This proves that at previous knapping stages they had shapes similar to that of the 64588 form. It can therefore be assumed that this form's shape reflects the perfect original idea of group II tool, immediately after edge forming and just before starting next repair series. Perhaps a similar knapping scheme was adapted in case of the 64587 tool. The oldest sequences visible on the surface of 64587 may represent sequences analogical to the unsuccessful process of thinning the 64588 tool's upper face. In both cases, cutting edge is located on the tool's left side–conversely to what is found in other tools (edge II).

**II. Repair.** Based on the BB1 artifact, it can be seen that edges repair/resharpening, in its simplest version, would have been limited only to deriving series of alternate percussions onto the lower face of the distal posterior edge and series of semi flat retouch onto the upper face of the cutting edge (Fig.82). In more extensive repairs, however, removals were derived onto both edges' all faces respectively. First, flat removals onto the lower face of the cutting edge were derived. Then flat, angular, thinning removals were applied on the distal posterior edge's lower face. Next stage was the retouch of cutting edge and distal posterior edge on the upper face. If possible, removals onto cutting edge's lower face were avoided (64593, 64590,

BB1, 64592) (Fig.82). The BB3 tool was repaired differently, at least at the last few repair stages. The tool was retouched on the upper face, around the entire length of all edges. This action could have been an attempt to rework the tool from being a form which during subsequent repairs and due to its large width, lost its exposed tip. A similar form is the 64592 tool, though without a retouch on the tip's edge. Here, the tip was being protected with an angular retouch, at the very tip and on the distal posterior part's edge. Owing to repairs and subsequent rejuvenation removals, edges became more and more abrupt, which consequently led to their blunting and tool abandoning. A good example is the 64590 tool, which has small width and considerable thickness (3.1cm wide, 1.8cm thick).

The artifacts of group II are characterized by **different treatment of both edges**. Shape symmetry is associated with parallel repair of both edges, but the aim of deriving removals onto both edges during repairs was different. In the form in which they had been found, the tools seem to be **single cutting edge tools, highly exhausted as a result of several repair stages**. The artifacts' shape is diverse and represents the mean result of subsequent tool repairs. As it can be seen on the BB3 artifact, the repair could have even led to tip obliteration and the creation of tool in the form of endscraper.

The analysis of Brno Bohunice tools showed that among bifacial forms there are those that both in their morphology and in their knapping process show considerable care for shape, symmetry and tip exposure. These tools display no repair signs and are made with utmost precision. On the site, there are also tools that bear many traces of edges repair/resharpening. They are plano-convex in cross-section, have one straight edge retouched on its entire length and the second, more angular, with a less precise retouch concentrated around the apical part.



### 3.2.1.2.2. Moravský Krumlov IV

In total eight artifacts from the Moravský Krumlov IV site were analysed (115 670, 115 671, 115 711, 115 736, 115 769, 115 778, 115 828 and 115 907) (Fig.84). The artifacts are now part of the Moravian Museum collection in Brno. Three of them are broken tool fragments; five are preserved as a whole or as refittings. One form has additional two refitted flakes which complete the knapping scheme with a few removal series which are not visible on tool surface. The artifacts are made of local cherts. In publications, the artifacts are referred to as leafpoints at different knapping stages (Nerudová, 2010; Neruda & Nerudová, 2009; Neruda & Nerudová, 2010).

The analysis allowed for naming two tool knapping stages:

**I. Surface formation, thinning and decortication.** At this stage, the adapted scheme of action depended upon the selected nodule. If the blank was a flat plate, like in case of 115 769 (Fig.84), then a tendency can be seen for the formation of lower face's flat surface with flat, extensive removals. Next, semi-abrupt, decortication and thinning removals from both edges onto the upper face were derived (Fig.85).

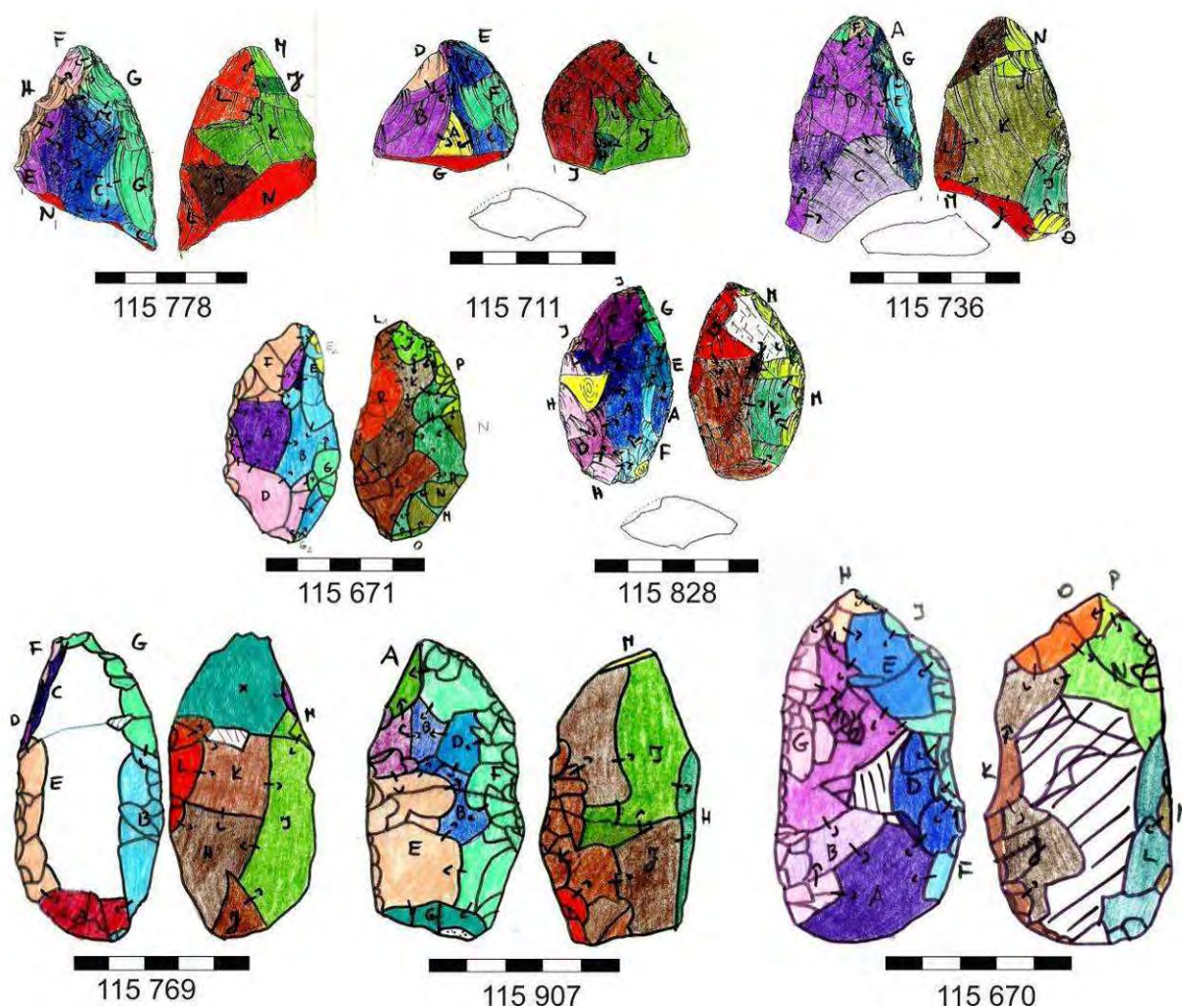
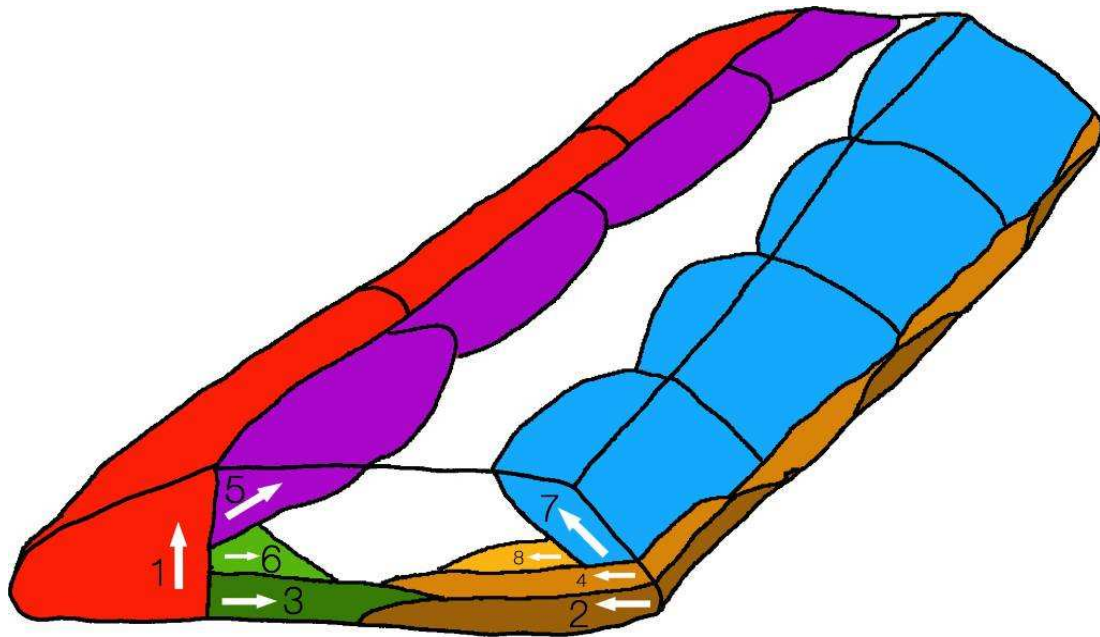


Fig.84 The analysed Moravský Krumlov IV tools comparison.



*Fig.85 Bifacial artifacts formation scheme on the Moravský Krumlov IV site, based on the 115 769 artifact.*

A characteristic feature is deriving almost abrupt removals onto one of the edges. Perhaps at early knapping stages it was meant to serve as the angle for further flat, thinning removals. If the nodule was thicker (115 907–Fig.84), then a vertical surface on one of the edges was created, and further on, the tool was gradually thinned with flat, extensive removals derived from both edges on the upper face (Fig.86). At a later stage, flat lower face was formed and then the tool was further thinned with the use of semi-flat removals derived on the edge opposite to the blunted one. The last stage of surface formation was gradual obliteration of the vertical surface through deriving, as far as possible, removals onto both faces from this exact edge.

**II. Shaping.** This stage consisted of thinning and a preliminary, and then a more advanced edge line correction at the tool base and tip. In all three artifacts, which are preserved as complete specimens, the tip is formed separately from the base (115 671, 115 828, 115 670–Fig.84). If base is present on the tool, then its shaping precedes tip knapping (115 671, 115 828–Fig.84).

**Base formation.** At this stage, removals are derived in a surrounding scheme of knapping, in a plano-steep manner. Subsequent knapping may be limited to semi-flat removals on the upper face.

**Tip formation.** Near-the-tip part is usually plano-convex, triangular in cross-section, with flat lower face (Fig.87). One of the edges is formed with semi-abrupt removals (edge I), whereas the other one is formed with flat removal series (edge II). Flat removals are derived onto the upper face of edge II, placed angularly to tool vertical axis. These removals reach far into tool surface (115 670–E sequence–Fig.84; 115 671–F sequence–Fig.88–in light pink; 115 828–C sequence–Fig.84). By contrast, edge I is formed with semi-flat or even semi-abrupt removals on the upper face (115 711–Fig.84, 115 736–Fig.87–A, E sequences, in blue). In addition to that, one should note the increased convexity of edge II due to deriving angular removals onto the edge. In all the artifacts, this edge is more convex than edge I, thus moving the tip off artifact vertical axis.

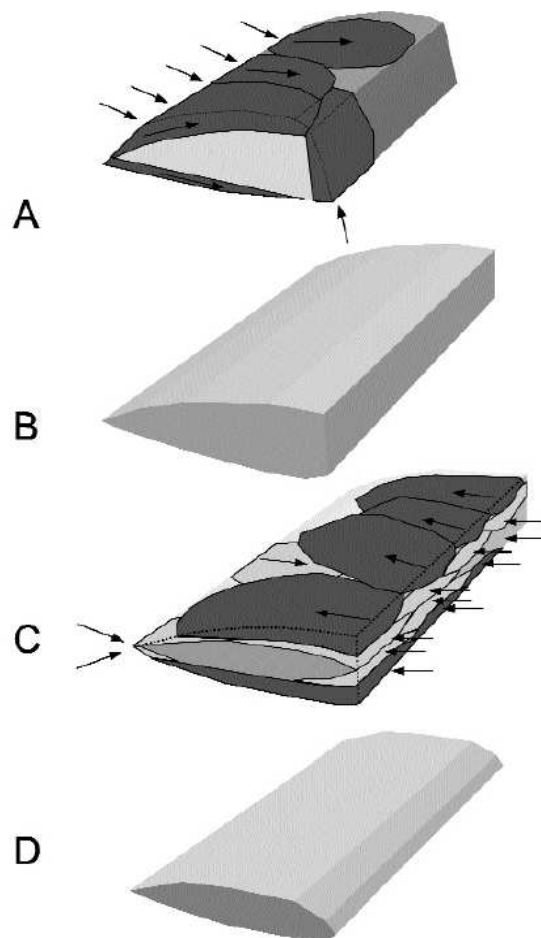


Fig.86 Surface formation scheme in bifacial tools on the Moravský Krumlov IV site. Reconstruction based on refittings (after: Neruda & Nerudová, 2010, Fig.10).

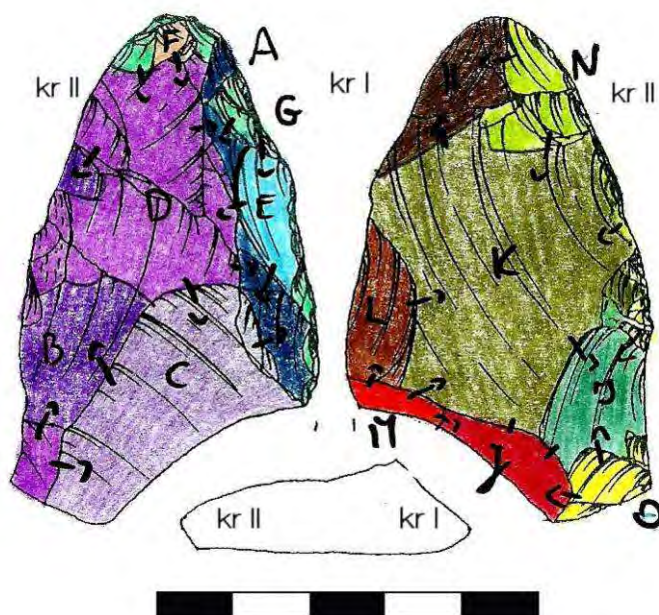


Fig.87 Near-the-tip tool shaping scheme, based on the 115 736 artifact.

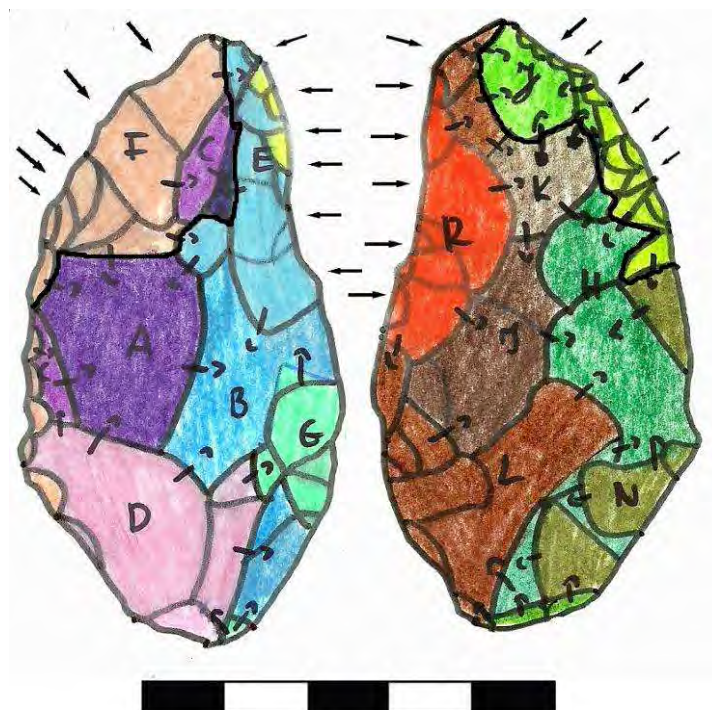


One of the artifacts (115 736) was broken at this stage in about its middle (Fig.87–J sequence–in red). After the breakage, the angles near the fracture scar were removed by two semi-abrupt removal sequences (Fig.87–O, M sequences–in yellow and red). Then edge I, previously formed semi-abruptly, was retouched (Fig.87–G sequence–in aquamarine). The same was done with the broken tip of 115 711, which was retouched on edge I after the fracture.

The 115 778 (Fig.84) tool provides an interesting example of failed thinning near the tip. Removals derived on edge I wedged themselves out in the form of very high hinges. Even though the knapper was successful to avoid hinged removals on the opposite edge, removals derived from it were not able to surpass the middle part's thickness and obliterate the created hinges. After establishing the first hinges, it was decided to correct the angle with a semi-flat removal sequences on the lower face and repeating the surrounding scheme of knapping. This, nevertheless, did not lead to tool thinning or hinge scar removing. At this stage the artifact was broken (the breakage might have been intentional), and then the tool was abandoned.

The remaining of the described forms were abandoned at such early knapping stages because of either a very high hinge at the very tool edge (115 670–Fig.84), or because of the failed thinning sequences and the hinged character of one of the edges (115 671–Fig.84). It might have also been due to the impossibility of further tool thinning, or perhaps inconvenient angles (115 907–Fig.84), or else, failed thinning on the lower face (115 828–Fig.84).

The analysis showed that all artifacts from the Moravský Krumlov IV site were knapped in a similar technological scheme. Their distinctive features include: blunting one of the edges at an early knapping stage, as it had been already noted by Petr Neruda and Zdeňka Nerudová (2010 p. 171; Neruda & Nerudová, 2005 pp. 277–280), as well as performing shaping sequences at later knapping stages.



*Fig.88 Removal directions arrangement on both edges on the 115 671 tool, demonstrating different edge treatment.*

These tools have a series of characteristics that result from the adapted scheme of deriving flat, axis-angular, thinning removals at the tip, on the upper face. Due to the fact that these removals are derived from one edge only (and not alternately, as it happened on other sites), the effect is lifting the tip off the vertical axis and obtaining tool asymmetry at this knapping stage (Fig.88).

The features owing to which the tools were discarded at a given knapping stage allow for deducing that their knapping was aimed at obtaining tools which were:

- thin in cross-section (unsuccessful thinning disqualified the artifact),
- plano-convex,
- with straight, parallel edges formed with semi-flat removals,
- with exposed, thin tip,
- with angular or rounded base.

**None of the analysed forms is a finished tool.** Only the 115 711 and 115 736 artifacts were retouched after breakage. Still, it might be presumed that it was only an attempt at re-using a failed tool, and not its aimed shape.

### 3.2.1.2.3. Vedrovice V

The analysis included 16 bifacial artifacts from the Vedrovice V site. The artifacts are stored in the collection of Moravian Museum in Brno. In the literature, 12 of them were referred to as leafpoints (Nerudová, 2000; Valoch, 1993; Valoch, 1984b). Five of the artifacts are unfinished, failed or broken forms. Two artifacts were refitted two fragments, of which at least one has signs of post-fracture repair.

The artifacts of Vedrovice V were made on flint. These are tools whose dimensions range from 3.9cm to 9.7cm in length. The morphology of individual tools is very different, but the artifacts show significant technological consistency. Due to the presence of artifacts abandoned at early knapping stages, it was possible to trace the whole manufacturing process.

All Vedrovice V artifacts are characterized by a consequent edge scheme of knapping. The analysis allowed to distinguish two basic knapping schemes which, as a result, define two basic artifact types.

#### Group I

Group I contains four artifacts (50142, 50143, 50156 and 16842) (Fig.89). Two of them are preserved in complete forms (50142 and 50143), the other two are broken tips. The 50156 artifact is probably an unfinished form.

The artifacts are characterized by a specific scheme of nodule formation. First, one of the edges was formed with extensive and flat removals derived on both faces; then the second edge, using semi-abrupt removals also introduced on both tool faces. Thus, a deltoid artifact was obtained (Fig.90). After the initial surface formation, tool shaping was done, its scheme at this stage being adapted to given tool's needs.

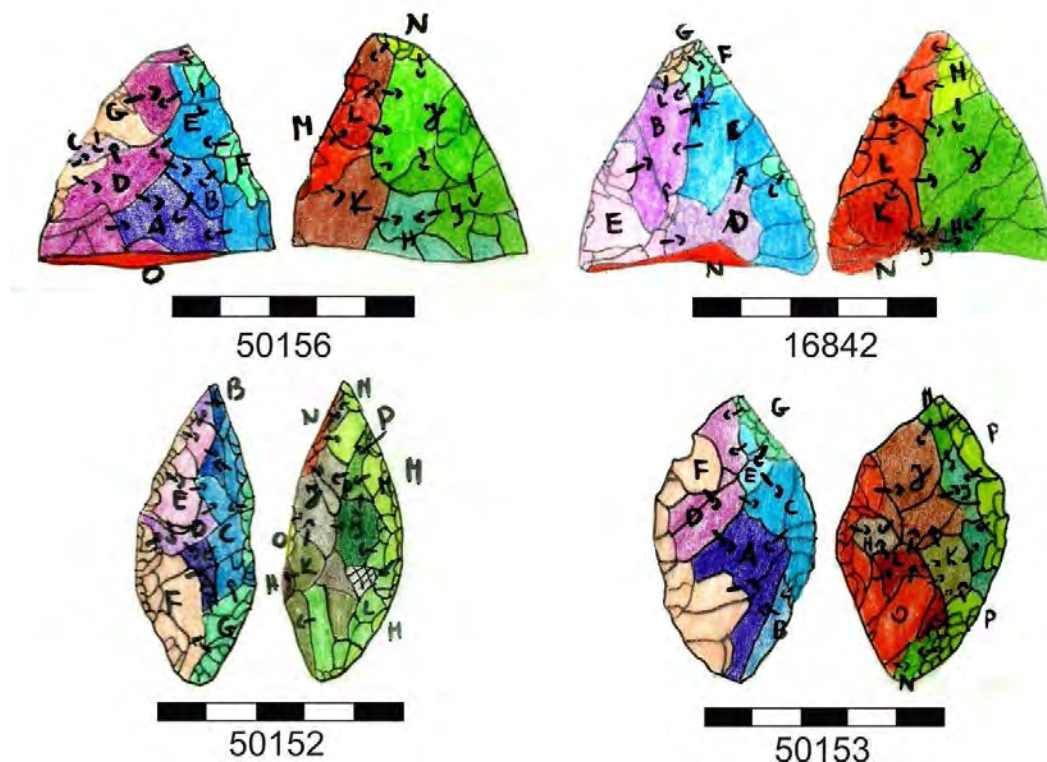
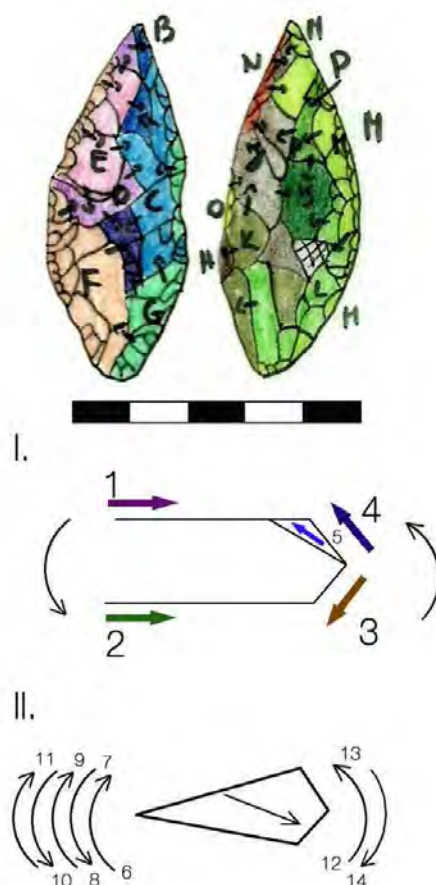


Fig.89 The analysed Vedrovice V group I tools comparison.



*Fig.90 Group I tools edge scheme of knapping based on the 50142 artifact shown in cross-section.*

In case of the 50142 artifact, a consequent edge scheme of knapping can be observed, where one of the edges is formed completely, including the finest removals, and only after its formation has been finished, shape correction on the opposite edge begins (Fig.90).

In case of the 50143 tool, knapping runs in a surface surrounding scheme. However, individual sequences are derived on both sides angularly to vertical axis, forming the artifact shape and leading to tip and base exposure. None of the edges is favoured, both are treated equally. Final edge correction is done in an edge, bottom-top scheme. Still, knapping at the final stage involves the whole tool, both the apical and the base parts (Fig.89, Pl.47).

The edges of the 16842 tool were formed in an edge surrounding scheme. The same pattern is repeated twice. In its first round, long removals reaching far onto the tool surface are derived. Then, small, edge profile correcting removals are performed. After the fracture which followed the edges correction, no further repair traces can be seen on the tool (Pl.44).

Only two artifacts included in the group are fully preserved. Based on them, it can be said that both edges, despite the specific knapping scheme adapted, were treated and formed equally at later stages. No preference for any of the edges, nor deriving different removals to one of the faces or edges can be seen on the described artifacts. The artifacts do not bear any repair traces or marginal retouches meant to sharpen the edge and form its perfectly straight profile. All removals observed on the artifact's surface are intended to thin the tool and form its final shape.

Group I artifacts are characterized by considerable **vertical axis symmetry and cross-section biconvexity**. Huge concern for the artifacts symmetry is visible; nonetheless, the use



of a consequent edge scheme of knapping did not simplify the process of obtaining a perfectly symmetrical tool. Thus, the 50142 artifact displays some edge profile asymmetries in its both edges. However, the derived removals, especially those performed at the end, onto the second edge, are aimed at **maximum tool shape correction, even at the expense of its slight blunting** (N and G series-Fig.90).

## Group II

The second group consists of 8 artifacts (117327, 16840, 16841, 50140, 50144, 50154, 73200 and 73199) (Fig.91). Among these, there is a form's tip, broken during an initial knapping phase, as well as 7 completely preserved artifacts. One artifact underwent a transversal fracture. The tip was probably re-used after fracture, as evidenced by a repair removals derived in the fracture's angle. The base has no signs of post-fracture repair.

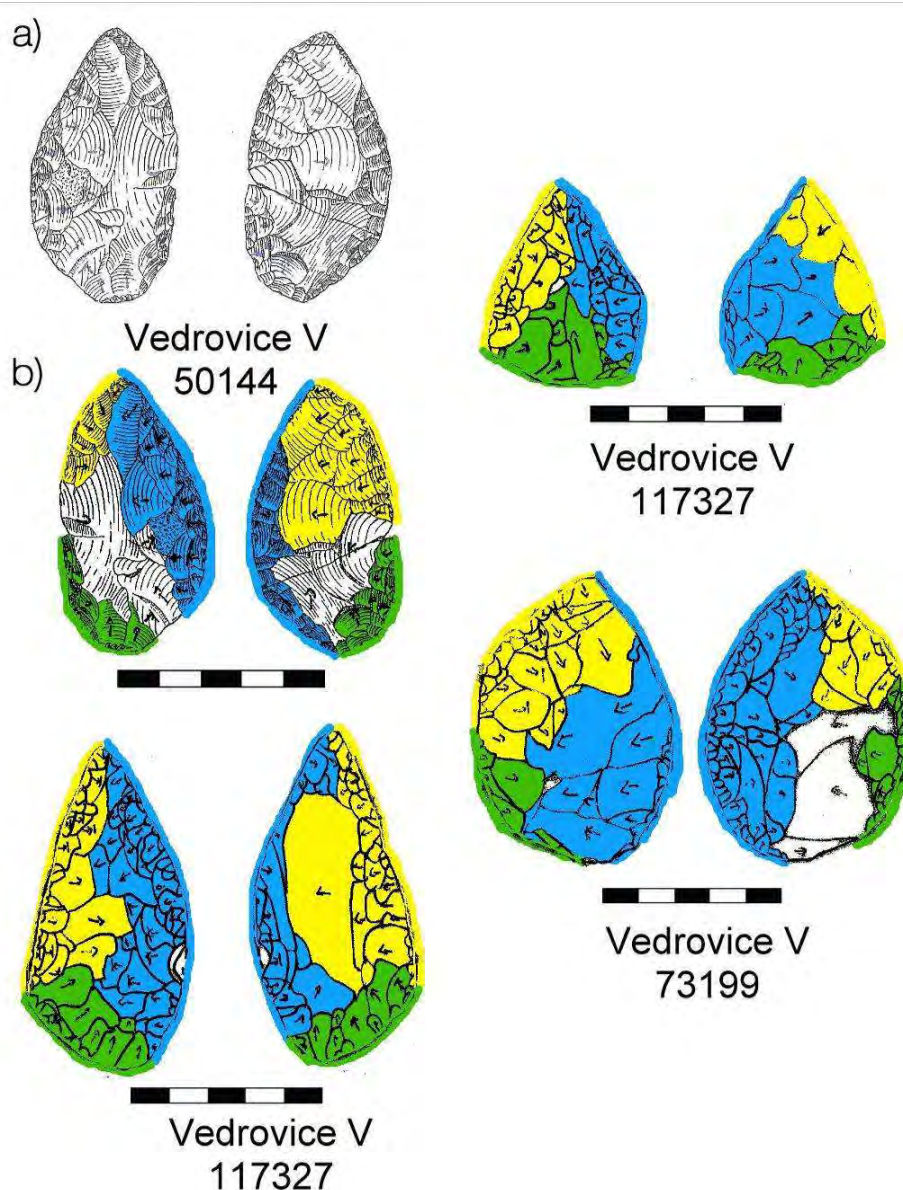


Fig.91 Group II artifacts comparison with techno-functional units marked on group II tools. Red marks cutting edge, blue–base, green–distal posterior edge. The 50144 artifact presented in scheme b) in its mirror reflection, in order to show analogies in its design. Correct artifact projection depicted in scheme a).

The tools can be divided into the following techno-functional units:

**A) Cutting edge.** Shaped with flat removals on both faces, on the lower face (50144, 117327, 73200) or the upper one (16841, 73199). Thinned at the tip with a series of flat, angular removals, reaching far into the surface and derived from the distal posterior edge. This edge has a semi-flat retouch on the upper face (50144, 117327, 73200), or a flat one on the lower face (16841, 73199), where both described features correlate with each other like alternate removals. The artifacts with thinning removal series on the upper face of the distal posterior edge, have a cutting edge retouch on the lower face and *vice versa*. The cutting edge retouch is most frequently applied to the whole cutting edge and reaches as far as to the base. In some cases, the cutting edge bears traces of several resharpening sequences (117327, 73200 and 16841).

**B) Distal posterior edge.** Positioned angularly in relation to tool vertical axis, converging with the cutting edge at the tip (Fig.91). It is formed on one face, as already mentioned, with flat, long removals reaching far into the surface, derived angularly to tool axis. The other face usually has a retouch, or corrective removal series. A characteristic feature is the biangular outline of distal posterior edge in relation to the remaining edges, which is the result of performing angular removal series, overlapping with one another (73199, 117327, 50144, 73200, 16841 and 16840–Fig.91).

**C) Base.** An edge running transversely or angularly to tool axis, equipped with separate removal series forming its profile—performed on both faces. In some tools, the base is formed as an almost sharp edge (intensive thinning sequences 117327, 73200). In other cases, the base is formed with semi-abrupt removals (73199, 50144, 16840), or left as a natural, cortical surface (16841). The 73200 artifact, bearing traces of intensive repairs, also displays signs of base shape's repair.

**D) Back.** It is not present in all the artifacts. In some, the distal posterior part's edge switches directly into the base's edge (117327, 73200, 50144). In other artifacts, though, the distal posterior part close to the base becomes an edge which is formed by semi-abrupt removals derived to the upper face (73199, 50140). In some situations, this edge is a remnant of a non-removed steep edge from the surface formation stage (73199). In others, it was formed later, at the stage of edge shape formation (50144, 50140), and displays traces of correction during subsequent tool repair phases.

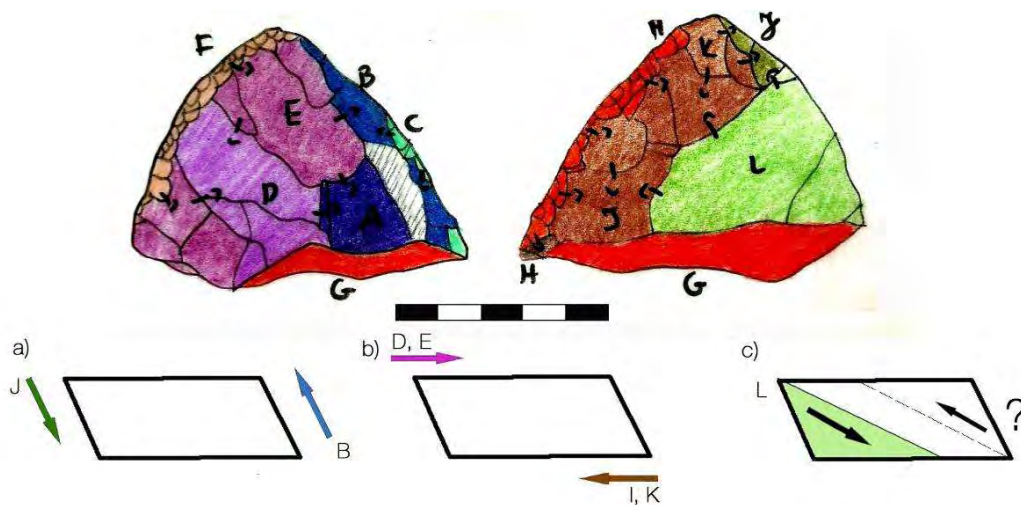
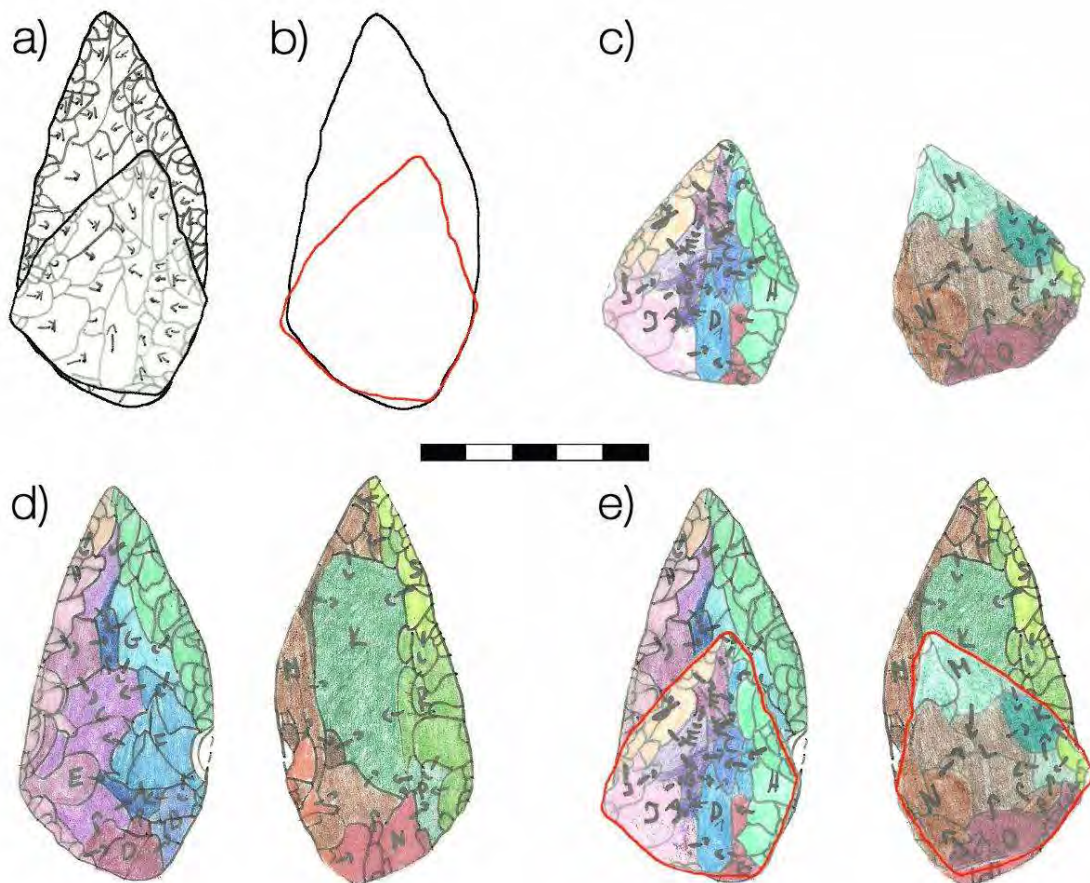


Fig.92 Plano-steep group I artifacts knapping scheme, based on the 50154 artifact shown in cross-section. Detailed description in the text.

All group II tools are marked by a coherent tool formation technology:

**I. Surface and edges formation.** Best presented on the 50154 artifact, abandoned in its preform. The phase consists of deriving abrupt removals on one face and flat on the other edge/face. The second edge is knapped analogously but alternately, owing to which the tool has a specific plano-steep, biconvex cross-section (Fig.92). From the very beginning, flat removals are performed angularly in relation to tool vertical axis and they reach far into the artifact's surface. Deriving such removals type alternately causes tip thinning and exposure. Group II artifacts have characteristic differences in the apical and near-the-base tool parts treatment. While at the tip, after the formation of a plano-steep cross-section, flat, thinning removals are derived replacing the old, semi-abrupt removals (Fig.92), at the base one of the edges is left to be semi-abrupt or else, it is formed to be semi-abrupt at tool shape formation stage, through semi-abrupt removal series. This edge is also more sinuous in profile than the opposite one and has no retouch, or the retouch is limited to apical parts (Fig.91).

**II. Retouch.** In some cases, the cutting edge retouch is derived onto the lower face and formed by small flat removals along the edges. In other cases, retouch is introduced in the form of semi-flat marginal removals onto the upper face. In the second described case, the edge shape changes more with subsequent repair stages than in case of a flat retouch onto the lower face (Fig.91).



*Fig.93 Analogies in sequences arrangement in the 73200 and 117327 tools, suggesting tool reshaping during subsequent repairs. a), b), e) the tools contours comparison. c) the 73200 artifact with marked removal sequences; d) the 117327 artifact with marked removal sequences.*



**III. Repair.** Several of the described tools show repair signs (16840, 73200, 117327, 16841, 50144 and 50140). In some cases the repair was limited to cutting edge resharpening, in other to near-the-tip edge re-forming by deriving alternate removal series (one, thinning from the distal posterior edge, the other, edge resharpening from the cutting edge (16840, 16841). Some of the tools were repaired by repeating the whole scheme of edges shaping (50140, 117327 and 73200). The 73200 artifact has 4 distal posterior part's repair series, which do not have their equivalents in the form of cutting edges repair series. It can be assumed that this tool was repaired gradually, and only the last retouch series abolished the signs of prior cutting edge repair.

Due to the occurrence of analogous sequences and the specific character of base formation, it can be assumed that at earlier stages, this tool's shape resembled the 117327 artifact (Fig.93).

**Both edges were treated in different ways. The cutting edge is characterized by a more straight profile than the opposite edge. The artifacts have a separately formed base, and some also have a blunted distal posterior edge.** An exposed tip is the result of performing alternate, angular, thinning removals and a retouch on both edges. On the tools (except for 50140), there is visible care for tip exposure and preservation. These tools, due to the nature of surface formation process and the nature of alternate, flat removals at the tip, take a specific shape. It is the consequence of differing character of removals derived from the cutting edge and the opposite edge. The semi-abrupt removals have bigger butts, resulting in a more noticeable change of edge shape than the flat removals performed from the tip. For this reason, the tools which had had their edges formed and do not bear any repair traces, are S-shaped (Fig.91). Despite no visible signs of concern for symmetry, group II tools cannot be denied considerable concern for edge shape. In some cases, the base's or the distal posterior edge line correction constitutes one of the repair stages. Even the supposedly non-functional units are not left unknapped and have a defined shape; and the base's edge, e.g. in the 117327 form, has a very straight and precise line.

### Group III

The third group consists of three artifacts, among which there is an unsuccessful, plano-convex tool half-product (50139), a small bifacial tool made on a blade with preserved flake ventral surface on the lower face (50149), and a refitting of two fragments in which the base was resharpened after fracture, and probably used as a cutting tool without an exposed tip (50166) (Fig.94). The broken tip bears no post-fracture repair signs and might not have been used further on.

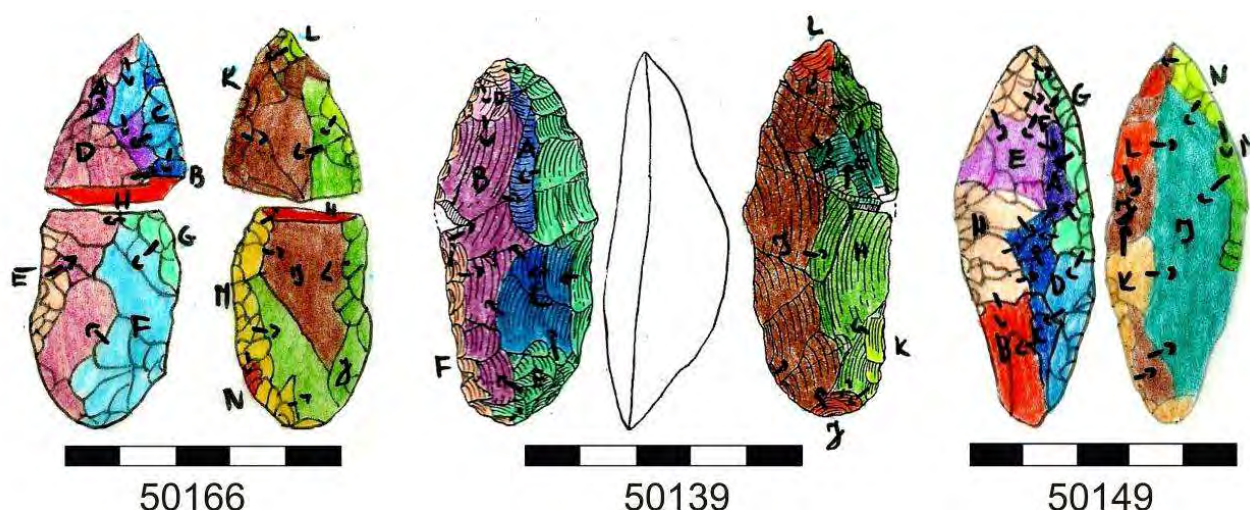
Before fracturing, the 50166 tool (Fig.94) was a very precisely knapped bifacial tool. It was formed in an edge knapping scheme at the early stage of shape formation, and in an edge alternate knapping scheme at the last stage of edge profile retouching/resharpening. This knapping scheme probably helped to obtain tool shape symmetry and cross-section biconvexity. This tool has an **exposed tip and two symmetrical, analogously treated edges**. The rounded base also has traces of sequences forming its shape. The knapping finished, the tool was transversally broken. After the breakage, the base bears traces of "face-wise" alternate repair sequences of one edge. These sequences might have constituted several subsequent repair/edge sharpening phases. The tip has no post-fracture repair signs.

The 50149 artifact was formed in an edge knapping scheme. On each edge face two or three removal series were performed, starting from intrusive and extensive, up to marginal and precise. Both edges are treated equally during knapping. The lower face has flattening

removals derived on it, whereas the upper face has **removals aimed at edge shaping and line correction**. The tool was formed so as to obtain a symmetrical shape and an exposed tip. It is evidenced by sequences of final marginal removal series, aimed at final shape correction, but which were not edge sharpening sequences. The two edges remained slightly S-shaped in profile; none of them was more precisely treated because of that.

In a similar scheme, the 50139 tool (Fig.94) was knapped. It was formed in a surface surrounding scheme, where first the lower face was shaped with flat removals, and next removals shaping the upper face's surface were derived. These removal series, repeated twice, failed to thin the half-product adequately, thus the tool was probably retouched on one of the edges and used as a cutting tool. Despite this, an attempt to form an elongated, symmetrical tool shape can be seen at particular knapping stages. None of the edges is favoured nor treated in any differing way.

Similarly, the 50188 artifact (Fig.94) was discarded as a preform. The tool was also knapped in a plano-convex scheme, but along the edges. At an early knapping stage there was an attempt to thin the tool one of its edges. Several series of alternate, semi-abrupt removals to the upper face, and some flat on the lower face, were derived on this edge. Still, these did not produce the desired result. The hinged removals left a blunted edge. It is interesting, however, that already at this stage, removals closer to the tip and the base were derived angularly to vertical axis. Due to them, the tool was shaped with each new sequence and the edge became convex. After the unsuccessful thinning of the first edge, the opposite edge's knapping was commenced. It proceeded analogously to the previous one, with semi-abrupt removal series on the upper face and flat on the lower face. The removals at the tips were also performed angularly. The removals on the other edge did not allow for complete decortication and the elimination of tool's middle part thickness. In consequence, a half-product of symmetrical shape but considerable thickness was created (9.7cm length, 4.5cm width, 2.4cm thickness). Only the apical parts were sufficiently thinned; nevertheless, no signs of further knapping can be observed on the tool. From the perspective of this thesis, it is an interesting example of a tool whose shaping was introduced at the earliest stages of manufacturing process.



*Fig.94 The analysed Vedrovice V group III tools comparison.*

In case of the 50166 and 50149 artifacts (Fig.94), both edges are treated equally, they do not have signs of intensive repair or repeated retouches. These tools have no retouch sequences at all, in the sense of sequences forming an ideally straight, sharp edge. Removals, even the marginal ones, do not form the straight profile, but the edge shape. The removals location depends on the aim being tool shaping, not edge profile correction. Consequently, both edges remain slightly S-shaped in profile. These tools also have a well-exposed tip.

The 50139 form is an unfinished preform made on a blade or a flake. It was supposed to have an elongated shape and two parallel edges. The artifact could not be sufficiently thinned, which probably caused abandoning the reduction course and retouching only one of the edges. Such tool could be used as a cutting tool. While in case of the 50139 tool, the artifact's size allows for such interpretation, in case of the 50188 form, due to its large size and early knapping stage, does not provide grounds to conclude that it is a leafpoint half-product. Certainly, however, one is dealing with a form where shaping and keeping the item symmetrical are reflected since early knapping stages.

### 3.2.1.3. Germany

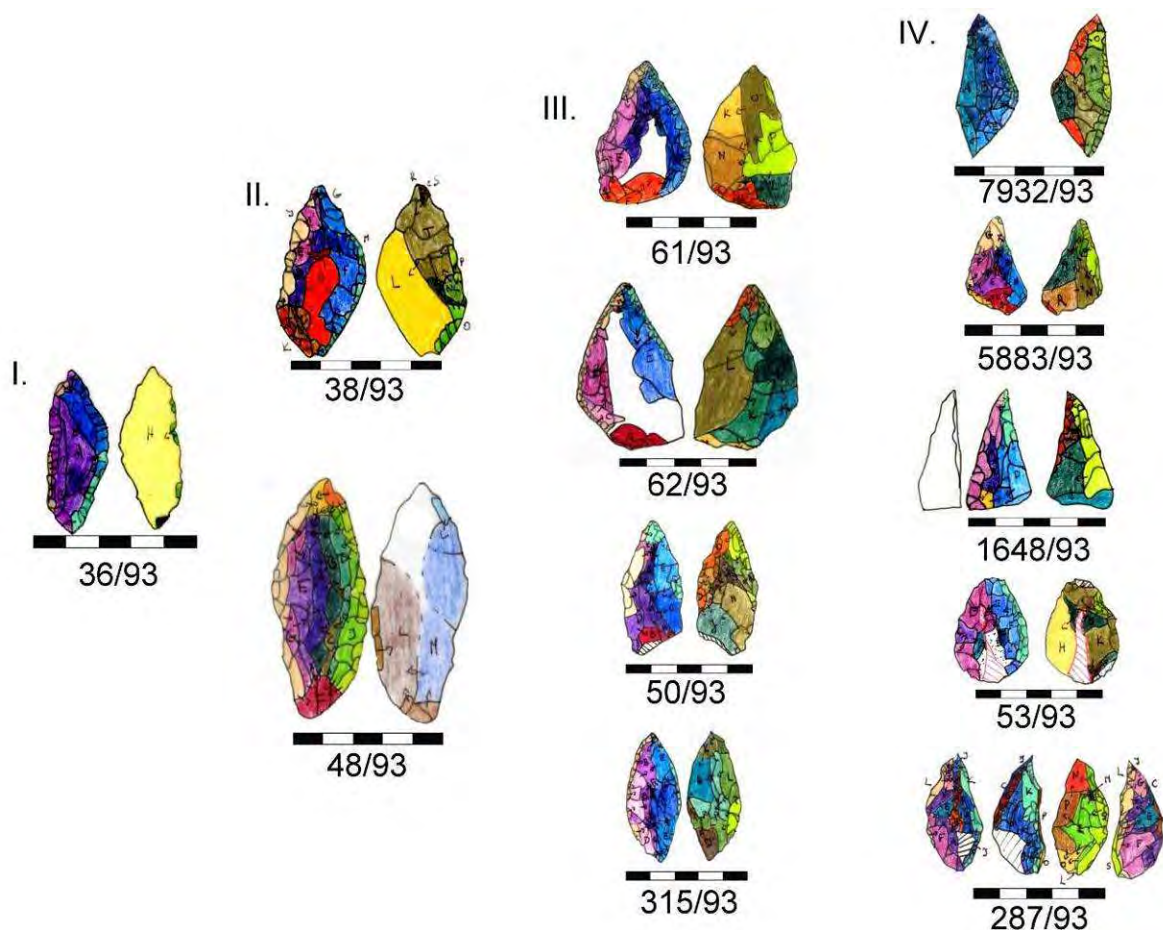
#### 3.2.1.3.1. Ehringsdorf

The analysis covered 36 artifacts from the Ehringsdorf site. Twenty-eight of them were discovered in the central part of the site where the excavations took place. Eight of the analysed artifacts were discovered outside the main excavations area and their dating is not clear. Nevertheless, it was decided that the analysis will include these tools as in terms of shape, the tools resemble leafpoints. These are the artifacts 2242/93, 7932/93, 2304/93, 79/93, 315/93, 77/93, 1463/93. The 284/93, 315/93 and 79/93 tools were called “leafpoints” in the literature (Gladilin, Slitlvyj & Tkachenko, 1995 p. 113; Feustel, 1983 p. 30) but the 77/93 form was termed as a knife/side scraper (Behm-Blancke, 1960 p. 196). The remaining four artifacts have not been published so far. Among the artifacts originating from the site’s central part, seventeen have already been published (Feustel, 1983). Nine of them are called “leafpoints” in the literature (Behm-Blancke, 1960; Feustel, 1983; Gladilin, Slitlvyj & Tkachenko, 1995). These are the following forms: 47/93, 79/93, 36/93, 52/93, 51/93, 46/93, 48/93, 316/93, 57/93, 283/93, 284/93. Due to the fact that the archaeological horizons on this site containing bifacial tools are dated to OIS 7, the tools are referred to as “the oldest leafpoints” (Kozłowski, 2003). Except from the symmetric forms, eight other bifacial tools underwent analysis. The tools were of similar morphology and the literature calls them either knives or side scrapers (60/93, 31/93, 43/93, 287/93, 56/93, 61/93, 55/93, 63/93) The eleven remaining artifacts (1648/93, 5875/93, 64/93, 53/93, 62/93, 50/93, 37/93, 54/93, 5883/93, 58/93, 38/93) have not been published so far. Still, their analysis was conducted owing to their symmetrical shape and morphology similar to that of the published items (e.g. 50/93 to 46/93, 37/93 to 36/93, 62/93 to 61/93). All the examined tools, except for 283/93, can be considered as a technologically coherent artifact group.

The tools are usually of small size (average length–5.07cm, average width–2.65cm). They are most often made on flake, plano-convex, and quite thick (1.26cm) artifacts. The tools are characterized by an exposed tip, which is often sharp and set in the tool vertical axis. Parallel to that, both edges are retouched onto the upper face. However, one of them is usually straight, whereas the other is slightly S-shaped in profile. This difference, as the analyses have later showed, stems from the specific character of the tools rejuvenation method. Both edges have traces of several rejuvenation phases in the form subsequent resharpening retouch series which gradually become steeper. A few of the tools have an almost blunted edge due to its repeated retouching (48/93, 57/93, 316/93) and in one case, the edge curves under the lower face (287/93).

Numerous resharpening series left the tools in a heavily exhausted state, which makes their analysis difficult. In some cases, one may observe gaps in sequence chronology (287/93–Fig.96); and in most cases it can only be speculated about, as some retouch or removal series are not visible on the surface.

Based on the conducted analysis, it is not possible to state that the tools were knapped in a defined scheme. The stage of obtaining flakes from which the tools were knapped is scarcely known. The flake was retouched onto the upper face on both edges, and it was given an appropriate shape. The target shape was that of a willow leaf–then, all edges were retouched or only the tip was exposed via a convergent retouch of both edges. The subsequent process of edges rejuvenation caused their blunting. To avoid it, it was necessary to reduce the cutting edge angle, which was done by performing series of flat percussions onto the lower face. What is typical of Ehringsdorf tools is deriving a series of flat removals onto the lower face from edge II only; removals frequently angular to the tip’s vertical axis (Fig.95).



*Fig.95 Comparison of Ehringsdorf tools example shapes, depicting different tool repair phases. Stage I–no removals on the lower face, Stage II–single removal series on the lower face performed from distal posterior edge, Stage III–regular series of flat thinning removals on the lower face and subsequent retouch series on the upper face, Stage IV–exhausted tools with repeated rejuvenation stages on both edges.*

Such removals, flat and long, once they went through the whole tool near the tip and reached the opposite edge I, caused tool thinning and edge I angle reducing, due to which the edge remained straight. Removals onto the upper face's both edges were performed after a series of flat removals onto the lower face. Yet, the retouch on edge II, from which the flat removals were performed, was less regular and the edge often remained more S-shaped. By contrast, the retouch on edge I was very regular and the edge remained straight. If in the course of rejuvenation, subsequent series of flat removals from edge II did not thin the surface enough, and did not correct edge I angle, then a series of flat removals was performed on this edge's lower face as well and next, both edges were retouched on the upper face. As a result of performing a few removal series onto one of the edges at the tip, and retouching both edges onto the upper face, the tool and both edges changed their shape.

Fig.95 depicts approximate schemes of Ehringsdorf tools' shape changes in consequence of subsequent rejuvenation series. Generally, after repeated rejuvenations the tools are characterized by:

- the presence of a flake ventral surface fragment on the lower face, located at the base near the straight edge (56/93, 38/93, 62/93),
- the presence of a base most frequently formed with blunting removals,

- an exposed tip,
- the presence of two retouched edges.

Only two tools (43/93 and 52/93) have removals from the edge at the very tip. Their knapping caused the removal of a sharp tip, and consequently, the appearance of a separate edge at the tip. This edge was rejuvenated several times with removal series on both faces. Probably, the act was connected with considerable blunting of the 43/93 tool near the base, which left the tip section as the only one repairable and usable. In case of the 52/93 tool, the reason is difficult to explain.

Regarding the different ways of treating various tool parts, one can name the following techno-functional units:

**A) Cutting edge** (the more straight one among the edges, usually edge I). It displays several retouch series onto the upper face. If there are any removals onto the lower face, they are of two kinds: flat, broad removals aimed at correcting the angle (reducing the edge angle), or very small removals aimed at ultimately correcting the edge profile (usually at later repair stages, when the edge becomes less regular as a result of subsequent resharpening). Flat removals onto the lower face do not span as much as their analogous removals performed from the second edge. They are also not aimed at reaching the opposite edge in order to reduce its angle, which points to their edge angle correcting function.

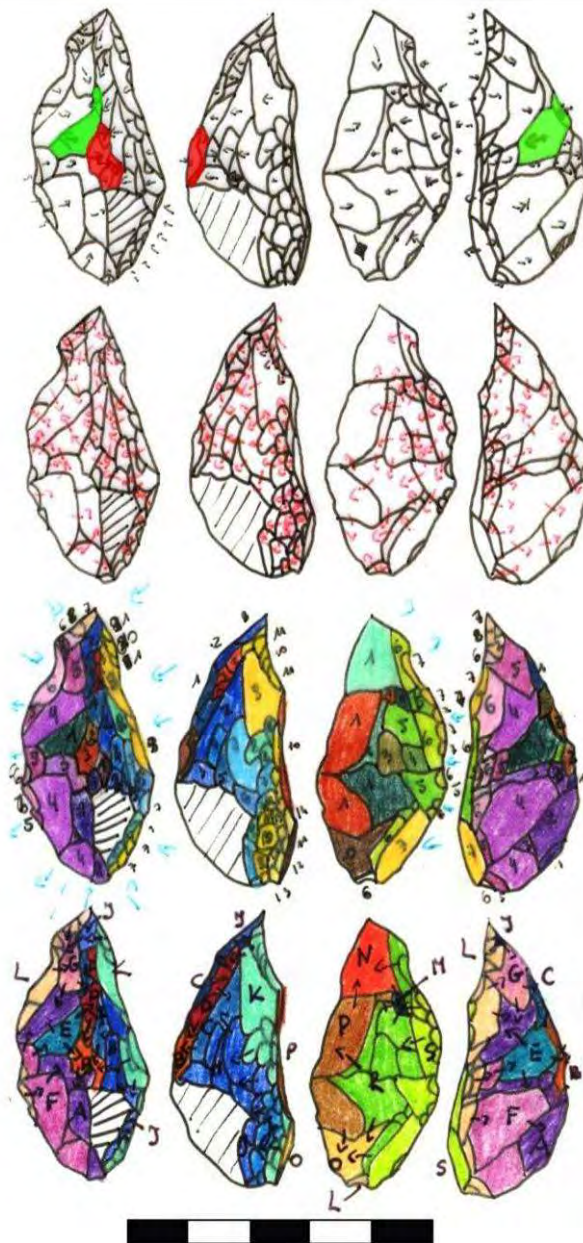
**B) Distal posterior part** (more S-shaped than the cutting edge). An edge with a retouch, which usually does not cover the entire edge but only the near-the-tip part. It has a retouch on the upper face. Flat, broad removals crossing the tool axis and often reaching the opposite edge (mostly in the tip section) are performed on the tool's lower face. These removals are aimed at reducing both edges' angle. Owing to the fact that they overlap onto the second edge, this edge gets retouched while remaining straight. Because of several repetitions of this operation, it is difficult to establish whether the semi-flat removals preceded the semi-steep percussion series onto the upper face, in view of preparing a suitable edge angle for performing the latter ones. Series of removals on the 46/93, 50/93 tools may reflect that. Still, the sequences might be remnants of earlier edge sharpening stage and the repair sequences might have been started from performing flat removals onto the lower face. After this procedure, the edge was again retouched onto the upper face. Deriving flat, axis-angular removals usually lifted the tip off the axis while transversal removal series caused the creation of a concave edge.

**C) Base.** Usually formed with a series of semi-flat/semi-steep removals or with the use of breakage scar, or else the natural surface. The base was not usually corrected apart from the tool reorienting instances. This resulted in retouching the edge at the former base (38/93).

The lower face of all of the Ehringsdorf tools is flat and used only to correct the edge angle or edge profile. All retouches are performed onto the upper face. Unsuccessful tool thinning on the lower face often led to the creation of considerably thick tools. The most significant is the 287/93 tool, which is thicker than wider. What is more, during the repair there was an attempt to thin the tool by removing fragments from the middle of the upper face which was the thickest place. In order to thin the tool, 4 series of removals were performed alternately from the top, down to both edges; however, this was not successful. Lastly, the tool was retouched until it became blunted. The last retouch sequences curved under the lower face and made the edge not so much blunt as vertical or even convex.

The 57/93 tool is also interesting, as its tip part was again retouched on both edges after the fracture, even though the tool was only 1.4cm long.





*Fig.96 The 287/93 tool with repeated resharpening series on both faces. When it was abandoned, the tool was thicker than wider. Green and red in the second scheme mark removals performed from tool top in order to remove its thickness.*

Numerous repair series and the use of even broken forms (57/93, 55/93) may reflect the scarcity of raw material sources.

Some specimens were made of bent flakes (316/93, 62/93). These tools were knapped as the ones previously described. In the course of subsequent rejuvenation stages no signs of bend-removing attempts can be observed. On the contrary, in case of the 316/93 tool bulb-obliterating removals caused further bend deepening.

Overall, bases on the analyses it can be concluded that the tool shape was not formed before edge retouching. **The tools bear no signs of shaping. All removals visible on the tools are consecutive tool rejuvenation series.**

The elements specific of Ehringsdorf artifacts should include:

- repeated rejuvenation-resharpening series of both edges,
- tool orientation change,
- retouch usually limited to the near-the-tip part,
- the base and the edges at the base are not retouched or they only have traces of early rejuvenation sequences,
- tools are plano-convex,
- some tools are bent in their horizontal section,
- retouches of both edges are steep, often blunting,
- tools are very thick in comparison to their width.

Among the analysed tools there are those that were dropped at preliminary knapping stages, that have no removals on the lower face, or they only have marginal removals correcting edge profile (316/93, 36/93, 37/93, 47/93). One can also notice tools with several removal sequences onto the lower face (46/93, 38/93, 48/93, 31/93), as well as exhausted tools bearing signs of repeated rejuvenations (55/93, 58/93, 63/93, 43/93, 57/93, 54/93, 287/93, 1648/93, 5883/93, 5875/93). Only one analysed specimen can be treated as an unfinished form (60/93), abandoned during the production process and bearing no traces of rejuvenation. It is a flake tool whose edges were formed analogically, alternate to each other. The formation of each edge took place in three steps. First, three series of removals were derived, starting from flat removals to one face which created a platform for semi-steep removal series onto the other face, and ending with semi-flat removals onto the first face, which corrected the tool's acute angle. Using this scheme of tool knapping alternately caused the creation of a tool double-convex in its cross-section. This tool deviates from the scheme of knapping used with the remaining tools, as it does not display different treatment of either face. Probably, the underlying idea of manufacturing was to create a tool with two cutting edges that would be knapped alternately. Nevertheless, owing to failed thinning sequences (sequences M and H-Pl.75), the objective was not met.

The 64/93 tool should be treated individually. It is the middle part of a broken, flat bifacial tool. The tool significantly differs from the other ones due to its small thickness and very precise bifacial knapping. The tool was knapped in a surrounding scheme through a series of flat removals derived on both faces, first on one, and next on the second edge. Surface formation was followed by edge formation with less broad but still flat removals, performed on both faces in the edge scheme of knapping. The tool has transversal fractures on both ends. One of the breakages has traces of an additional flat removal scar, performed onto an earlier breakage scar from one of the edges. After breakage, the tool was remodeled on both edges. One of the edges was additionally retouched, whereas there was an attempt to remove an edge fragment from the other one, using a vertical percussion applied to the breakage surface and derived oblong to it. The removal, however, quickly ended up in the edge's middle, creating a small hinge. The post-fracture knapping on both edges indicates that the tool was also used in the form in which it was found. Simultaneously, it is not possible to establish its shape from before the fractures. Its morphology, especially in the light of the above presented description of Ehringsdorf-characteristic artifacts, puts into question its belonging with the described assemblage.

### 3.2.1.3.2. Lenderscheid

The analysis included 10 artifacts from the Lenderscheid site, called leafpoints in Fiedler's publications (1994). The artifacts come from the collection of Vor-und Frühgeschichtliche Museumslandschaft Hessen in Kassel.

The sample included three complete specimens, and 7 fragments (bases, tips and middle parts). The scar pattern analysis showed that all the artifacts bearing fracture scars were remodeled after the breakage, which implies their further exploitation.

#### Group I

The first group consists of artifacts characterized by:

- plano-convex cross-section,
- transversal fracture located in the middle of the tool,
- presence of two notches placed alternately on both edges, near the breakage scar.

The break runs either through or below the notches' central part. This group of artifacts includes V11\_56, V11\_54, as well as V11\_57 (Fig.97).

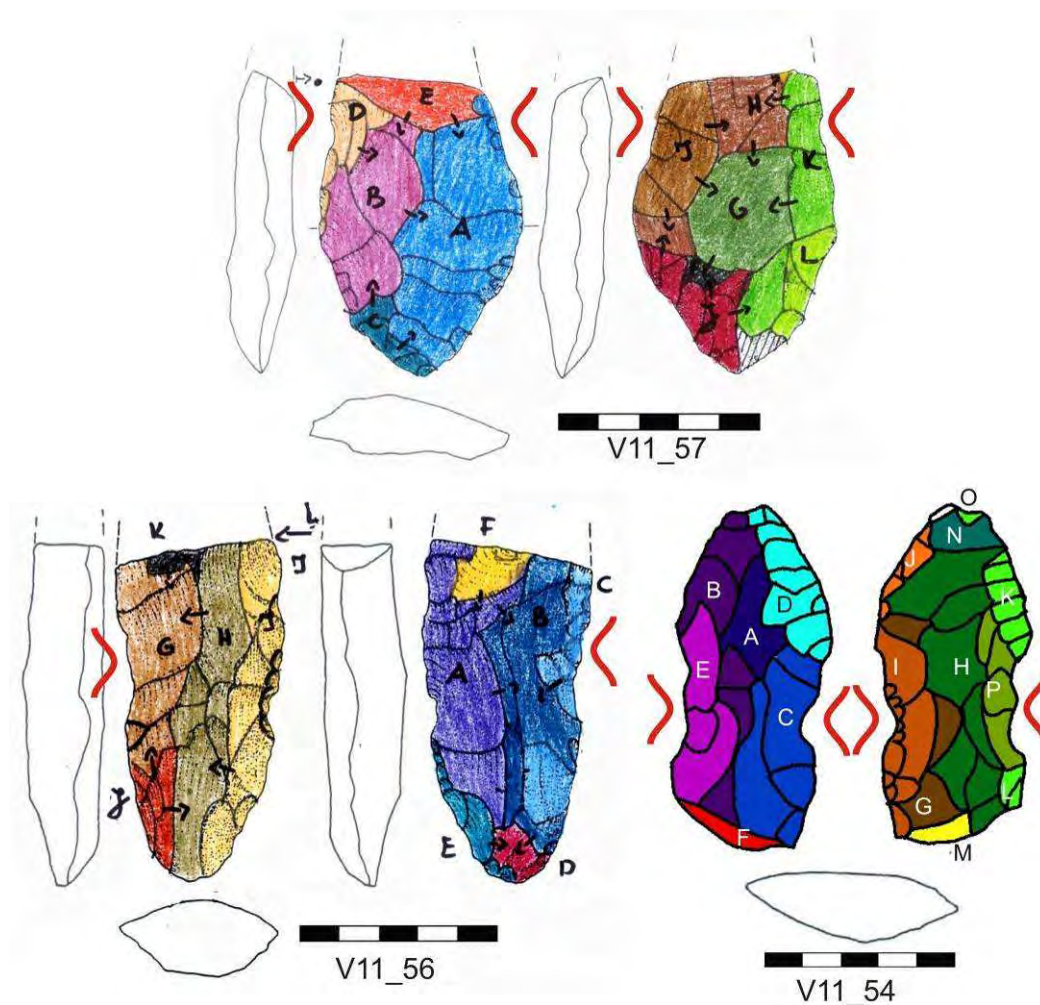


Fig.97 The analysed Lenderscheid group I tools comparison.

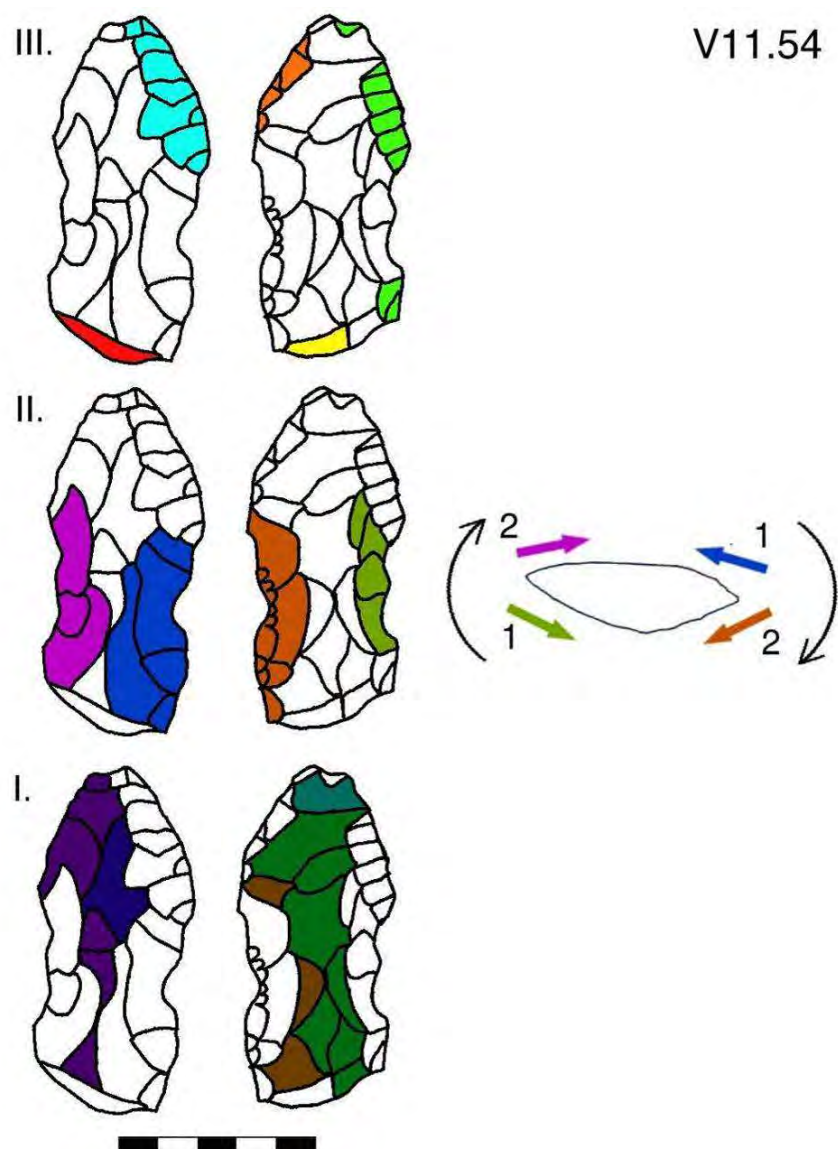


Fig.98 Knapping scheme of group I tools, on the example of V11\_54 artifact shown in cross-section. I–surface formation stage, II–alternate notches formation stage, III–edges fracture and retouch at the tip.

Even though each tool from this group had a different manufacturing process, its final goal was comparable in each case. The tools' characteristic elements were created in a similar manner, yet at different manufacturing stages. For this reason, the most important formation stages are enumerated below. It should be noted, though, that their order was different on each tool, and sometimes one stage appeared in the course of another stage (shaping the tip while forming the tool surface (V11\_57–Pl.99). The production of such tools type consisted of the following steps:

**I. Surface formation.** At this stage, knapping proceeded either in an edge or surface scheme of knapping. In all the analysed artifacts knapping began, however, from a sequence of semi-flat removal sequences, forming a convex upper surface, starting from edge II. Later, either edge II was formed with a flat removal series onto the lower face, or edge I on the upper face. Only in one case (V11\_57) full reconstruction of early knapping stages was possible. On this tool, the upper face was formed with three removal series, derived from one and then from the other edge (Fig.98.I–dark blue and purple). What followed was the



formation of the lower face's flat surface (Fig.98.I–green and brown). In all cases, the plano-convex cross-section is achieved by forming both edges with series of semi-flat removals onto the upper face first, and next with a flat removal series onto the lower face.

**II. Notch formation.** Each of the two notches was formed by two percussion series. First, one series of flat percussions was introduced on one face, and then, in the same area, a series of semi-flat or semi-steep smaller and more intrusive removals on the other face. The second notch was formed analogously but alternately to the first one (Fig.98.II).

**III. Shape formation at the tip.** At this stage, all three artifacts show remarkable conceptual cohesion, and all have semi-steep removal series forming the tip shape. They are also aimed at preparing for a series of flat removals on the other face. The second edge is formed with a series of flat, fairly precise removals at the tip. Quite possibly, the retouch might have been done already after the breakage, in order to resharpen the edges.

**IV. Fracture.** Each of the described tools has a transversal fracture scar at the base, which runs close to the alternate notches made on both edges. For the V11\_57 tool, the fracture runs in the middle of both notches (Fig.97). For the V11\_54 tool, the point of percussion is in the middle of the lower face; so, it can be assumed that the tool was hit in the middle of a flat surface. For the remaining two scars, it is difficult to determine their character and point of percussion.

It is interesting to notice that the notches were not always performed at the end of the production process. In case of V11\_56, the sequences leading to notches formation were performed already at the stage of surface formation and incorporated into subsequent tool production stages. This, and the above-described transversal character of the fracture on the V11\_54 tool suggest that these tools were broken intentionally and the alternately knapped notches were to facilitate the process of breaking and increase its precision.

Therefore, a hypothesis can be made that **the entire production process was a preparation for the creation of two mirror tool forms with a base formed via a transversal fracture scar. The target tool would have notches at the base (fracture scar) to facilitate tool hafting, together with the retouch of one or both edges at the tip.**

At the same time, the V11\_54 artifact would provide an example of a tool which broke in an undesirable location, below the created notches. For tool V11\_56 it can be also assumed that the notches were made after the fracture in order to re-break the tool below, and to obtain a rectangular segment (see artifact group II).

## Group II

The second group of tools is known as the middle parts of broken leafpoints. This group includes V10029\_7 and V55\_9 (Fig.99). The analysed tools are in the form of rectangular pieces with parallel edges and transversal fractures on both ends. However, the production technology analysis and closer observation of fracture scars allow to assume their intentional character.

In the examined collection of Lenderscheid, two such artifacts were analysed, and the next two were identified in the collection but not submitted to meticulous scar pattern analysis.

These artifacts are characterized by:

- biconvex cross-section with plano-steep surface formation scheme,

- parallel edge profile,
- precise retouch of both edges,
- transversal fractures on both ends,
- retouches on fracture scars or in fracture angles.

The artifacts production ran in three stages:

**I. Surface formation.** At the first stage, a distinctive, plano-steep, biconvex tool cross-section was formed. This was done in an edge surrounding scheme of knapping. On one face, then, a series of semi-steep removals was derived, and next, once the tool had been rotated, there was a series of flat, extensive removals on the same edge's second face. Further on, the same process was repeated on the second edge alternately. Knapping in a surrounding scheme was done in order to achieve better angles for removing flat, thinning sequences, and by consequence, for obtaining biconvex tool cross-section (Fig.100). For the V59\_5 tool, a correction of both abrupt edges was performed via a series of semi-flat removals onto both edges, formed abruptly beforehand. This resulted in obtaining a fully lenticular-biconvex tool cross-section.

**II. Edge knapping.** Subsequent removal series had their range and invasive character adapted to edge profile. The aim was to obtain the most straight and finely retouched edge possible.

**III. Tool transversal fracture.** In the V10029\_7 tool, the first breakage was made at the base, and next, after a series of removals correcting edge II, another fracture was made. For the V55\_9 tool, one of the fractures shows signs of two scars, which suggests that the tool was broken twice. Most probably, one of the fractures went too angularly in relation to the tool's vertical axis. Therefore, the second percussion was decided upon. A similar situation is encountered on the Wahlen site (Fig.123).

**IV. Post-fracture correction.** The last stage was a post-fracture tool correction through a flat retouch on the fracture scar in order to flatten it; or by a steep retouch in the fracture angles so as to remove the acute angles between the edge and the fracture scar (Fig.100).

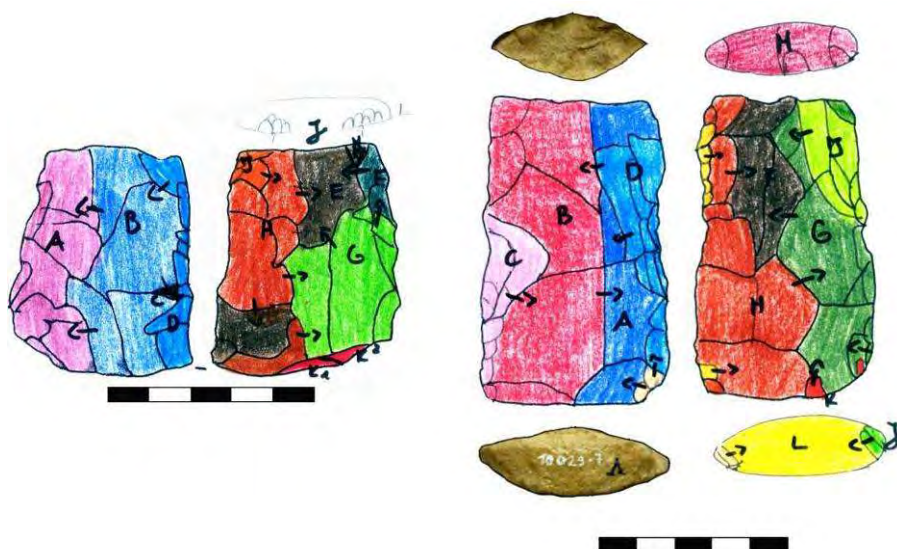


Fig.99 The analysed Lenderscheid group II tools comparison.



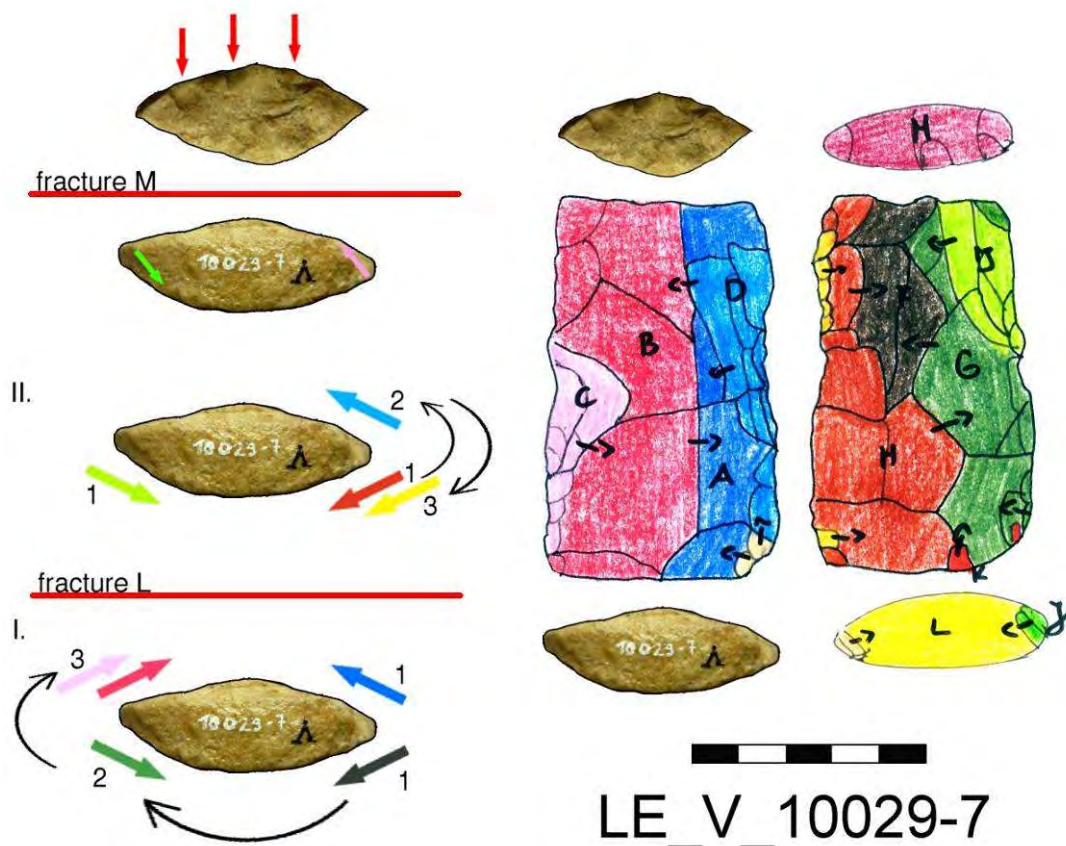


Fig.100 Knapping scheme of group II tools on the example of artifact V10029-7 depicted in cross-section. Numbers from I to II correspond to subsequent knapping stages described in the text.

The fact that both described tools were made almost identically, the presence of other **rectangular segments with fractures on both ends**, as well as the fact that in case of V10029\_7 the breakage was derived as one of the manufacturing process' steps, suggest that the analysed tools are the final production stage, whose aim was to obtain rectangular segments **with two parallel retouched edges**.

### Group III

The third group of analysed Lenderscheid artifacts consists of three tools V11\_3; V11\_13 and V11\_55 (Fig.101).

In this group there is a small artifact (V11\_13) with at least two repair series of the entire tool. On the tool, however, one can distinguish a back, a base, a distal posterior part and a cutting edge. The back was repaired with semi-steep, irregular removals onto the upper face. The base was blunted with steep, alternating retouch series derived from the base. The distal posterior part was repaired with a series of flat, small removals near the tip, and finally, the cutting edge was retouched with flat removals on both faces (Pl.95). The last stage of repair concerned the tip only, while the previous ones, performed in exactly the same surrounding scheme and sequence (back and distal posterior part onto the lower face/ back and distal posterior part onto the upper face/cutting edge onto the upper face/cutting edge onto the lower face) affected the entire tool.

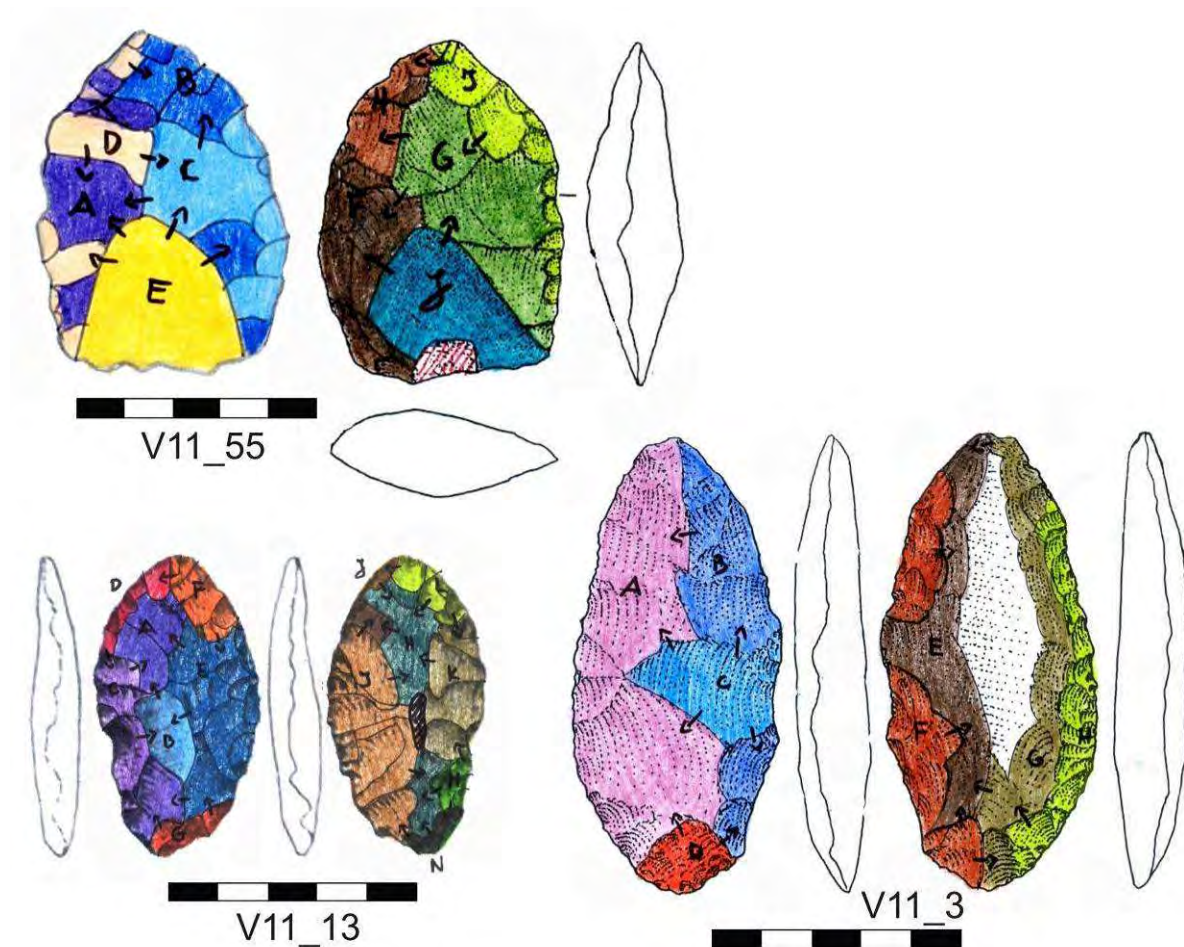


Fig.101 Comparison of the analysed Lenderscheid group III tools.

The second tool bears traces of repair, but was abandoned at a relatively early stage of its use. The surface and the tool shape were formed in a surrounding scheme of knapping, by deriving two series of semi-flat removals onto the upper face. Their purpose was also to decorticate the nodule. Then, two flat removal series were applied to flatten the lower face. The next step was correcting the tool edge on the back's edge. Removals close to the tip were more precise and created a straight edge. The tool was retouched with semi-abrupt removal series on the cutting edge; these were performed from the tip to the base. The retouch does not include the tip itself, which was removed by semi-abrupt removals derived from the tip at an early knapping stage.

The third tool qualified for group III was formed in an edge scheme of knapping, which is visible in all the stages observable on the tool's surface. First, edge I was knapped, and then edge II, which is consequently more straight and, additionally, bears traces of several repair series. The tool's shape resembles symmetrical handaxes, known from publications, and also found on the site (Fiedler, 1994, Abb. 118).

The last two of the analysed tools were not qualified for either group (Fig.102). One of them (V11\_58) has an elongated, lanceolate shape and is almost symmetrical. In 2/3 of its length, the tool has a transversal fracture scar. The tool is biconvex and lenticular in cross-section. The analysis showed that after the breakage, the tool was retouched with flat removals applied from the fracture scar edge onto the tool's lower face.

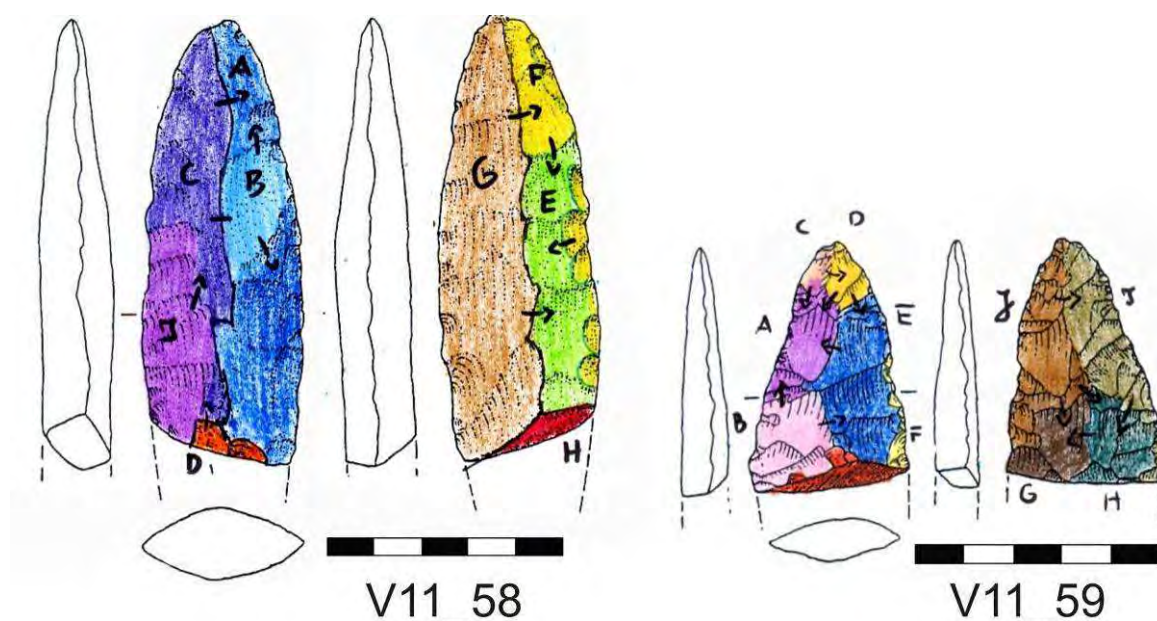


Fig.102 The analysed Lenderscheid V11\_58 and V11\_59 tools.

A detailed technological analysis showed that both edges were not treated equally; nevertheless, the tool has sequences whose purpose could have been increasing its symmetry. In the tool production, one can distinguish two stages. The first was surface and tool's cross-section shape formation. It was followed by the formation of working edges' shape. At the first stage, the tool was probably produced in a plano-steep manner, alternately onto both edges. Then, a series of semi-steep removals was performed at the tip, followed by a series of irregular removals on edge II. Later, a series of precise, flat removals, reaching far into the tool surface was performed in order to form a flat edge. It was probably meant to be a cutting edge. The fracture's intentional nature cannot be judged upon in this case.

The last of the analysed tools was thin, biconvex, transversely broken tool tip, which was repaired after the fracture (V11\_59). Unfortunately, the analysis did not allow to determine the tool's shape prior to its fractures and repair series. The retouch series on both tool edges, however, moved the tip off the vertical axis, which implies that symmetry was not an important factor in their knapping.

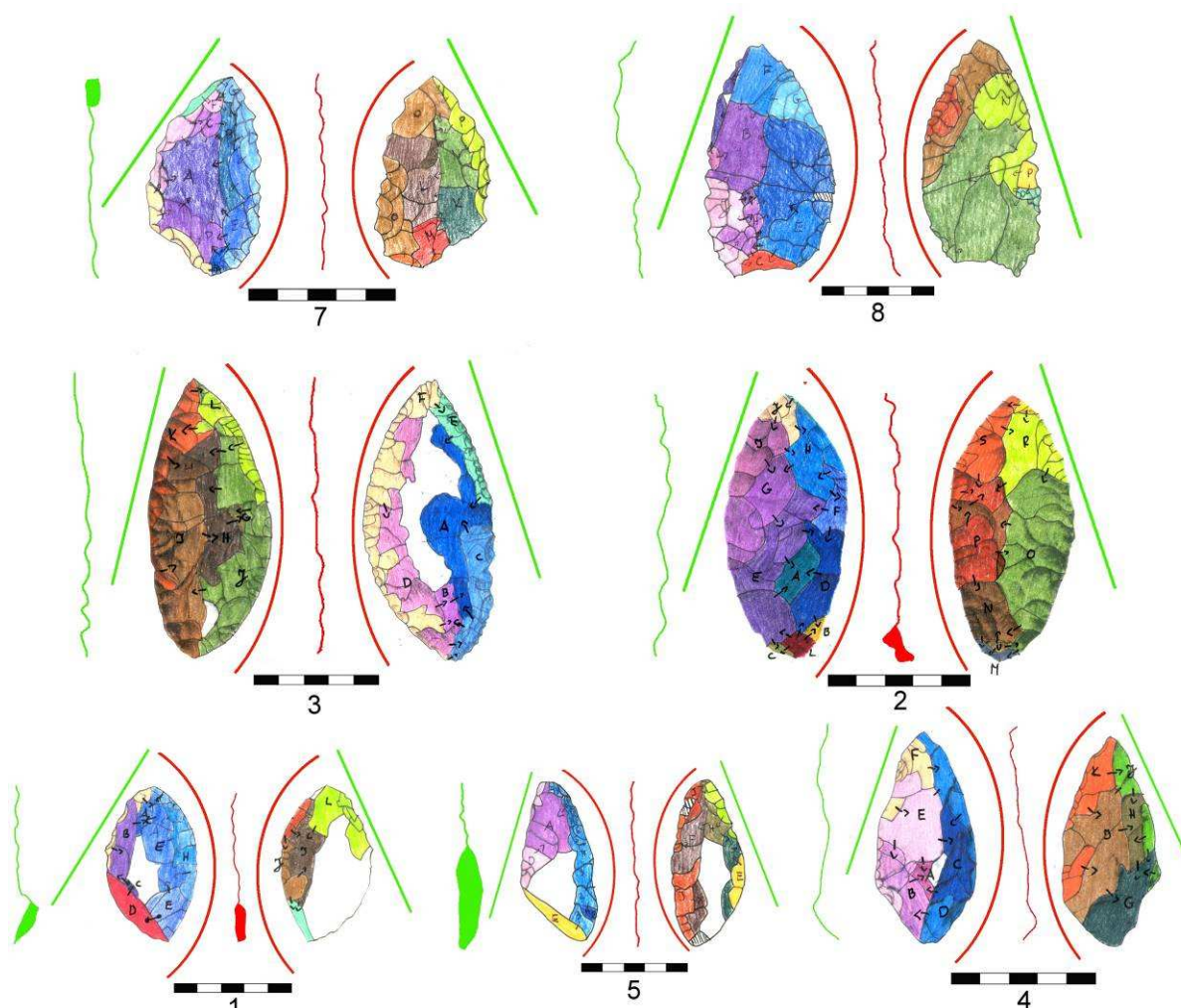
The analysed Lenderscheid artifacts are characterized **by the presence of transversal fractures which were made during the tool's formation process**. A hypothesis can be proposed that the artifacts were re-worked and repaired after an accidental breakage, and the intensity of their use could then point to shortage of raw material. However, it is worth underlining that the tools do not have intense, repeated repair series of the edge or near-the-tip parts, and they themselves are quite large. The argument related to size does not seem to support neither the thesis nor the significant intensity of tools' exploitation and knapping. It is also worth noting that very often the fractures and notches were created during the tool knapping process, and not after its completion. Such course of action indicates that these tools, from the very beginning, were made with the preliminary idea of creating the base via a transversal fracture.



### 3.2.1.3.3. Kösten

From the Kösten site, 13 artifacts were analysed, including 9 complete forms and 4 fragments. Among the analysed tools two were not published (Kös6 and Kös7), one (P.48) is referred to as Fäustel in publication (Zotz, 1959a), while the remaining 10 were classified into groups of leafpoints (Zotz, 1959a; Rossbach, 1913). Eight tools from the collection of the Archaeological Museum in Munich were analysed, as well as 5 tools and their fragments, stored in the collection of the Institute of Archaeology at the University of Erlangen. Due to lack of inventory numbers on the artifacts from the collection in Archaeological Museum in Munich, the tools were given ordinal numbers from 1 to 8, together with the "Kös" prefix. In the description of Erlangen artifacts, their original inventory numbers were used (e.g. P74, Pa1302).

The artifacts from the Kösten site are made of lydite, which is subject to intensive patination, owing to which all the postdepositional removals and fractures are clearly visible in the form of black scars on the gray patinated tool surface.



*Fig.103 Kösten artifacts edges arrangement (numbers correspond to artifacts inventory numbers). Red line marks the convex cutting edge retouched on its entire length, green line marks the distal posterior edge with a retouch covering the near-the-tip parts.*

The tools were made on flat raw material slabs, as indicated by traces of cortex on both artifacts surfaces (Kös3, Kös5). The raw material used in the production of the described bifacial tools determined their small thickness (1.35cm on average) and size (the largest analysed tool is 10.3cm long and 4.2cm wide). Kösten tools are mostly plano-convex in cross-section and show significant edges asymmetry in vertical axis. The tools' plano-convexity results from the applied knapping scheme, which presumed deriving flat removals onto the lower face, followed by semi-flat or semi-abrupt removals onto the upper face. The above mentioned edges asymmetry is distinguished not only by lifting the tip from the tool vertical axis, or different edge profile (usually one of the edges is longer and more convex), but also by different edges treatment via subsequent removal series. One of the tools (Pa1302) is heavily bent in its vertical axis, the remaining tools are straight.

Some items such as Kös8, Kös5 or Kös1 have an unexposed tip, which is the consequence of edge knapping aimed at its sharpening, and later repairing, with the omission of near-the-tip parts. In some tools, the edge resharpener retouch overlaps with the tip as well; however, in the process of edge sharpening at the tip no care for the tip's profile and shape can be seen. An example would be the Kös3 artifact, which has a series of flat removals on tip. The removals were elongating and sharpening the edge but at the same time they were moving the tip off the tool axis.

The following techno-functional units can be distinguished on the tools:

**A) Cutting edge.** Most frequently longer and more convex of the edges, formed in a plano-convex scheme with flat removals on the lower face and semi-flat removals on the upper face, with a possible correction on the lower face. The cutting edge usually has several retouch series-traces of subsequent tool repairs, which led to edge profile irregularity increase. Then, it became more sinuous. For this reasons, both edges profile looks very similar in most tools. In consecutive removal sequences on the cutting edge, removals are derived orthogonally to the edge and, therefore, if the edge was slightly convex at the beginning of exploitation, subsequent removal series led to an increase in its convexity. In one case (P74a), there might have been a change in the cutting edge. As a result of an abrupt F sequence retouch (Pl.114), the edge which probably had been a cutting edge beforehand, became blunted and either the retouch moved to the other edge or the tool was abandoned at this stage (Fig.103).

**B) Distal posterior edge.** Opposite to the cutting edge; usually the shorter tool edge. Its typical feature is the division into two parts. The part closer to the tip has a retouch and is formed analogously to the cutting edge (apart from the Kös8 artifact, whose distal posterior part's edge was blunted with semi-abrupt removals at the beginning of tool formation). The edge closer to the tip converges with the cutting edge and forms a tip. If the tool was knapped more precisely (such as P74, P75), then the tip is well exposed. In other cases, the distal posterior part's edge retouch was limited to the edge solely, it did not overlap with the tip as a result of which the tip move off the vertical axis (Kös5, Kös3). In one case (Kös6), one deals with performing removals derived at the tip, along the vertical axis and the edge. This caused the formation of a transversal edge on the tip, which was next retouched and repaired. Closer to the base, the distal posterior edge is knapped less diligently and more sinuous in profile. This tool part is also usually not concerned by repairs (Kös2, Kös3), or the repairs are aimed at this part directly, so as to change its shape (see notches creation at the base in Kös6–Pl.109, or blunting with a steep retouch in Kös7 (Fig.103.7—in yellow).

**C) Base.** The tools base was formed with abrupt tool-blunting removals, forming a separate surface (Pa1302, Kös2, Kös8, Kös5). Some do not have any base and both their edges converge at the base end (Kös3). In Kös3, the base is thicker than the tip and is

characterized by the absence of repair sequences and an abrupt edge retouch. However, both tool ends look much alike in a horizontal projection.

The Kösten tools are specified by the absence of a back exposed as the tool's separate surface. As well, the edge termed as the distal posterior part for the needs of the dissertation is formed in such a way, so as to form a sharp edge, solely at the tip. These tools have, therefore, one and a half of a cutting edge. The distal posterior part and the base are characterized by smaller removals precision and lack of repairs-edge-sharpening retouches. At the same time, taking into account small thickness of nodules on which the tools were made, one can try to derive an analogy to the Mauern site, where tools retouched on both edges and their entire length were also dealt with. Similarly to the case of Mauern artifacts, the edge morphology supports the hypothesis that the Kösten tools (at least some of them, such as Kös3, P74, P74a, P75, Kös6, Kös2) were formed as tools for hafting. It may be also indicated by very deep truncations on the distal posterior edge, close to the base on the Kös3 tool.

The knapping of all Kösten tools displays certain common traits. The knapping process can be divided into three stages:

**I. Surface formation.** Extensive series of flat removals, partly decorticating the tool and forming the shape of its surface, mainly a flat lower face and a convex upper face. The removals were performed perpendicularly to the tool's vertical axis. Due to the numerous repair traces, not all tools have visible removal sequences from this knapping stage. Wherever it was possible to reconstruct sequences chronology, knapping proceeded in a surface surrounding scheme. Usually, the lower face is formed as the first one and then the upper face (e.g. Kös3, Kös8, Kös5). The only exception is the Kös4 tool, which was formed in an edge/surface analogical scheme of knapping, according to a plano-abrupt manner. Further knapping of this tool was done in the same way, which caused the tool to be biconvex in cross-section and relatively thick at the base (only the tip part was successfully thinned).

**II. Edges formation.** Done in a surrounding scheme of knapping (Kös6, P74, Kös3), or an edge scheme of knapping (P48, Kös4). However, in both cases the cutting edge was retouched at the end of the scheme. In some tools, it is difficult to separate the edge formation phase from the earlier phases (Pa1302, Kös2), or later repair phases, especially when dealing with a heavily exhausted tool (Kös7, P75). Removals at this stage are adjusted to the particular edge's functions. The removals are, then, abrupt and blunting near the base and flat on the lower face, especially on the cutting edge. The distal posterior part is formed with removals larger and less precise than those on the cutting edge. At this stage, removals are derived on the cutting edge perpendicularly to the edge itself, thus creating the edge-line convexity (Fig.103.1,2,3,8).

**III. Repairs.** On each of the analysed artifacts, one can observe at least two tool repair phases. The repairs most frequently concerned the tool's near-the-tip part and the entire cutting edge. The repair was carried out mostly in an edge scheme by deriving flat, thinning removals on the lower face, which formed an angle for further retouch series on the upper face. At the end and if necessary, small correcting removals were performed on the lower face. The tool repair, though it usually entailed the entire tool on both faces, was focused on the retouch of cutting edge and distal posterior part's edge. Nonetheless, the cutting edge retouch was more precise and often concerned the entire edge (Kös3, Kös5 Kös7).

The repairs could result not only from the need to sharpen the edges, but also from the necessity to re-work the tool after the breakage. Such situation is encountered in two cases. The P74a tool was broken (N sequence–Pl.114), then the tip was retouched again (H, G, F, L sequences–Pl.114), and was probably exploited until its tip fracture (E sequence–Pl.114). A similar situation is present in the Kös8 tool. The tool was broken probably due to a repair



(deep removal on the edge-sequence I–Fig.103.8–in pink). After the breakage, both fragments, the tip and the base, were repaired. At the base, what has been a distal posterior part so far, became a cutting edge (O, P, J sequence–Fig.103.8–in bright pink and yellow).

Based on the conducted analyses, one can state that the Kösten tools are characterized by:

- asymmetry in morphology, edge knapping and repairing manner,
- lack of care for the tip, characterized by lack of its exposure due to absence of removals at the tip, or the presence of retouch series at the tip, which led to moving the tip off the tool vertical axis,
- lack of sequences aimed at correcting or shaping the tool with regard to, e.g. increasing its symmetry,
- production and repair sequences aimed at the creation of working edges; both the production process as well as the removals character reveal significant differences in the treatment of different tool parts' edges,
- tools were repaired at least several times, in repeated schemes,
- repairs most often concerned the tool's tip parts,
- tools show asymmetry in both faces treatment, where the lower face is formed flat, and the upper face convex, and it is on the upper face that the retouch sequences are derived (except for Kös4),
- significant standardization of tool knapping schemes, which at the stage of tool formation was done in a surrounding scheme, and at the repair stage–in an edge scheme.

Based on the above description, it can be concluded that none of the analysed Kösten tools was inherently symmetric. In their knapping process, there is **neither evidence of care for the tool shape** (apart from Kös3), **nor for their symmetry and tip**. Moreover, **these tools bear traces of repairing/resharpening, which resulted in changing the edge shape**. During the repairs, there is a visible lack of care for tip exposure, and for maintaining symmetry, which clearly indicates the randomness of Kösten tools symmetry.

#### 3.2.1.3.4. Mauern (Weinberhöhlen)

The technological analysis covered 21 artifacts from the Weinberghöhle site in the Altmühl Valley. The artifacts are currently stored in Archäologische Staatssammlung in Munich. Of the analysed specimens, 19 are referred to as leafpoints or their fragments in the literature (Bohmers, 1951; Zotz, 1959b; Zotz, 1955). Two forms (1951\_641 and 1951\_663) were defined as various types of knives (Bohmers, 1951, Taf. 35,41). It was decided to examine several knives in order to compare their production technology.

The artifacts differ from one another in terms of morphology, mainly the size and shape. The longest specimen (1951\_619) is 14.6cm long, which makes slightly more than half of its original length. The smallest tool, almost completely preserved, is 5.6cm long. All the artifacts of Mauern are plano-convex and characterized by small thickness, which was caused by using very thin slabs of Plattensilex. The average thickness of Mauern tools is 0.93cm. The tools were made on very thin slabs (about 1cm thick) of flint, surrounded on both sides with cortex of about 2–4mm thickness. The form of a tool was conditioned to a large extent by the kind of used raw material. Also the manufacturing scheme had to be based on flat, extensive removals which formed bifacial tools.

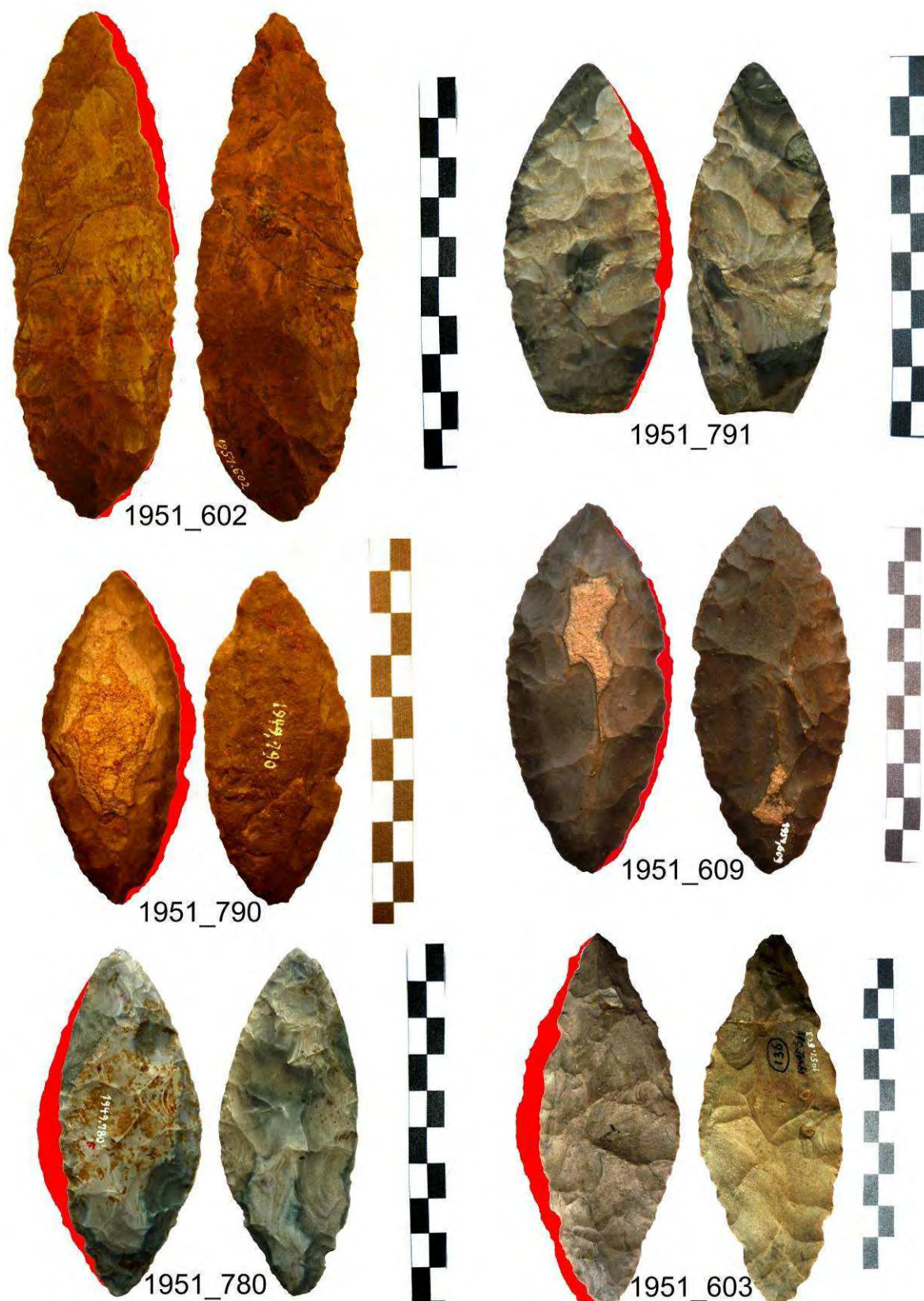
All the analysed tools are characterized by significant technological cohesion. Even forms different in terms of their usage were knapped analogously (see e.g. the 1951\_641 and 1951\_602 tools). However, the tools can be divided into three major groups. Two tools (1951\_663, 1951\_641) do not fall into any of the groups and so they will be described separately.

#### **Group I**

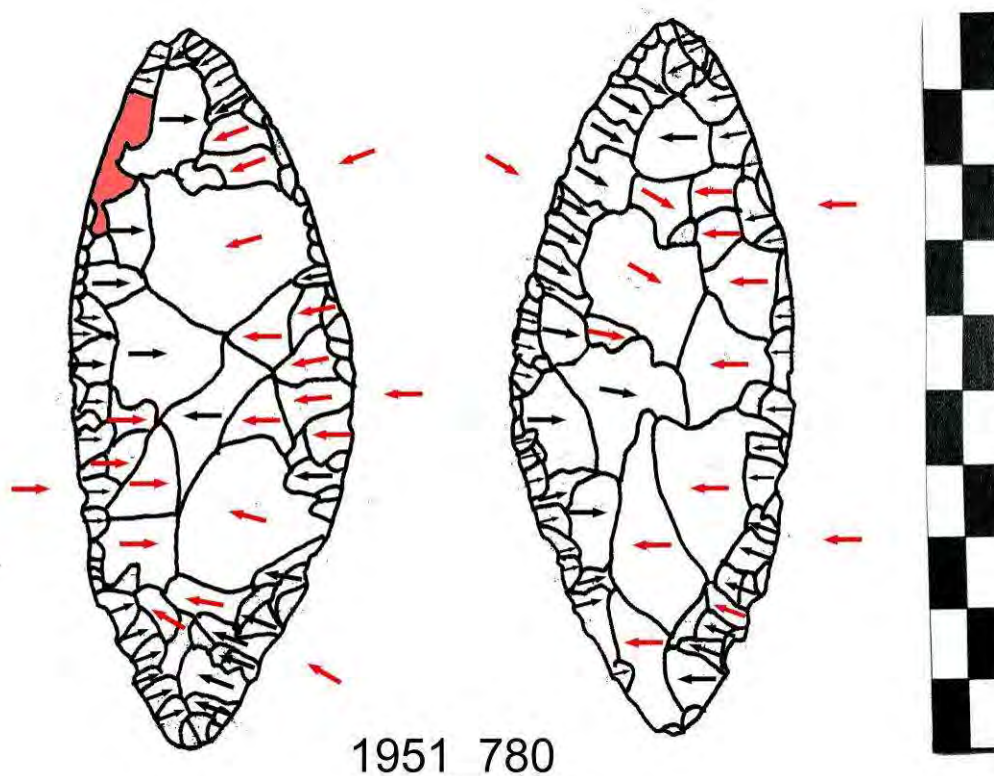
The first group includes six tools, among them: 1951\_602, 1951\_603, 1951\_609, 1949\_790, 1949\_780, and 1949\_791. Five of the artifacts are complete specimens, one (1949\_791) has a base broken at about 1/10 of its height. This tool was retouched afterwards near the fracture angle. The described artifacts are characterized by slight edge asymmetry (one edge is slightly more convex than the other one (Fig.104). In two cases (1949\_780, 1951\_603), the asymmetry is more visible and the more convex edge even has a biangular profile. The last two tools are also characterized by much clearer base/tip exposure.

The artifacts 1949\_780 and 1949\_791 had gypsum fillings at the edges which made it difficult to analyse them properly. Due to the courtesy of the Archaeological Museum in Munich, it was possible to remove the fillings. They were also removed from the 1949\_788 artifact, which is included in group II. As revealed in the analysis, the fillings existed in the notches whose location corresponds well with the remaining notch system in the artifacts included in group I.

In case of the 1949\_780 tool, one can be sure that though one of the percussions (which created a notch) is postdepositional, earlier notch-creating percussions are older than the marginal retouch derived along the edge, therefore they were derived during the manufacturing process. Thus, it can be assumed that in this case, part of edge underwent postdepositional truncation within an existing notch. In case of the 1949\_791 artifact, nothing indicates that the maintenance of the filled notch had postdepositional nature.



*Fig.104 Group I tools shape classification with marked edge profile asymmetry in vertical axis.*



*Fig.105 Removal directions on group I tool. The scheme shows different treatment of both edges already at tool shape formation stage (red arrows).*

In the aspect of distinguished techno-functional parts, the tools do not show differences in terms of edges. It is even difficult to say with complete certainty which tool end was used as the tip and which as the base. Only the 1951\_602 tool has a more rounded base, whereas the tip here is more exposed. For the purposes of analysis, the thicker and less knapped tool end was called the “base”. However, the example of another tool group may indicate that these tools could have had two tips, which were used interchangeably. Both edges were equally retouched and have similar profiles. The retouch and removals near the tip are generally smaller and more precise. The tip is exposed. In one case (1951\_609), the tip was blunted and moved off the tool vertical axis with a series of small and steep removals. Two tools (1949\_780, 1949\_790) have notches formed by steep, deep scars near the tip (Fig.104).

In these tools one cannot see any differing edge treatment due to removal types. What is interesting is the fact that removals were performed at a different angle in relation to each edge. One of the edges was formed with removal series perpendicular to vertical axis. This led to the creation of a straight vertical edge. The other edge was formed with angular removal series in relation to vertical axis, creating a convex edge (Fig.105). The difference in both edges treatment appears already at the stage of edge forming and is then continued at the stage of edge retouching. Both edges were formed in parallel at each production stage. What appears to be also typical is both surfaces’ different treatment. One face is flat and has no retouch, whereas the second is slightly convex and displays all the retouches. For the purpose of analysis, the convex face was agreed to be the upper face.

Tool knapping proceeded in four stages:

**I. Surface formation.** Flat extensive removals were performed onto both tool faces. Their purpose was not only surface formation, but also nodule decortication. Shaping at this stage proceeded in an edge scheme of knapping, which was repeated at subsequent manufacturing stages. The scheme was applied in a bottom-top-bottom-top manner by introducing flat removals onto the lower face and semi-flat onto the upper face. All of this was done on one and then on the second edge. It seems interesting to note that the convex edge was treated as the second, whereas the first to be knapped was the more vertical one. Surface formation done in the described scheme can be observed in tools 1951\_603, 1949\_791, 1949\_790. The 1951\_609 and 1949\_780 tools at this stage were treated in a surface surrounding scheme of knapping, where the first to be formed was the lower face and next the upper face.

**II. Edge formation.** At this stage, differences in the treatment of both edges manifest themselves. As already mentioned, one of the edges is formed with series of perpendicular removals, which reinforces the formation of a vertical edge. The second edge is formed with angular removals which make it become more convex (Fig.105). Removals in an edge scheme of knapping were applied along the edges, according to the scheme described previously (1951\_603, 1949\_791, 1951\_609) or in a surrounding scheme (1949\_780, 1949\_790).

**III. Edge retouches.** The edges were retouched in a bottom-top edge scheme. A flat removal series applied onto the lower face preceded a marginal retouch series. The marginal retouch is semi-flat. After the marginal retouch, a series of small, edge profile correcting removals can be done on the lower face. Only the 1951\_602 tool bears traces of both edges' alternating retouch. The second retouch series, especially on one of the edges, caused its partial blunting. The remaining tools bear no repair signs.

**IV. Notches.** At the end of the manufacturing process, notches were formed. Some of them, made with a single semi-abrupt removal could be treated as postdepositional damages; nonetheless, their identical location on subsequent tools can indicate their intentional nature. The tools have at least three notches, of which in case of the 1949\_790, 1951\_609 tools one is located at its base/tip, the other two on the edges. A similar notches arrangement is found in 1949\_791, but the very tool base was not preserved. The 1949\_780 and 1951\_603 artifacts have notches near the base on both edges where they are located almost analogically (Fig.106). The notches might have occurred either during the use, or be the trace of tools hafting. The second option is implied by their location.

The tools show no signs of intensive repairs, which may be due to the fact that the next retouch series would only cause total edges blunting. Small slabs thickness prevented any attempts to renew the edges angle by means of removals onto the lower face. An example can be the 1951\_602 tool, for which the subsequent retouch series of edges led to their partial blunting. Thus, only minor edge elements, such as the tip of 1949\_791, or the edge closer to the tip in 1951\_609, show signs of resharpening.

The tools display traits of care for their shape. The angular sequences at the very tips resulted in the creation of convex edges converging at the tip. However, greater strain was put on edge profile, even though tool symmetry could have been achieved at a very small expense. For example, in the 1949\_780 or 1951\_603 tools, additional retouch series could have led to a better tip exposure and its return to vertical axis. Such action is visible on the 1949\_791 tool, the last two sequences of which concern the tip parts only, causing its sharpening, increasing the symmetry, as well as its better exposing.

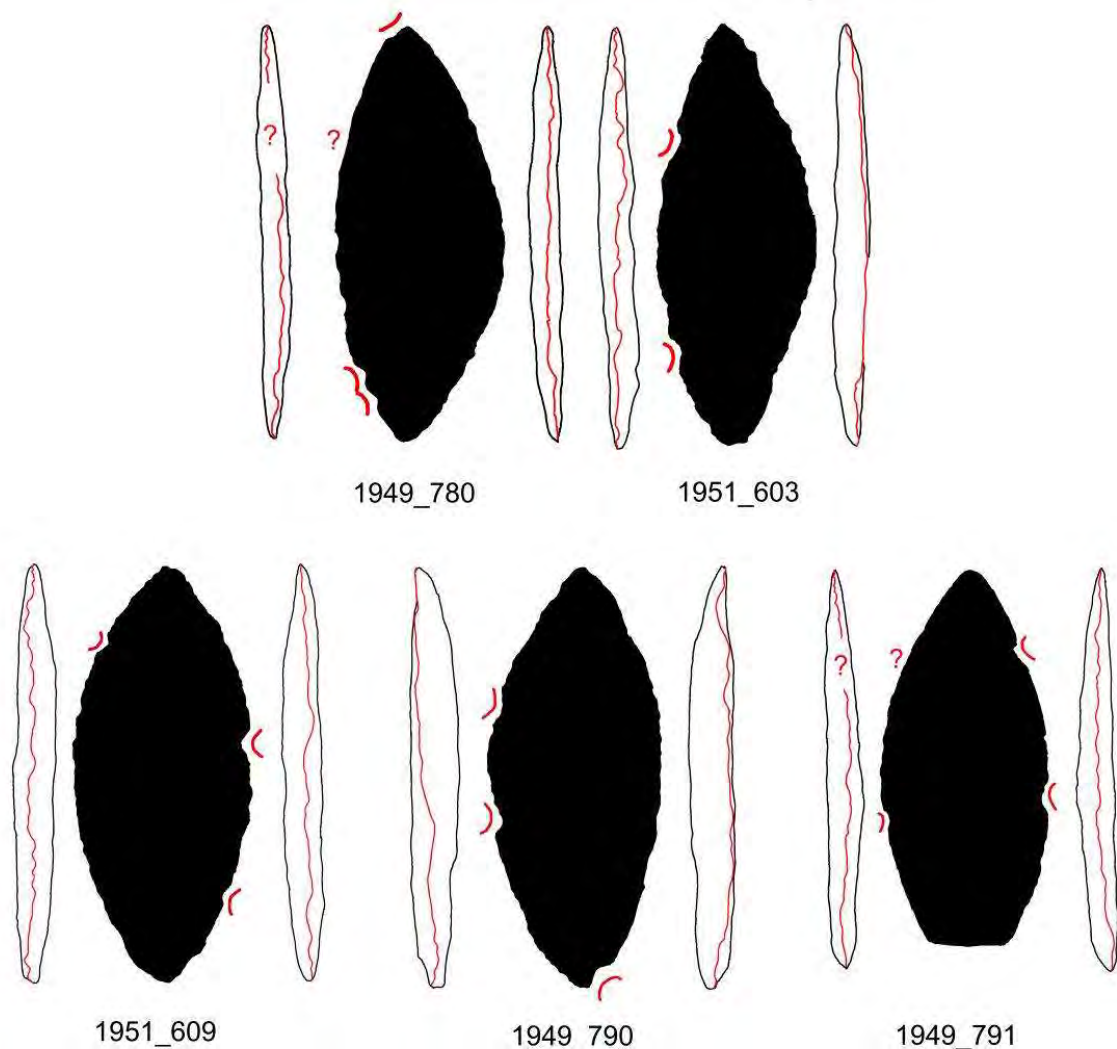
The tools of group I exhibit asymmetry in vertical axis, lack of care for the tip (except for 1949\_791). More attention was devoted to edges profile than to their symmetry. The tools also have series of notches on the edges, the base or the tip. At the same time, the tools are



knapped very precisely. Both edges are treated in a parallel manner. No traces of preference for any edge in particular are visible (except for a different removals angle, which creates bigger convexity on one of the edges; it is difficult, though, to find an explanation for such edges treatment).

In addition, however, the tools are largely symmetrical in horizontal axis—the tip was treated analogously to the base.

The construction of group I artifacts suggests **that these tools were used in hafts**. As a matter of fact, all their edges are sharp and the tools not **only do not have the back**, but also, in most cases, the base, which could serve as a handle. Therefore, the tools were shaped and made with the idea of hafting. Hence, probably the notches and truncations may be traces of tool hafting or its working in the haft. The arrangement of notches suggests that first one of the tips could have been used, and then the tool was rotated and the second tip was at work. This might be indicated by **equal treatment of both tool ends, as well as both edges on their entire length**.



*Fig.106 Positions of notches in group I tools and the line of both edges.*



## Group II

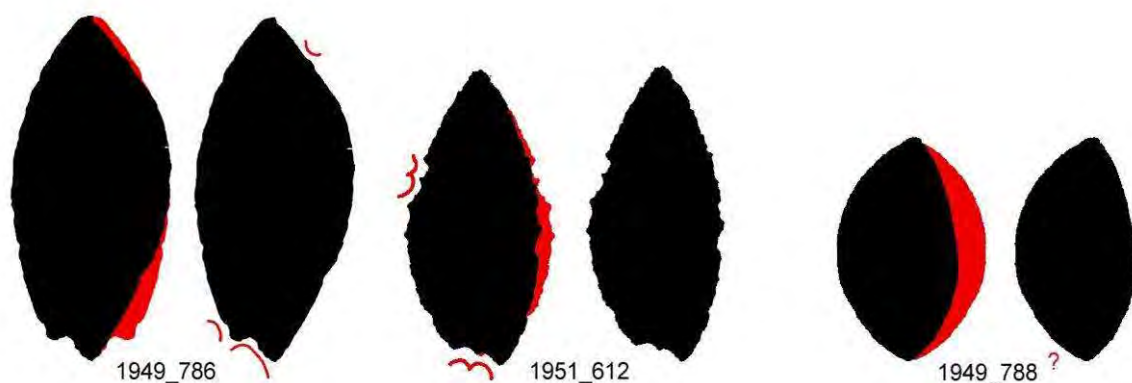
The second group of artifacts includes three tools: 1949\_788, 1949\_786 and 1951\_612. Two of them were made on flakes (1949\_788, 1951\_612). The size of 1949\_788 indicates that it was made on a flint slab. The tools vary greatly in size. The largest of them, 1949\_786, is 11cm long and 5.5cm wide, and the smallest, 1949\_788, is respectively 5.6cm long and 3.1cm wide, with a maximum 0.7cm thickness. The tools, just like all Mauern artifacts, are characterized by very small thickness in relation to their length.

A characteristic feature of the described tools is significant edge asymmetry, of which one is much more convex than the other (Fig.107). In this respect, the artifacts resemble the tools from group I, but what distinguishes them is above all the production technology, which might have led to such different arrangement of both edges.

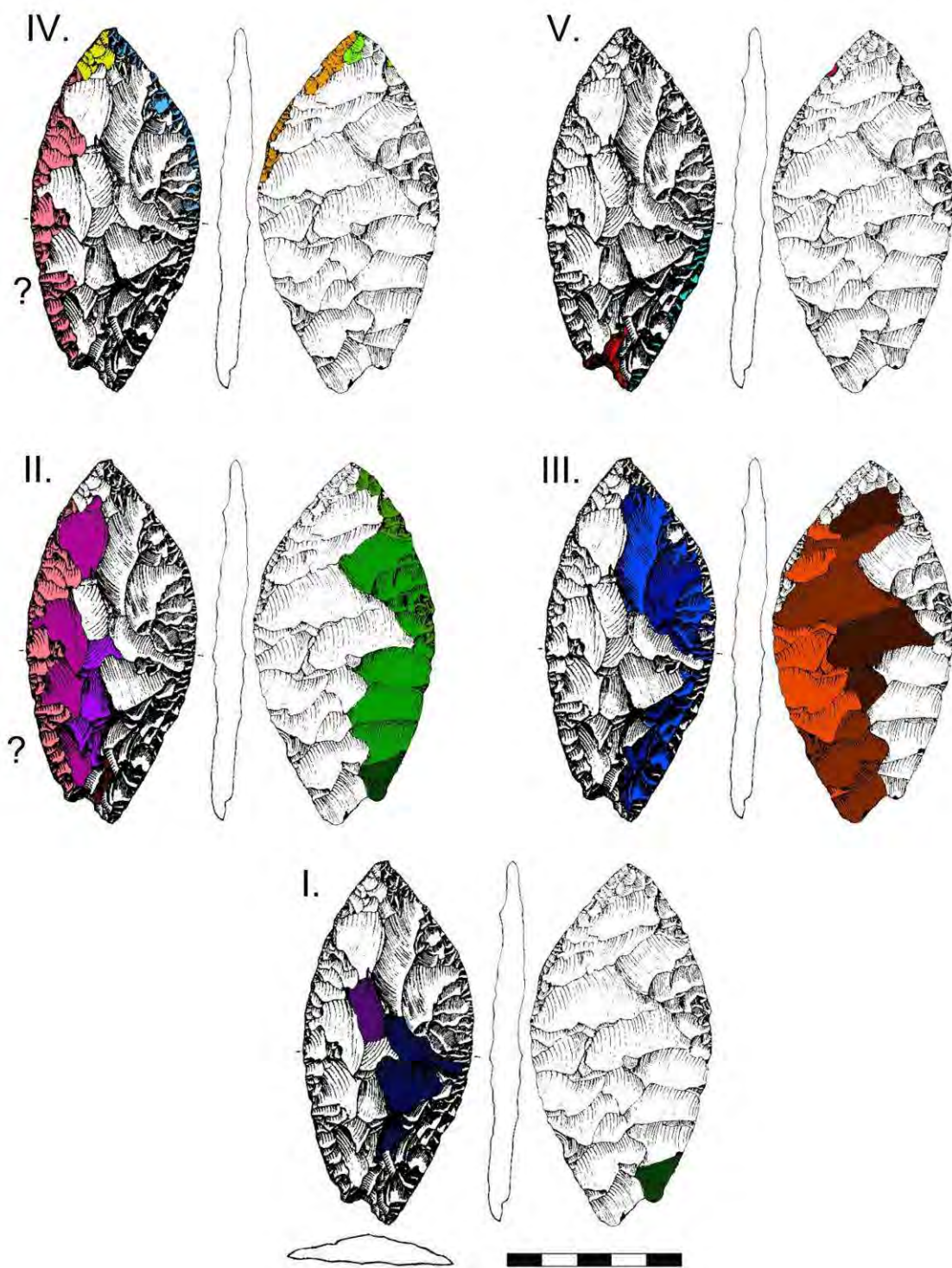
From the perspective of retouches, both edges are treated equally and have a similar, straight profile. One can notice significant care for a straight edge profile throughout its entire length, from the tip to the base. The tip, due to edge asymmetry, is not in the tool axis, and it is well exposed. The artifacts reflect a tendency for lack of a marginal retouch at the very tip, perhaps due to the care for edge profile, which would indicate greater attention devoted to the edge profile than to the tip itself. As a result, the tip is slightly exposed but not retouched.

Additionally, the 1949\_786 and 1951\_612 tools have a characteristic big notch located at their base on one of the edges. The notch is formed with several semi-abrupt or abrupt removals and also has traces of usewear. The process of notch knapping removes the base off the tool axis and exposes it at the same time (Fig.107). The 1949\_788 tool has multiple postdepositional fractures and during maintenance procedures it was glued together and subjected to addition of gypsum in place of the missing components. By courtesy of the Archaeological Museum in Munich it was possible to remove the gypsum and observe the entire artifact. Hence, the very base of the tool is missing, which makes it impossible to see whether the tool had a notch at the base or not.

It is interesting that all artifacts classified into group II have a very similar knapping scheme. This regime can be described as a consequent edge scheme of knapping, where the tool, after initial manufacturing, was knapped on one edge from the moment of shaping until its marginal retouching. Only then the second edge was formed, from surface formation to edge retouch. In case of flake tools, knapping was limited to edges formation and retouches.



*Fig.107 Comparison of group II tool shapes with marked edge profile asymmetries in vertical axis, and with notches on the edges.*



*Fig.108 Consequent edge scheme of knapping of the 1949\_786 tool. Phase I–surface formation; phases II and III edge formation from extensive removals to probably marginal retouch series; phase IV–repair; phase V–notch formation.*

The most consequent edge scheme was applied in the 1949\_786 tool, where the convex edge knapping begins with extensive removals forming the surface on the lower face, right after forming, shaping and correcting removals or maybe even after a marginal retouch of the opposite edge (Fig.108).

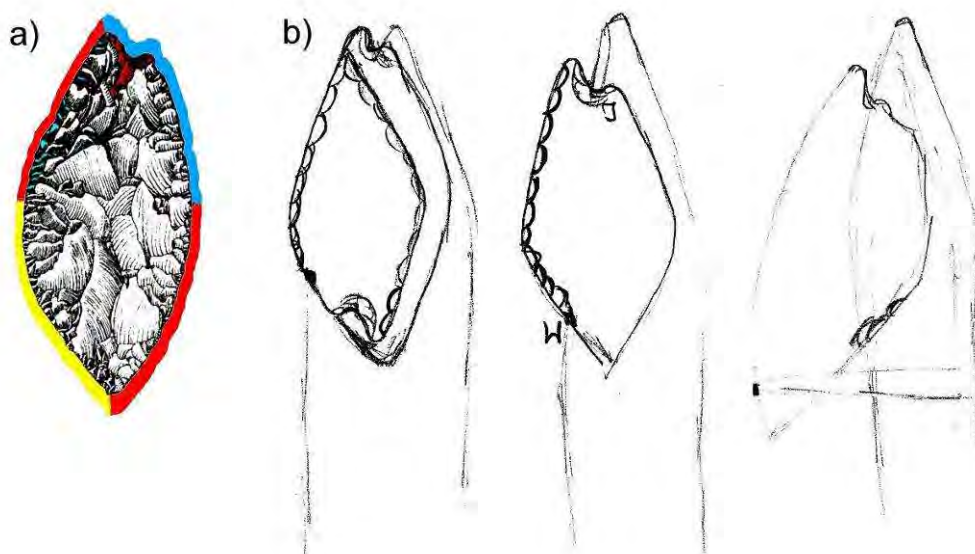
The tools are also characterized by different treatment of both tool surfaces, one of which is flat, and the other one is convex and retouched. Each knapping stage follows a bottom-top scheme, where flattening removals are derived on the lower face, whereas the upper face is formed with semi-flat removals and retouches. A slightly different situation is observed in flake tools where the straight, sharp profile of unretouched flake's edge was used as much as possible. Hence, deriving removals onto the lower face was avoided through performing semi-flat removal series onto the upper face only. The lower face correction was limited to the near-the-bulb part of a flake and, for tool 1951\_612, also to one edge. It is worth noting that the more convex of tool edges does not have, in both cases, removals onto the lower face. These tools could have been made more symmetrical by performing a series of removals onto the lower face, but the removals would have made the edge profile more S-shaped, which, as it seems, was avoided. This may indicate that for the described tools, the retouch and straight edge profile were more important than the tool symmetry in itself.

From the point of view of reduction sequence it appears to be an important fact that the steep notches at the base were made during the manufacturing process. In the 1951\_612 tool the notch appeared before knapping the other edge, and in case of the 1949\_786 tool, after the notch had been created the edge fragment at the base, placed on the edge opposite to the notch, was retouched very precisely. Also in case of the first described tool (1951\_612), the retouches focused on the near-the-base edge, opposite to the notch. An analogous retouching scheme in relation to the created notch as well as identical notch location and morphology suggest that these tools represent a similar way of tool using and, probably, its hafting. The following figure shows a hypothetical reconstruction of how these tools were hafted (Fig.109).

Parallel to that, it ought to be underlined that on the 1949\_786 tool, two zones differing in terms of usewear can be distinguished on both edges. This may likely be the trace of usewear. The parts located directly near the notch do not have traces of usewear, in contrast to the part of the same edge located closer to the tip which has traces of intensive usewear, visible even without magnification. On the other edge the usewear is very clearly visible on the part of the edge located near the notch. The part closer to the tip has a less intensive usewear (Fig.109a). Such distribution of usewear may suggest not only the tool hafting method, but also the fact that the edges could have been used interchangeably. Perhaps, therefore, first after retouching one of edges a notch was created at one of the tips. Then, after edge blunting, the manufacturing and retouching of the second edge were done by removing the previous notch and creating a new one on the opposite end (Fig.109b). Hence, one can assume that the state in which the described artifacts can be seen today is only the final stage of entire tool using and reshaping scheme.

There is no direct data pointing to the presence, at earlier knapping stages, of a notch placed at the second tip. In case of the 1951\_612 and 1949\_788 tools, its existence is impossible due to very little flake thickness in its apical part. However, even with the second notch absent, it is a fact that in case of the 1949\_786 tool, first the apical part of edge I was subjected to intensive use. Then, the second edge was formed and retouched, and the part at edge's II base was used. The tool in this respect is, therefore, its own mirror reflection in the diagonal axis (Fig.108, 109a), which can be explained only by changing the tool's orientation and changing the base into the tip.

If the described tools are to be regarded as forms with only one edge used at a time, then the question arises as to the described tools' ergonomics, and mainly the 1949\_786 tool. What was, then, the purpose of such precise convex edge line formation and tip exposure, if at that time only half of one edge and tip were used?



*Fig.109 Artifact 1949\_786. a) Usewear placement on the edges. Red marks edge fragment with intensive usewear, yellow—less intensive usewear, blue—edge without usewear. b) hypothetical hafting of group II tools according to visible notches and usewear placement. The scheme depicts two usage phases with one tool edge being used first, and the other one next.*

Comparing the amount of effort put into the formation of both tools (1951\_612 and 1949\_786) with the final effect in the form of cutting edge length, one can have doubts as to the validity of presented tool hafting reconstruction. On the other hand, the notch diagonal location, with no technical obstacles for forming a transversal notch which would enable vertical tool hafting, allows for a hypothesis that the artifacts were hafted diagonally.

What is characteristic of the described artifacts is:

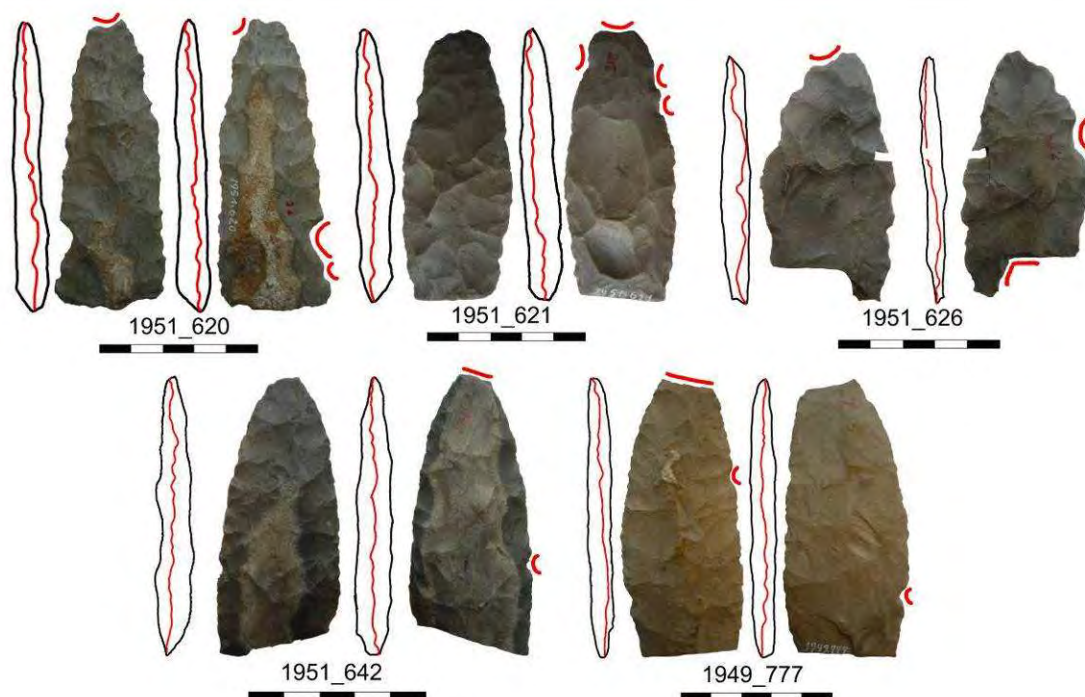
- edge manufacturing scheme, focused on obtaining a long, convex edge,
- mirror placement of edge sharpening retouch and usewear in diagonal axis (Fig.109a).

The observed edges asymmetry is probably related to their edge scheme of knapping and their non-parallel manufacturing process. This means **that the edges were formed from the beginning until the end first one of them, and next the second**. Such manufacturing process indicates that **the edges and their profile in the described tools were more important than their symmetry**, which might have even not been taken into account. The edges, then, do not have shaping sequences. Every consecutive sequence follows the edge shape formed by the previous sequence, only slightly affecting the overall edge shape. In case of these tools, **getting a straight edge profile appears to be a major feature in relation to the rest of tool**. Also, the system of notches, with a large notch at the base, indicates that at this point, for the purpose of producing or resharpening one of the edges, it was possible to partly remove the opposite edge or blunt it by producing a series of notches (1951\_612).

### Group III

The largest group consists of broken tools which were retouched and rejuvenated after breaking. This group includes 10 artifacts (1949\_777, 1949\_787, 1951\_604, 1951\_607, 1951\_618, 1951\_619, 1951\_620, 1951\_621, 1951\_626, 1951\_642).





*Fig.110 Group II tools shape comparison and edge profile scheme. The scheme also shows notches placement.*

These tools have two edges processed in parallel and treated with identical types of removals, one of the edges is usually more convex but it is not a rule (1949\_787, 1951\_620, 1951\_621). Only two tools have an exposed tip (1961\_618, 1951\_604). In three cases, the tip was broken (1949\_787, 1951\_607 and 1949\_777). The tool 1949\_777 has a usewear retouch at a fracture scar at the tip. It may reflect using the tool after the tip had been broken. In five other tools there are visible removals derived from the tip and causing its partial (1951\_619, 1951\_642) or total blunting (1951\_620, 1951\_621, 1951\_626).

The tools, like other bifacially worked artifacts from Mauern, are plano-convex, which is the result of different tool surfaces treatment. At the same time, as already mentioned, edges were formed simultaneously during tool manufacturing process and also, after the breakage retouch is derived analogously onto both edges.

All artifacts included in this group have transversal fracture scars at the base (Fig.110). Most tools were broken in about half of their length. Only the 1951\_604 tool has a fracture in 1/10 of its height, and the 1949\_787 tool was preserved in more or less 1/3 of its height. Each of the described artifacts was retouched after fracture. It is interesting that in 7 cases, the fracture appeared after the edge formation stage. All the retouching was done only after the transversal fracture. In the reported cases, both edges as before the fracture, are treated in parallel, by receiving a retouch.

These tools show no signs of earlier retouching. Only the 1951\_604, 1949\_777 and 1951\_618 tools, have retouching sequences made on one of the edges before breaking (or the analysis did not allow to establish with full certainty that retouching was performed after fracture). In all three cases, the second edge is retouched after fracture, whereas there are no traces of post-fracture repair applied on edge I.

In three cases (1951\_619, 1951\_620 and 1951\_621) one can find an impact point on the fracture scar. In 1951\_619, it was derived from the middle of the lower surface, and in two

other cases from the middle of the upper surface. In the last two cases, marginal truncations caused by percussion can be seen on the fracture scar.

All of the presented features, that is: the transversal fracture, impact point visible on some fracture scars, no retouching or partial retouching before breakage, parallel retouching of both edges after breakage or the retouch of an edge non-retouched earlier, indicate that these tools had been intentionally broken after the edge formation stage. Subsequent production stages and edge retouches, ran analogously to those in, e.g. group I tools. It therefore cannot be said that the described tools were reshaped after fracture and that their original concept was different from the ultimate effect.

In addition to that, 8 tools of group III have notches on the edges which are similar to those observed in other tool groups of Mauern (Fig.110). Two of the tools do not have such notches, but 1951\_604 tool has a denticulated retouch on one of its edges.

From the perspective of manufacturing process, the tools were formed analogously to group I tools.

**I. Surface formation.** By performing flat, broad removals on both surfaces. At this stage, two knapping schemes were used. Edge scheme of knapping, in which first removals on the lower, and then on the upper face were derived (such scheme is observed in the 1951\_642, 1951\_618, 1951\_619 tools). The 1951\_626 tool has an analogous, but a reversed top-bottom scheme. Perhaps in this case, at some stage the tool faces were changed (during the analyses, the upper face was estimated to be the one retouched at final repairs stage). This tool is highly worn, has numerous repair traces and a retouch onto both faces. It can therefore be assumed that its orientation changed several times. The second applied surface formation scheme was a surrounding scheme (1951\_621, 1949\_787), with a clear tendency for the formation of the lower face first, and the upper face next.

**II. Edge formation.** At this stage, edge shape and profile correcting removals are derived. The removals are less extensive than during surface formation, but they go far onto the tool's surface. Their aim is also to thin the thickest blank parts. Removals are not performed along the entire edge length, but only where this is necessary. At this stage, two knapping schemes manifest themselves. Edges are treated in a bottom-top surrounding scheme (1951\_604, 1951\_626) or an edge scheme of knapping (1949\_777).

**III. Transversal fracture.** As already mentioned, an impact point is visible on three fracture scars. In the following four cases one can recognize that the tool was broken by a percussion introduced in the middle of either the lower or the upper face. In three cases, the scar is not clearly visible or its observation was not detailed enough to unambiguously determine the fracture's nature. Only in case of the 1951\_626 tool, one can judge by the fracture's outline and curved profile that the percussion could have been derived from the edge, though this is not certain. If the fracture scars required correction, its surface was additionally retouched (1951\_620, 1951\_604), or the angle between the fracture scar and the edge was removed with a series of steep removals (1951\_618, 1949\_787, 1951\_620).

**IV. Edge retouch and potential repairs.** Edge retouch was derived according to the previously applied bottom-top scheme, where a flat removal series on the lower face was done first, and then a convex surface was formed with semi-flat removals retouching the upper face. If necessary, a further series of minor edge profile correcting removals was derived along the lower face (1949\_787). The tools are, then, retouched on both edges to the upper face. Two of the described tools (1951\_620 and 1951\_626) have an irregular edge profile caused by applying a denticulated marginal retouch. This may indicate that the edges were repaired, and this caused their blunting. Additionally, the 1951\_626 tool was retouched



on both surfaces. The remaining tools show neither repair signs nor edge resharpening removals.

**V. Notches.** Eight of the described tools have notches along their edges (Fig.110). They differ among themselves in both their size and their creation intensity: from those with a single truncation on the edge up to those formed with multiple, steep removals (1951\_620). In most cases, the notch shows signs of wear, which can be the trace of usewear, or getting worn in the hafting process. In three cases, semi-steep or steep removals were derived on the tip, resulting in its removing and blunting, or even more, creating a notch on the tip (1951\_620 1951\_621, 1951\_642). The described notches may be related to the notches at the base observed in group II tools, and therefore could have been used for tool hafting the tool. This conclusion, however, is not a definite one.

Among the described artifacts, the 1951\_604 tool stands out (Pl.119). It was broken in about 1/10 of its height. Next to a transversal fracture on the base, it has a steep fracture scar on one of the edges. The scar was developed even before the tool's surface formation, and possibly conditioned the process of its subsequent knapping. The angle formed by that fracture hindered deriving flat removals on the lower face. Hence, the lower face at the base was formed entirely with flat, extensive removals derived from the other edge and crossing the entire tool width. It is not possible to determine definitively whether the retouch of edge with the fracture scar was done before or after base fracture; nonetheless, the other edge's retouch was created directly after its fracture. Both retouch series differ from one another for if the first is accurate and makes a straight edge, the one made after fracture is less regular and denticulated, especially near the tip. This edge is also more straight in profile but the retouch does not overlap with the tip itself, resulting in the tip being exposed, but unretouched, as well as moved off vertical tool axis.

One should take into account the fact that the described artifacts' shape was acquired by these forms after the base fracture. In addition to that, the artifacts are characterized by symmetry in both edges retouching process, as well as lack of retouching on the very tip, which moves it off the axis.

Even if group III tools were not broken intentionally, which seems to have been successfully proved above, they bear witness to the re-usage of failed preforms of other unfinished bifacial tools. The **post-fracture care for both edges**, with parallel **lack of concern for the tip**, or even its obliteration with steep removals, testify to the fact that these artifacts should be seen as **double working edge tools** (probably not at the same time, but interchangeably).

### Other tools

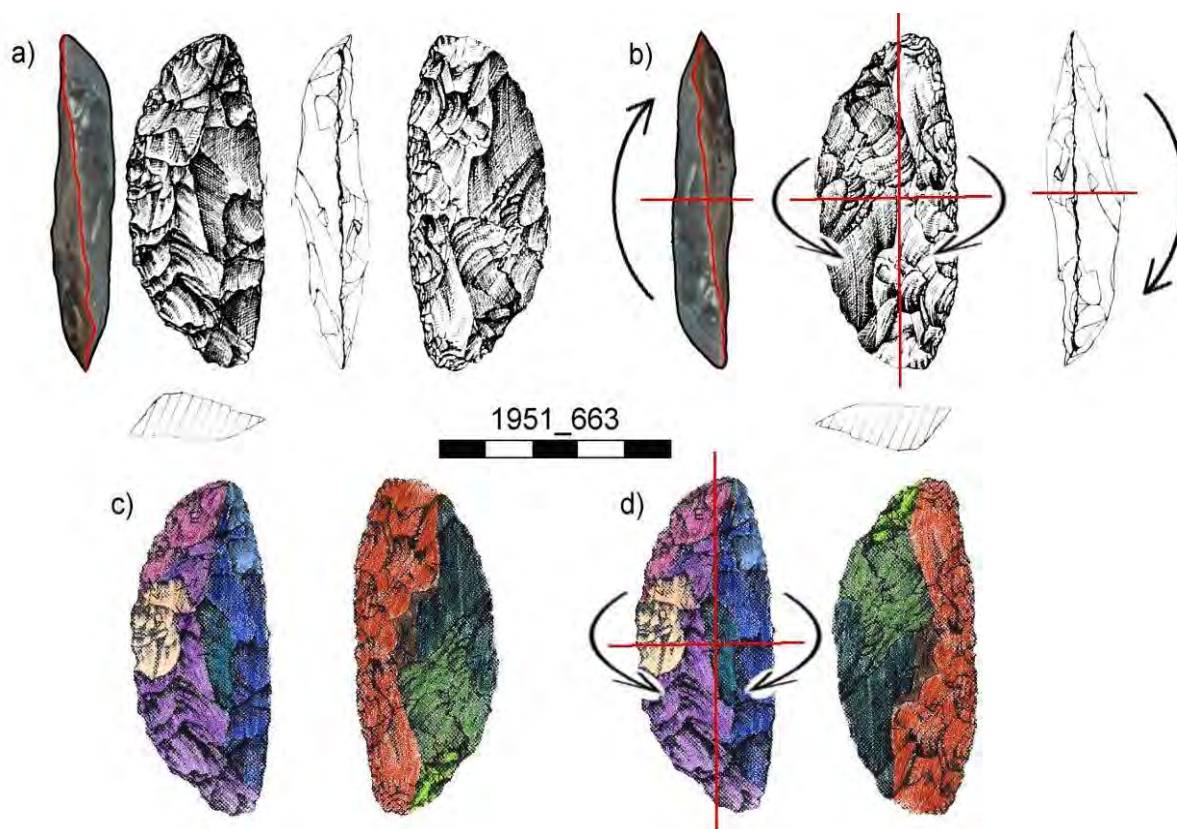
None of the groups can include the 1951\_641, 1951\_663 tools.

The 1951\_641 tool (Pl.128) is a triangular form with two retouched, convergent edges set at an angle of 55° to one another, and a base formed with a transversal fracture. The tool was found in two parts (tip and removed base), which allows to trace the entire process of its production. The tool was made on a flat, flint 1.7cm thick slab. Both edges were treated equally during knapping. Only the base was formed in a different way. It has a series of decortication removals, but they are less accurate and more steep than the removals derived on the edges. The tool was knapped in three stages. The first was decortication and surface formation. Knapping done in an edge scheme; however, unlike usual, it was commenced with semi-flat decortication removals on the upper face, then a series of flat removals on the lower face was introduced. At further stages of edges formation, knapping was done according to

the already known from other tool types bottom-top scheme where the lower face gets flat and the upper face semi-flat removals. At both stages, removals supposed to form the base's edge are also derived, though, as already mentioned, they are less precise. The third stage is an edge retouch repeating the scheme from prior stage. Both edges are equally retouched; there is no visible preference towards any of them.

After the edge retouch, the tool was diagonally broken and thus a diagonal base surface was created. The fracture scar indicates that the percussion was introduced from one of the edges. After breaking, the tip was neither repaired nor additionally retouched. Only very small percussions on the tip on the lower face might have occurred directly after the break. Even so, the tool base was knapped after fracture, probably in order to create another tool, however, at some point after several series of steep removals the base was abandoned. The tool is interesting in the respect that it has a huge angle between edges; but on the other hand, it has two uniformly knapped and retouched edges.

Another interesting tool is 1951\_663. This is a completely bifacially knapped tool with one edge straight and the other convex. The tool is equally knapped both at the tip and the base, both tip are unexposed. The manufacturing process can be divided into two stages. At the first one, tool surfaces were formed. Knapping proceeded in an edge scheme with series being derived on one, and next on the other face. In case of the described tool, the upper or the lower face cannot be considered since the tool, when convex at the tip, it is flat at the base and vice versa on the other face. Perhaps the faces formation is due to the original shape of blank used during production. Certainly, however, this shape was used to create a tool whose base is the mirror image of its tip after the tool's rotation by  $180^\circ$  (Fig.111). Its production was therefore performed in such a way that when rotated, the tool was still functional.



*Fig.111 1951\_663 tool edges arrangement scheme, the tool being symmetrical after its reorientation achieved through rotating it in its vertical and horizontal axes.*

All the described Mauern items have several common features, among which one should enumerate:

- different treatment of both faces, the lower surface-formed with flat removals, and the upper surface formed with semi-flat removals,
- tools were made using a core technique, on flat, flint slabs of ca. 1cm thickness. Only three tools were made on large flakes,
- manufacturing process proceeded in three stages of surface formation, edge formation and edge retouch,
- knapping was usually performed in a bottom-top manner with removals onto the lower face and then onto the upper face. The tools were formed in a surface edge scheme or a surface surrounding scheme,
- both edges were formed with identical removal series, analogously to each other; both edges were also retouched,
- in case of most tools (except for group II tools), edges were knapped gradually and in parallel at each knapping stage,
- a lot more effort is put into edge retouch and profile than into tip exposure and its symmetrical placement,
- most tools show certain edges asymmetry, one of which, however, is more convex than the other. The asymmetry appeared already at the moment of edge formation, the retouch usually only made it deeper. Sequences which eliminated edge asymmetry and formed the tool shape are notably absent.

Group I tools and the 1951\_604 tool have a slight edge asymmetry and show lack of work done on increasing the tip's penetration ability, while the edges are being knapped very precisely on their entire length. At the same time, it ought to be noted that these tools bear no repair traces.

The described artifacts appear among other bifacial forms which show traces of intentional transversal fracturing (group III). The fractured tools were retouched after transversal breakage. The other group of tools are those which are asymmetrical and have traces of tool reorientation and using both ends as working edges and tips (group II). Additionally, on the site one can find triangular tools which have two symmetrical edges converging at the tip at a quite big angle (1951\_642).

From the perspective of the manufacturer's plan, the greatest emphasis was put on creating straight in profile, long, sharp edges. The straight profile was obtained by leading the edges, from the beginning, according to the scheme of flat removals on the lower face and then semi-flat removals on the upper face. Thus it was possible to minimize edge profile sinuosity and keep its acute angle.

The raw material used to produce Mauern tools certainly conditioned the tools' form in itself. The small thickness of flat, flint slabs meant that in order to obtain a working edge, it was necessary to perform extensive, flat, decorticating removals onto both faces. Further knapping had to follow the same scheme, so as not to blunt edges. At the same time, the thickness of material was too scarce to create tools according to the scheme used in Klausennische or Königsau forms. It would have been impossible, then, to form edges in semi-abrupt and flat schemes, or the more so, to thin the cutting edge from the distal posterior edge. Simultaneously, the raw material allowed for producing tools with long working edges. It was logical, therefore, to change the manufacturing scheme of subsequent repairs of one

edge into creating a tool, in which it would be possible to use interchangeably consecutive edge fragments. Then, the fragments would be abandoned. At the same time, notches would be created on this same edge, enabling tool hafting with the use of a subsequent tool part. The original concept was to retouch the sole edge, and all reduction sequence actions were subordinated to this aim.

### 3.2.1.3.5. Rörshain

A total of 34 artifacts from the Rörshain site were analysed. The artifacts can be found in the collection of Vor-und Frühgeschichtliche Museumslandschaft Hessen in Kassel. 24 of them have been published. An attempt was made to extend the sample with further 10 artifacts, mainly with preforms (Rh\_1, Rh\_57, Rh\_79, Rh\_83, Rh\_89, Rh\_92, Rh\_93), or otherwise interesting forms (Rh\_91, Rh\_127, Rh\_140), in order to trace the whole knapping process. Among the published tools, 14 were defined as leafpoints or their fragments (Rh\_11, Rh\_13, Rh\_15, Rh\_39, Rh\_53, Rh\_88, Rh\_101, Rh\_102, Rh\_103, Rh\_104, Rh\_105, Rh\_107, Rh\_110, Rh\_114), (Graßkamp, 2001; Luttrupp & Bosinski, 1967; Bosinski, 1967; Fiedler, 1994; Allsworth-Jones, 1986). To compare the production technologies, 10 more artifacts were examined. These were symmetrical tools known as knives or handaxes (Rh\_5, Rh\_7, Rh\_17, Rh\_35, Rh\_42, Rh\_43, Rh\_45, Rh\_59, Rh\_109, Rh\_113). While choosing the sample, it was considered that each type should be represented by at least two artifacts so as to compare and clarify the production schemes of particular tool types.

Based on the analysis, one can divide the Rörshain artifacts into four major groups. Below, they will be described in detail.

#### Group I

This group covers eight tools: Rh\_5, Rh\_7, Rh\_11, Rh\_17, Rh\_35, Rh\_104, Rh\_109, Rh\_113 (Fig.112), two of which (Rh\_11 and Rh\_104) are termed as leafpoints in the literature (Allsworth-Jones, 1986; Luttrupp & Bosinski, 1967).

Typical of the tools is their different edges treatment. One of them has a natural vertical surface which forms the back, or it is knapped with vertical steep edge-blunting removals. The other edge is formed with flat or semi-flat removal series and retouched onto the upper face. The tools are plano-convex in cross-section. Their typical feature is both edges retouch performed onto the upper face. The tip is not usually exposed, and one can observe the absence of interest in knapping the very tip itself (Rh\_104—the fracture surface at the tip not removed during knapping—Fig.112), or that the cutting edge retouch overlaps with the tip, composing a separate, retouched tip edge, transversal to the tool's vertical axis.

On those tools, one may distinguish the following techno-functional units:

**A) Cutting edge.** Formed with extensive flat removal series performed onto the lower face, and next with semi-flat removals onto the upper face. The edge rejuvenation is done via subsequent retouch series onto the upper face (Rh\_5, Rh\_7, Rh\_113) or, if the angle is too large, via a retouch onto the lower face (Rh\_109).

**B) Distal posterior part.** It forms an edge that runs angularly to the tool's vertical axis and converges with the cutting edge at the tip. Formed with a series of semi-steep removals onto the lower face and flat removals onto the upper face (Rh\_5, Rh\_7), or conversely (Rh\_104, Rh\_109, Rh\_113). The typical feature of this tool type is performing the last sequence of distal posterior part's knapping onto the upper face.

**C) Back.** Formed via leaving a natural vertical surface (often cortical—Rh\_7, Rh\_5, Rh\_17). What is more, most frequently a series of flat removals are performed from the back's surface onto the lower face. Those removals form the tool's surface and thin it (Rh\_5, Rh\_7, Rh\_35, Rh\_113).



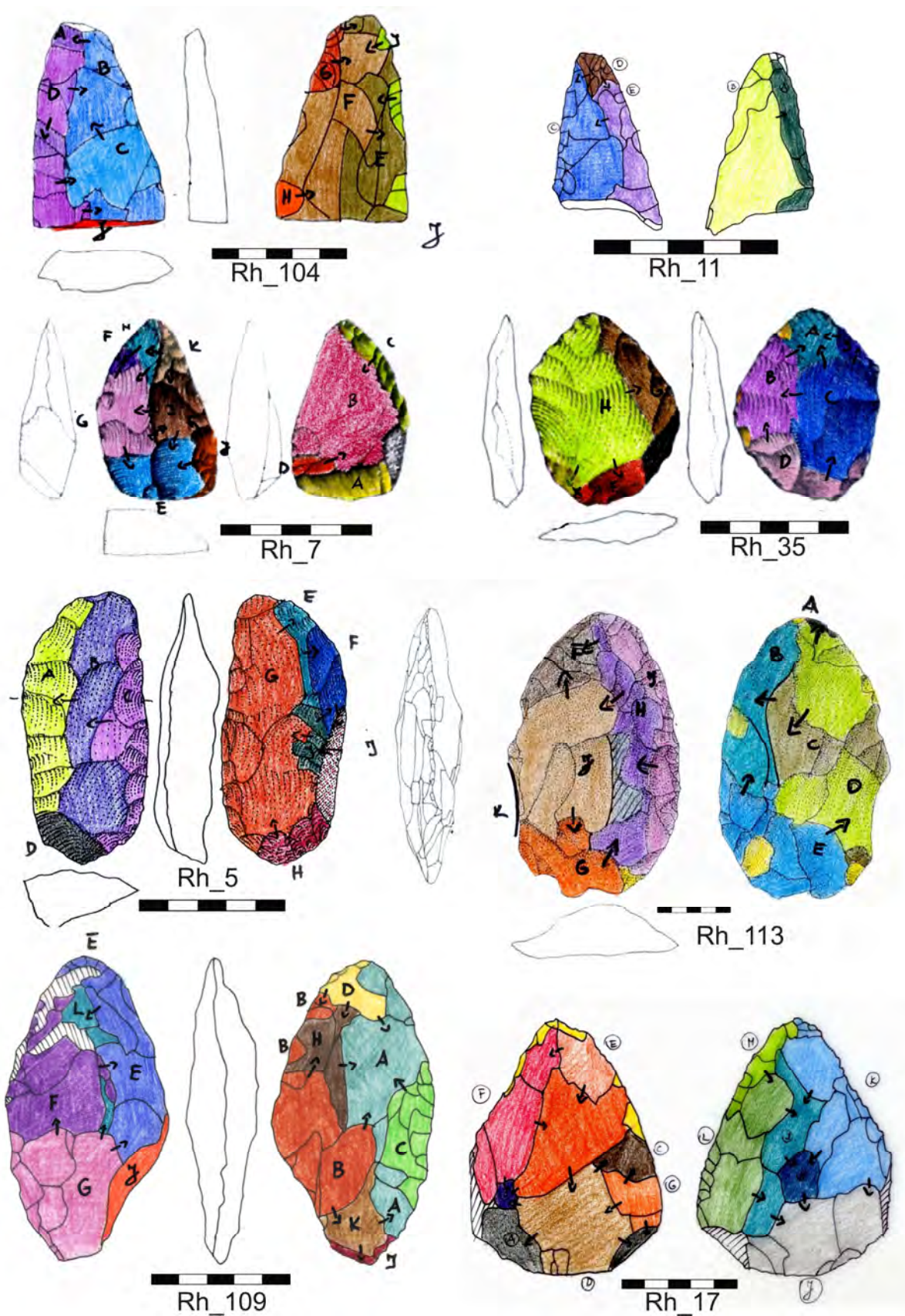
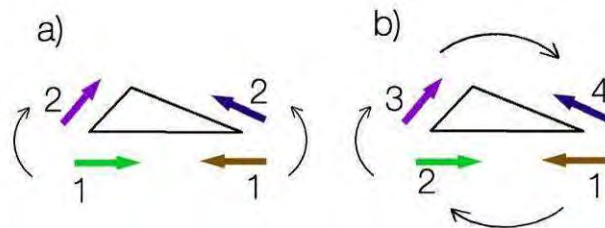


Fig.112 The analysed Rörshain group I tools comparison.





*Fig.113 Group I tools knapping scheme shown in cross-sections. a) edge scheme of knapping with removals performed onto the lower face first, b) surrounding scheme of knapping starting from flat removals onto the lower face.*

**D) Base.** Formed with semi-steep, alternate removals performed on both tool faces from the base. In case of flake tools (Rh\_7, Rh\_35) (Fig.112), flake butts were used as a base. During the manufacturing process, the base is treated as a separate surface and its formation is incorporated into the entire production scheme.

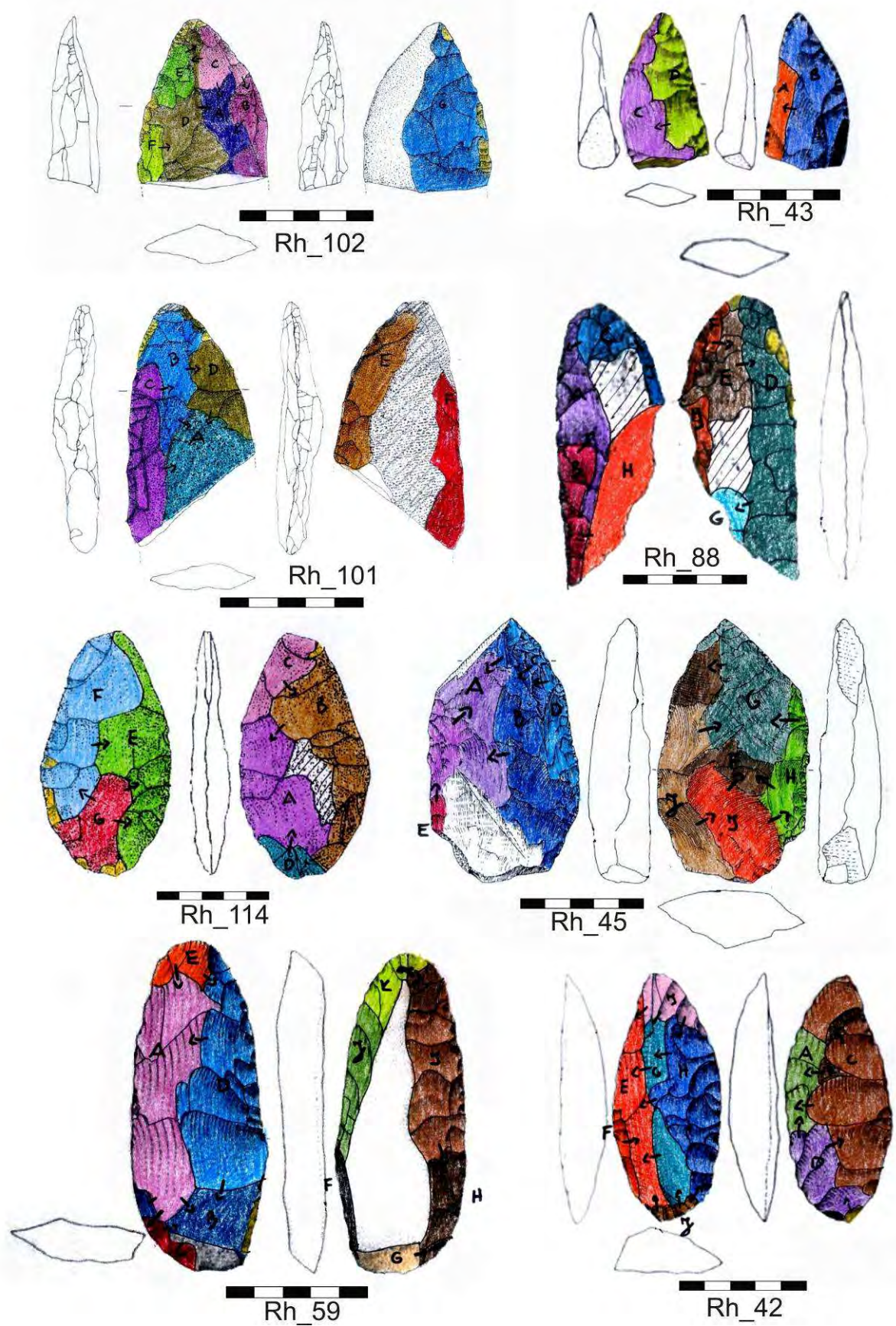
The tools do not have a cohesive scheme of knapping and the creation of edges each time adheres to the nodule/blank properties. Nevertheless, based on the conducted analyses, one can determine two idealised knapping schemes of such tools type. It is either done in an edge scheme, starting from the lower face each time (Fig.113a) (Rh\_17), or in a surface surrounding scheme, beginning with flat removals onto the lower face and ending with the cutting edge retouch onto the upper face (Fig.113b) (Rh\_11, Rh\_109).

These tools are marked **by absence of symmetry and tip exposure**. In the knapping process **none of the removal series is explicitly designed to increase tool symmetry**, whereas some rejuvenation series remove the tip by performing removals directly from it (Rh\_11, Rh\_113).

## Group II

The second group includes 8 tools, among them 5 complete and 3 fragments (near-the-tip parts). These are the following forms: Rh\_42, Rh\_43, Rh\_45, Rh\_59, Rh\_88, Rh\_101, Rh\_102 and Rh\_114 (Fig.114). Four of them (Rh\_88, Rh\_101, Rh\_102, Rh\_114) are defined in the literature as leafpoints (Allsworth-Jones, 1986; Bosinski, 1967). These tools are characterized by different edges treatment and a specific distal posterior part treatment via a series of flat, long removals on the lower face. These removals are performed angularly to the vertical axis and they often cross the entire tool at the tip, thus thinning a cutting edge fragment. This procedure was used to reduce the cutting edge angle while maintaining its straight profile. This allowed to avoid removals derived from the cutting edge onto the lower face, which would result in its sinuous profile. These tools also have a retouch on the cutting edge's upper face, which causes the artifacts to be plano-convex at the tip in their cross-section. The following techno-functional units can be noticed in the tools:

**A) Cutting edge.** Like in the previous artifact group, formed in a plano-convex scheme with extensive series of flat removals on the lower face, and then semi-flat removals on the upper face. Additionally, near-the-tip part of the cutting edge is formed with a series of flat removals from the distal posterior part towards the lower face. The cutting edge rejuvenation is done via a series of removals from the distal posterior edge onto the lower face. Yet, if the percussions do not reach the cutting edge, the rejuvenation is based on flat removals performed onto the cutting edge's lower face (Rh\_45, Rh\_59, Rh\_114).



*Fig.114 The analysed Rörshain group II tools comparison.*

**B) Distal posterior part.** Formed with flat removals onto the lower face, reaching far into the cutting edge. Frequently, the series runs along the whole back edge and the distal posterior part (Rh\_42, Rh\_43, Rh\_59) (Fig.114). The tools of this type either do not have removals on the distal posterior part's upper face (Rh\_42, Rh\_102) or the upper face is formed with just a few more steep removals in order to adjust the angle for deriving flat removals onto the lower face (Rh\_43, Rh\_59). In one case (Rh\_45), the tool has a vertical natural surface which creates the surface of the distal posterior part. This surface is angular to the tool's vertical axis. A series of flat removals were performed from this surface onto the lower face.

**C) Back.** Formed via leaving the vertical natural surface or the fracture surface. If the tool did not have such a surface, the back was formed with steep removals along one of the edges (Rh\_42, Rh\_59, Rh\_102) (Fig.114).

**D) Base.** Formed, just like in the case of previous artifacts group, with semi-steep alternate removals performed on both tool faces from the base (Rh\_42, Rh\_59). In one case, it was formed with a transversal fracture before the manufacturing actually began. Most likely, the tool fragments (Rh\_101, Rh\_102—Allsworth-Jones, 1986, p. 59; Bosinski, 1967, p. 47) can also be treated as tools with a transversal fracture at the base. To support this assumption, one should note that in Rh\_102, the base fracture appeared during tool knapping, even before the cutting edge retouch.

From the technological perspective, the tools are generally characterized by a surrounding scheme of knapping which starts with a series of flat removals onto the cutting edge's lower face, or from vertical removals that formed the back. This is followed by a series of flat removals from the distal posterior part to the lower face and finally, a semi-flat retouch of the cutting edge. Each tool is marked by a certain deviation within the presented scheme, connected with the absence of necessity to knap one of the edges (e.g. the Rh\_102—lower face of the cutting edge), or with the use of back's natural surface. The rejuvenation usually concerns the cutting edge and the distal posterior edge only.

The tools, due to the alternate knapping of the near-the-tip part, are characterized by tip exposure and symmetry greater than in the other artifact group. At the same time, subsequent cutting edge rejuvenations lead to expanding its convexity and moving the tip towards the distal posterior part (Rh\_42, Rh\_43, Rh\_45). Only when the flat removal series derived from the distal posterior edge did not manage to reach the cutting edge, it was necessary to correct the angle on the cutting edge's face. This led to the tip displacement and such is the case depicted in the Rh\_59 and Rh\_114 tool.

The Rh\_114 artifact, referred to as a leafpoint in the literature, is the only example of a complete "leafpoint" from Rörshain. The analysis is made difficult by considerable erosion which caused the crumbling of the artifact's upper face. As a result, some scars cannot be seen and interpreted, and their analysis is impossible. Based on the visible scars, one may deduce that the tool, despite being thin and meticulously knapped, is marked by different treatment of both edges. One edge is straight and can be perceived as the cutting edge. The other one is more S-shaped and has series of angular removals at the tip and at the base. This gives the edge a biangular shape, characteristic of backed knives. What is more, the tool does not have a clearly exposed tip and the final series of removals causes its displacement. Parallel to that, the two final knapping sequences derived alternately to each other and angularly to the tool tip, could have been aimed at enhancing tool symmetry. Unfortunately, the erosion at the tip does not permit to verify this assumption. One may presume though, that if the C (Fig.114) sequence constituted the element of cutting edge rejuvenation, then

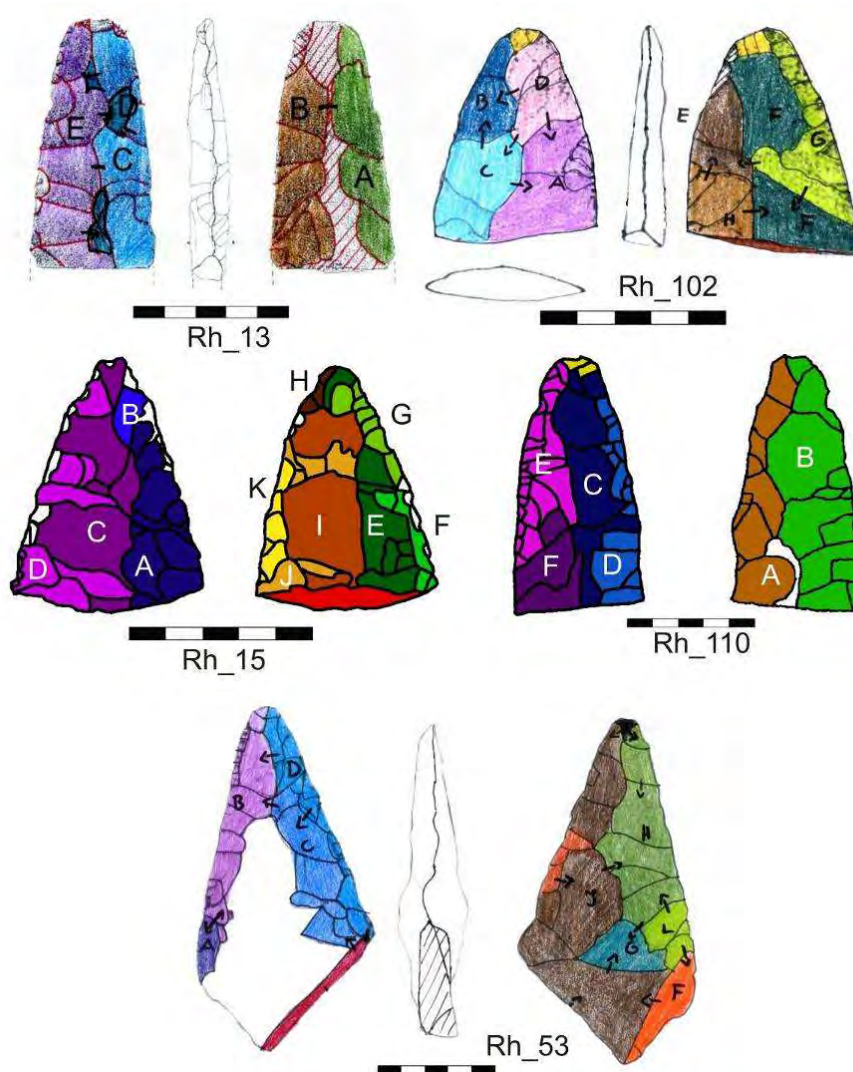


afterwards there was a retouch onto the upper face at the tip. Unfortunately, this edge fragment was not preserved.

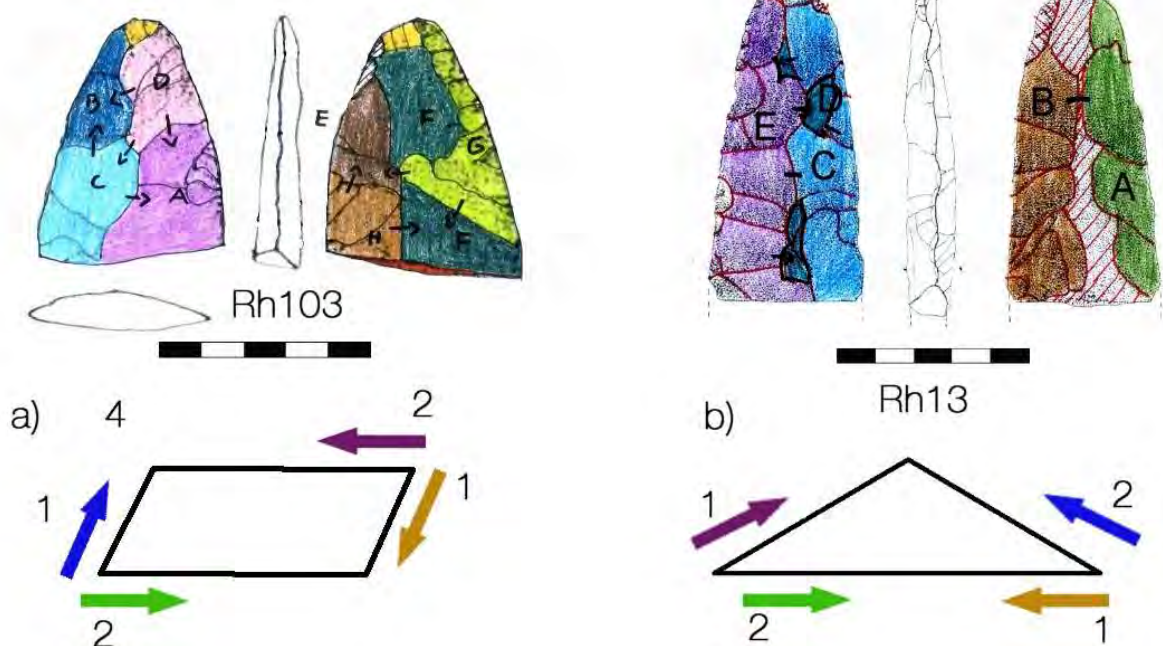
**Despite the tip exposure and noticeable symmetry, the described tools are marked by different treatment of particular edges.** The base and the back are blunted and, most frequently, do not undergo rejuvenation. The retouch, on the other hand, is limited to the cutting edge. The tools symmetry here is the effect of the applied scheme of knapping and not the presumed objective. At the same time, one can observe lack of care for the tool tip. **The knapping and wearing of each tool focuses on retouching and obtaining a straight edge,** whereas the rejuvenation series aim at reducing the cutting edge angle, even at the expense of tip displacement.

### Group III

Five artifacts with symmetrical near-the-tip parts can be included in group III (Fig.115). Their manufacturing process was aimed at creating symmetrical tools (Rh\_13, Rh\_15, Rh\_53, Rh\_103, Rh\_110). They are all called leafpoints in the reference literature (Allsworth-Jones, 1986; Bosinski, 1967; Luttrupp & Bosinski, 1967; Fiedler, 1994). A specific feature of the tools is the identical treatment of both edges. Four tools have a transversal fracture at the base.



*Fig.115 The analysed Rörshain group III tools comparison.*



*Fig.116 Group III tools knapping scheme shown in cross-sections. a) completely alternate, plano-steep scheme of knapping resulting in bi-convex cross-section, b) plano-convex edge or surrounding scheme of knapping; erosion made it impossible to establish full sequences chronology.*

Each of the tools, according to estimates, is preserved in 1/3 of its original length. One of the tools (Rh\_15) has a hinged fracture with a specific cross-section. The other ones have two angular breakage scars which are positioned towards one another at an angle of 90° (Fig.115). In case of the Rh\_53 tool one can state that after its breaking, the tool was again knapped and the post-fracture sequences gave the tool a symmetrical shape.

The following techno-functional units can be pointed out in the tools belonging to this group:

**A) Cutting edges.** Both edges converge at the tip. They are both retouched either onto the upper face (Rh\_53, Rh\_110) or alternately (Rh\_15, Rh\_103).

**B) Base.** Formed with one or two transversal fractures, set angularly to the tool's vertical axis.

A specific feature of these tools is the absence of back and rejuvenation traces. The knapping of the tools proceeded according to two different schemes. The first one involves initial surface manufacturing in a surrounding scheme of knapping, in a plano-steep manner. The series on one face is semi-steep, while on the other face it is flat, the second edge is formed alternately (Rh\_15, Rh\_103). As a result of such knapping, the tools are biconvex in cross-section. (Fig.116a). A series of retouches are derived alternately at the tip, at the stage of edges formation, along with flattening removals forming the edges farther away from the tip. Both tools knapped in this scheme are of triangular shape, especially Rh\_15, which also has a well-exposed tip.

The second scheme leads to the creation of tools plano-convex in their cross-section. This way of knapping involves a surface/edge analogical scheme of knapping with potential correcting of the edges by a retouch onto the upper face (Fig.116b). Both broken tips which

were formed in this scheme (Rh\_13, Rh\_110) have a lengthened shape, almost parallel edges and an unexposed tip. In the Rh\_53 tool, the edges form a more obtuse angle and the tip is a bit more exposed.

The tools included in this group **are characterized not only by clear symmetry but even their specific knapping aimed at, as it can be presumed, enhancing symmetry.** Some sequences, especially at the point of edge formation, aim at additional tool symmetry increase. **Both edges of the described tools are treated in the same way, and both are equally straight.** Only the tip, at least in case of several tools such as Rh\_103 and Rh\_13, was not exposed. The tip does not display any peculiar interest in the form of its retouch or additional, exposing it sequences. The presence of an old, not obliterated by an edge retouch removal sequence in the near-the-tip part of the Rh\_53 tool, additionally demonstrates, that it was not the tip itself as much as straight, convergent edges that made the major objective of this tool type production. What is more, **all artifacts are broken in the same place** (ca. 1/3 of the tool length). The Rh\_53 tool, also equipped with two symmetrical edges, has a base intentionally formed with two fractures. It is difficult to assume that both fractures were accidental, and even if they were, both edges retouch forming the entire tool was done already after the fractures.

While describing these specimens, one can refer to all the group III artifacts from Wahlen which are of the same morphology and knapping technology. Possibly, all the artifacts of this group were intentionally broken in order to create a transversal base surface.

It is also important to notice that the Rh\_15, Rh\_103 and Rh\_110 (Fig.115) tools have a notch at the tip, formed with a single scar of a deep truncation. The notches have a similar morphology and are located in the same place which shows they can be connected with a specific style of using the tools or, what is more probable, with a specific way of their hafting. The notches might have been created during tool exploitation, e.g. by rubbing it against the haft.

## Group IV

The fourth group consists of tools which were **knapped after the fracture or, intentionally broken at the tip or at the base.** The group encompasses five tools (Rh\_39, Rh\_91, Rh\_92, Rh\_127 and Rh\_140) (Fig.117). Four of them have one transversal fracture at the tip, one has two transversal fractures at both ends. The Rh\_39 tool is called a leafpoint in the literature (Bosinski, 1967, Taf.104.1). It is worth noting that the transversal fractures are usually angular to the vertical axis whilst longer of the tool edges was retouched after the fracture and has features of a cutting edge. Apart from Rh\_91, the remaining tools have a rounded base, formed more precisely than in the tools from groups I and II, or the preforms described below. This fact mostly concerns the Rh\_140 and Rh\_39 artifacts, which resemble the ones counted into group II from the Wahlen site.

The artifacts that constitute this group have no common knapping scheme. Each has a different formation method, either by forming the flat lower surface first and then by retouching the edges on the upper face (Rh\_39, Rh\_140), or by a surrounding scheme of knapping (Rh\_91); or by edge/surface analogical scheme of knapping (Rh\_92, Rh\_127). A characteristic feature is the one that each described artifact, after its breakage, was additionally retouched on one of the edges (the longer one). The Rh\_91 tool, after being fractured at both ends, was blunted abruptly on the shorter edge, which resulted in creating a back.



The frequency of tool fracturing, and its regular angular profile, may further reflect the intentionality of fractures. On the other hand, it can be also presumed that the group includes tools broken by accident as well as reutilized bases with purposefully removed tips. The Rh\_140 tool might have been broken intentionally because its base is strongly bent which could not be corrected with subsequent removal series onto the lower face.

The preserved scar fragments near the angular fracture on the Rh\_39 (Fig.117) tool suggest that one of the tool edges was straight and the other was convex also at the broken tip. This suggests that the tool had not been symmetrical and the tip had not been located in the tool axis. It can be therefore assumed that the tool was either an asymmetrical form before the fracture, or it was designed to be a tool with a broken distal posterior part. This made its morphology close to that of the Rh\_45 artifact. As far as the Rh\_91 tool is concerned, the two angular breakages (Fig.117) may suggest them to be intentional, whereas the Rh\_127 and Rh\_92 tools were broken at early knapping stages.

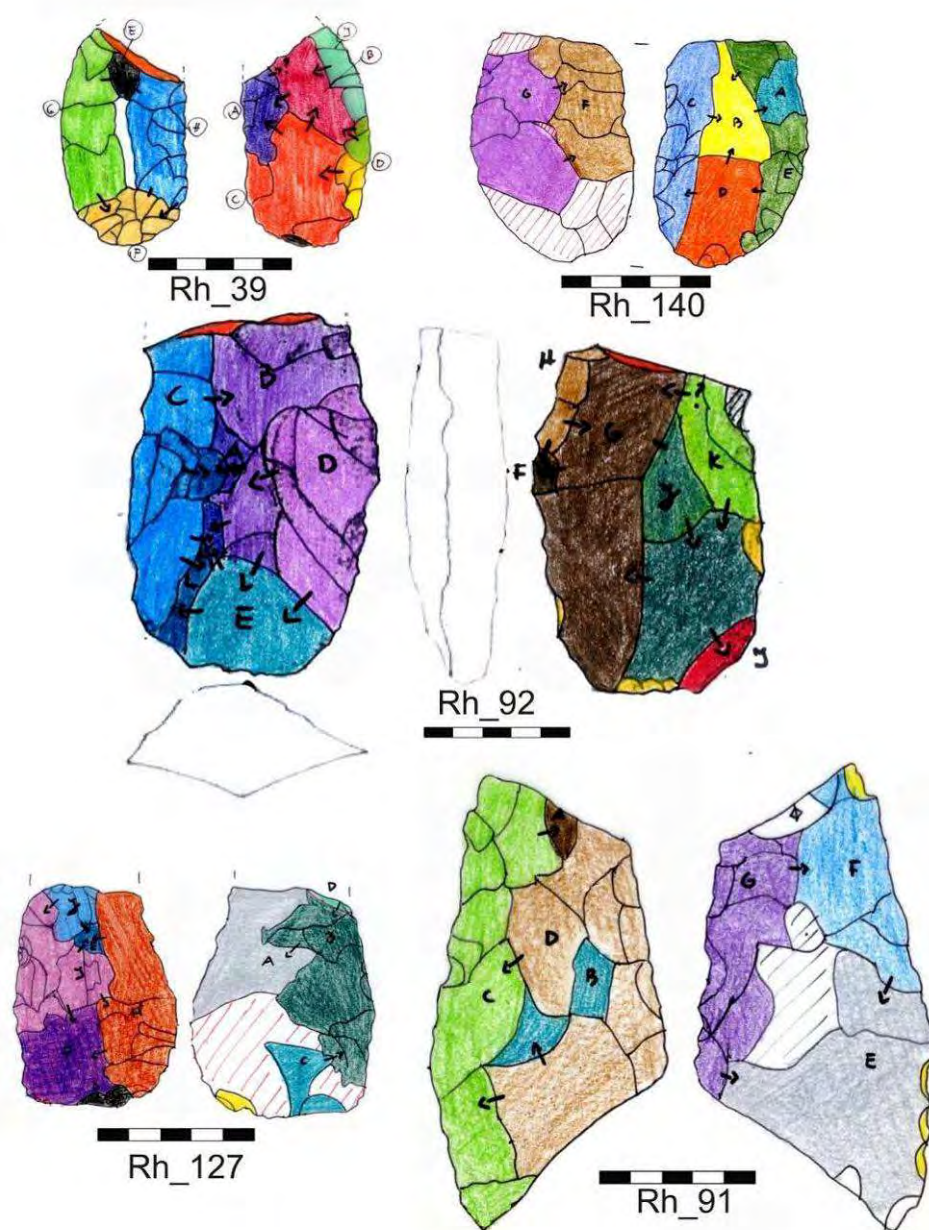


Fig.117 The analysed Rörshain group IV tools comparison.

The last artifact group consists of preforms (Rh\_1, Rh\_57, Rh\_79, Rh\_89, Rh\_93, Rh\_83, Rh\_105 and Rh\_107). The Rh\_105 and Rh\_107 forms are defined as leafpoints in the literature (Graßkamp, 2001, Taf.38,51). Most of them (6 of 8) have a transversal fracture. Fractures at such an early stage may suggest their intentionality, especially since four of the described forms are broken bases. As the tools were abandoned at different knapping stages, it is pointless to describe the knapping schemes of each one of them. However, the collective analysis can prove very helpful during the reconstruction of Rörshain tool production technology at their very early knapping stages

The first stage was nodule decortication and basic surfaces formation. If the planned tool was to have at least one flat surface, then a series of steep removals on one or both edges onto one face were derived (Fig.118). This allowed to create an angle for a series of flat, broad removals performed onto the second face (Rh\_89, Rh\_105). If the tool was made from a massive flake, then thinning the ventral face proceeded analogously. First, removal series preparing an edge angle were performed on the dorsal surface. Next, flat removals onto the ventral face were derived (Rh\_1, Rh\_107).

Further stage was based on the formation of tool general shape and its particular surfaces. Knapping was usually done in a surface scheme (Rh\_57, Rh\_93). During tool rotation, steep alternate removals, which formed its surfaces, were performed on the base. The Rh\_93 preform has a base formed with two angular fractures, positioned at an angle of 110° towards one another. One artifact shows signs of plano-steep alternate scheme of knapping with semi-steep removal sequences to one face, and flat, broad removals to the other face of a given edge (Rh\_79). This form was reshaped after the breakage and displays traces of semi-steep removals which eliminated the fracture scar at the tip. However, after these removals, further knapping was abandoned. The examined preforms, though they are more or less symmetrical, cannot be firmly classified as leafpoints preforms. First of all, traces of transversal fractures, because of their regular outline, seem to have been made by design. Secondly, each of the described artifacts (except Rh\_105, which was abandoned at a very early knapping stage, before decortication) is characterized by different treatment of both edges. In each case, one can also specify one of the edges which was formed more diligently. It is also possible that, after resigning from further tool knapping, this edge was predestined to be a cutting edge.

In the context of the 34 Rörshain artifacts analysis, there is a striking fact that 23 of them are broken forms. In many cases, no signs of accidental fractures, formed during the knapping process, are present. On the contrary, the fracture is transversal, obtained by hitting one of the surfaces in its centre. Such fracture characteristics, as well as the occurrence of double fractures, arranged angularly and forming the base (Rh\_53, Rh\_95), may indicate an intentional tool fracturing. Analogies with the Wahlen and Lenderscheid artifacts seem to be further strengthened by these arguments. Nonetheless, the Rörshain artifacts lack traces of alternate notches, which facilitated fracturing the Lenderscheid tools in specified areas (see Lenderscheid, group I).

Of the 14 tools referred to as leafpoints or fragments of leafpoints in the literature, only 4 can be considered as tools actually made with care for symmetry, but with little care for the very tip. All four tools (included in group III) have a transversal fracture. None of the analysed artifacts, reviewed in the collection stored in the Kassel museum, fits these tools as a base. The collection of Rörshain also has no completely preserved tool with a lengthened shape and two symmetrical edges. Given the artifact of Wahlen (WH\_49), with a deliberately removed base, it can be assumed that the analysed tools are final and deliberate products, and

not merely a fragment of an accidentally broken artifact. Perhaps also some of the near-the-tip fragments, assigned to groups I and II, can be considered analogously to the tools of Wahlen group III, as tools with the base formed by a transversal fracture.

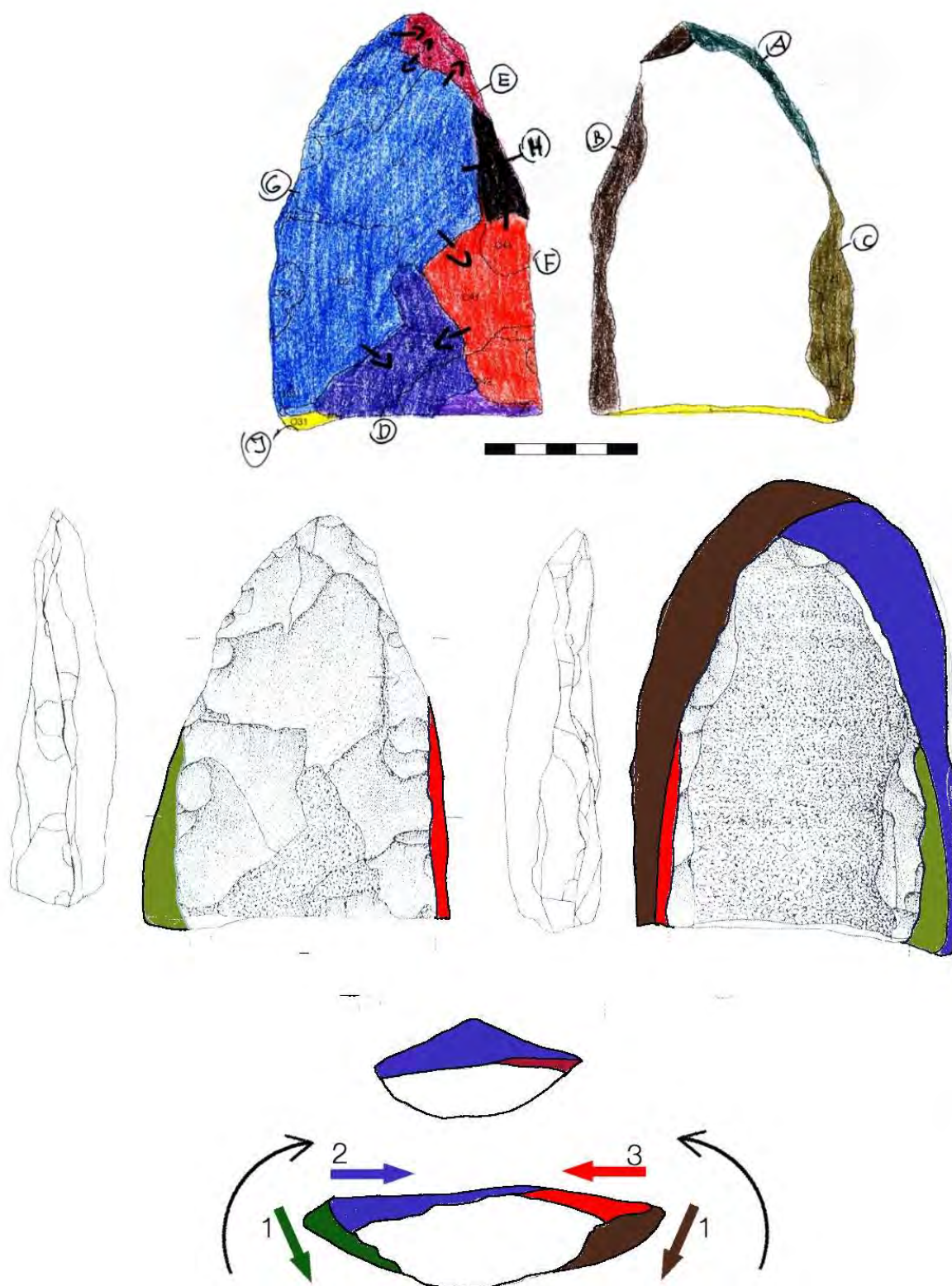


Fig.118 Rörshain preforms knapping scheme on the example of Rh\_105 artifact.

### 3.2.1.3.6. Wahlen

In total, the dorsal retouch analysis covered 25 tools from the Wahlen site. The items are now to be found in the collection of Vor-und Frühgeschichtliche Museumslandschaft Hessen in Kassel. 23 tools appear in publications, of which 21 were referred to as leafpoints (Fiedler, Quehl & Schlemmer, 1979; Junga, 2009). Two unpublished bifacial tools with traces of symmetry (WH\_II79 and WH\_149) were analysed for comparative purposes. In addition, an analysis of two artifacts referred to as knives in Fiedler's publication (1994) was conducted. The WH\_1969 artifacts were analysed as a result of their symmetrical shape, as well as the WH\_IIIc tool, which in terms of its raw material, manufacturing method and morphology resembles a previously analysed Rörshain knife (Rh\_45). With regard to the technological differences, the entire examined collection can be divided into four groups.

#### Group I

The first and the largest group (15 items) includes tools which, despite the fact that in their design (in two basic projections) they display certain symmetries, during a more detailed analysis they show significant differences in the treatment of both edges. These are namely: WH\_34a, WH\_II79, WH\_149, WH\_141, WH\_Wahlen, WH\_X-3, WH\_54, WH\_142, WH\_WA, WH\_129, WH\_1969, WH\_A827-3, WH\_5c, WH\_52g-C13, WH\_IIIc. Four of them are flake tools (WH\_Wahlen, WH\_X-3, WH\_54, WH\_142) (Fig.119). The other ones were either made of nodules, or the ventral surface traces were covered by subsequent removal series. On these tools, mostly plano-convex in cross-section (12 items), four techno-functional units can be distinguished: cutting edge, base, back and distal posterior part. During knapping, they were treated differently, with the use of different types of removal series.

**A) Cutting edge.** Most often plano-convex, knapped with flat extensive removals on the lower face and semi-flat, precise, small removals on the upper face. Edge rejuvenation is usually done either via repeating both removal types on relevant face (WH\_34a, WH\_II79, WH\_149, WH\_141), by an additional series of retouches on the upper surface (since then it is more steep) (WH\_5c, WH\_52g-C13), or with a series of small flat retouch on the lower face (WH\_WA, WH\_129, WH\_Wahlen, WH\_142, WH\_A827-3).

**B) Base.** A characteristic feature of the Wahlen tools is the presence of a natural surface, or the surface of a transversal fracture running transversely to the tool's axis and forming the tool base. This can be encountered in five cases (WH\_141, WH\_149, WH\_II79, WH\_129 and WH\_A827-3). To create the base, fractures or surfaces obtained even prior to the tool production were utilized. Flaked tools have a retained butt surface (WH\_X-3, WH\_54), and additional vertical removal series, which blunted the base (WH\_Wahlen). If the tool did not earlier have a suitable surface that could serve as a base, the latter was obtained through a series of vertical removals. Then, the base is formed with steep removal sequences that blunt the tool at an angle from the back's surface (WH\_142, WH\_WA, WH\_1969 WH\_5c) (Fig.119). The base is not usually rejuvenated during tool usage. An exception is the moment of tool breakage. An example of this is the WH\_52g-C13 artifact, which, after a transversal fracture at the base, was retouched by creating two notches at the base, formed with steep removals (Fig.119). One of the notches on the cutting edge's face is less invasive and more flat, which points to removals being adapted to different tool areas. Only one artifact does not have a separated base (WH\_34a). The last two removal series on this tool are very precise and they are located on the back's edge, which suggests a change in the tool orientation at the base after the appearance of a transversal tip fracture. Series of retouches



probably eliminated the more steep sequences forming the tool base. A similar situation can be observed in the reorientation of the WH\_5c tool, where the last removal series is a flat retouch at the base.

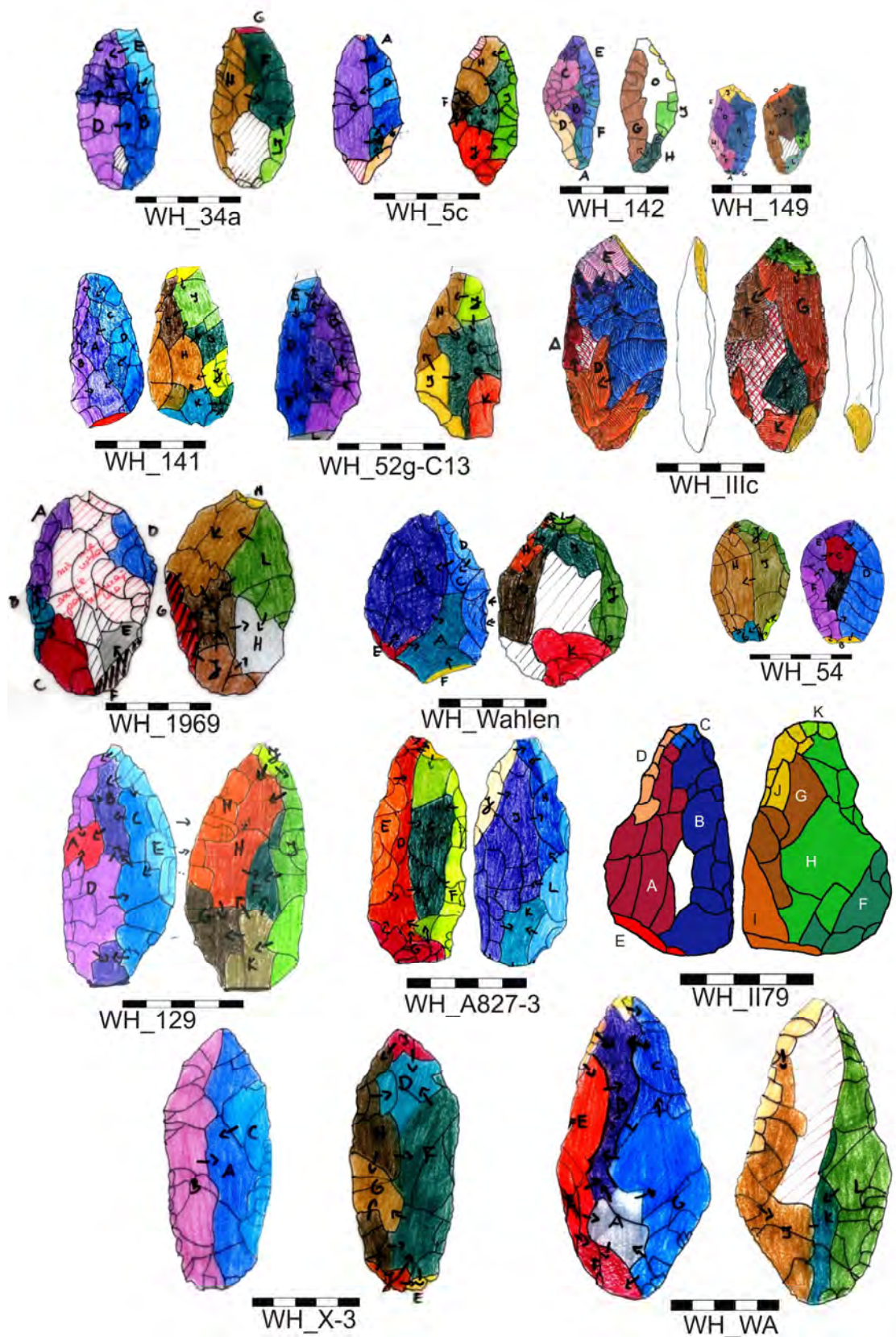


Fig.119 The analysed Wahlen group I tools comparison.

**C) Back.** Not formed in the Whalen tools as it is in typical backed knives, with a series of steep/semi-steep removals on the lower or upper face. Contrariwise, it is made of semi-flat or semi-steep removal series derived on both faces. These form an S-shaped edge without visible traces of blunting. The back is, on the other hand, characterized by the absence of retouch and precise knapping. The sequences that form the back often take the form of hinged removals (WH\_129, WH\_II79, Wahlen\_WH, WH\_WA, WH\_A827-3).

**D) Distal posterior part.** It is located near the tip and forms an edge convergent with the cutting edge. The distal posterior part has retouches on the same face as the cutting edge. Most often it is a retouch done onto the upper face. The distal posterior part is rarely retouched with alternate percussions onto the lower face. In case of the WH\_IIIc tool, the distal posterior part's rejuvenation and a removal performed from its edge onto the upper face, caused the destruction of the tool and the displacement of almost entire cutting edge by an overpassed removal (Fig.119). After this error, the tool could not be repaired in spite of some visible attempts undertaken at the tip. An interesting phenomenon observed on six artifacts is the presence of small semi-steep removals or truncations on the distal posterior part's edge, near the tip, on it's the lower face (Fig.121). The nature of these truncations is, due to their repeated character, difficult to explain. It may be associated with the tool hafting method or its specific utilization.

The knapping technology of the artifacts from group I shows no standardization in terms of sequence arrangement. What is rather observed is a pattern of adjusting the tool production scheme to the actual goal, which is obtaining a tool with a maximally flat and penetrating, as well as long and straight in profile cutting edge; a long and penetrating distal posterior part's edge and a blunted base.

The production scheme can be divided into three general stages: surface formation, edge formation and rejuvenation phases. In flake tools, surface formation was preceded by blank acquirement.

**I. Surface formation.** It is characterized by series of extensive, not very precise removals. In some tools, especially the small ones, which bear traces of multiple rejuvenation phases, this stage is likely to be invisible (WH\_5c, WH\_34a, WH\_149). The production was generally done in a surrounding scheme of knapping (WH\_142, WH\_X-3, WH\_54, WH\_WA). In one case the observed production is done with plano-steep alternate manner. First, there is a series of semi-steep removals to one face, and then a series of flat removals to the opposite face (WH\_52g-C13-Pl.178). This scheme had been used alternately, thus resulting in the tool being biconvex in cross-section. One side was next converted into a retouched cutting edge surface, whereas the other one left without further knapping became the back's edge.

In other cases, knapping began with flat removals on the lower or upper face and proceeded in a surrounding scheme. An interesting fact is that in those of the tools which, before commencing their knapping, did not have a surface used as a base further on, the base is formed during surface formation. This proves that the blunted surfaces, be it of the back or the base, are regarded as the tool's integral part and formed at the very beginning of its knapping.

**II. Edges formation.** At this stage, knapping is done in an edge scheme, or in a surrounding scheme, the removals being adapted to the edge's characteristics. The removals on the cutting edge's lower face are more extensive and flat, the removals on the back's edge



are limited to edge profile corrections or to distal posterior edge's retouch. The most precise removal series is usually done at the end, on the cutting edge.

**III. Edge rejuvenation.** Most often, it either concerns the cutting edge itself or is based on the rejuvenation of all tool edges and surfaces (usually except for the base), and is performed by repeating a surrounding scheme of tool knapping. In this scheme, the cutting edge is usually retouched as the last one.

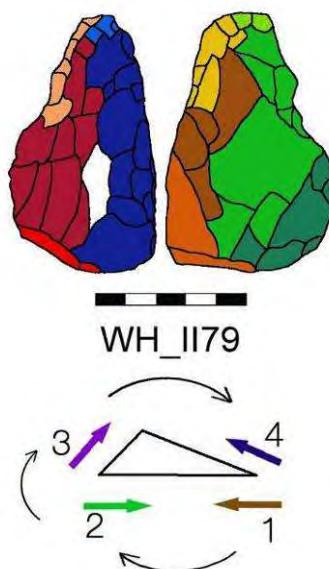


Fig.120 Surrounding knapping scheme of WH\_II79 tool depicted in cross-section.

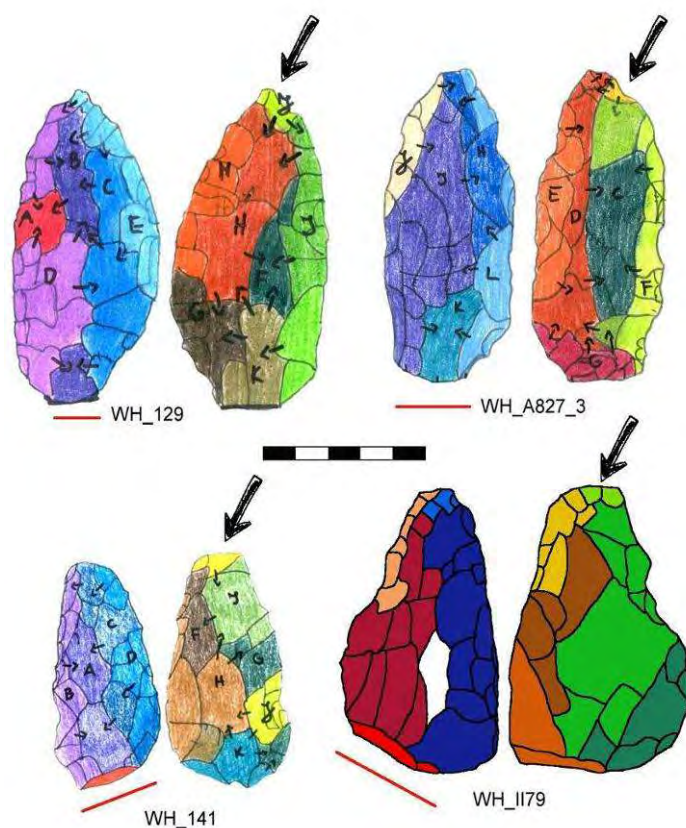


Fig.121 Comparison of group I tools with marked transversal breakage surface at the base. Arrows point to characteristic truncations at the tip of each tool on the lower face, which may constitute a hafting trace.

Three tools in this group (WH\_II79, WH\_129 and WH\_141) show a very consistent production pattern, which comprises the surrounding scheme of surface knapping, either starting from flat removals on the lower face of the future cutting edge and ending with semi-flat removals forming the cutting edge's upper face (Fig.120). Otherwise, knapping could have been done reversely, starting from the flat removals in a surrounding scheme on the back's upper surface, and ending on the cutting edge's upper face retouch. In all three cases knapping was done on a nodule with a transversal breakage scar at its base, which later formed the tool's base. Perhaps the tool could have already been used at this stage, after the cutting edge retouch, and subsequent actions are stages of tool rejuvenation. The rejuvenation actions include, in the first place, a series of flat removals on the lower face, regulating the cutting edge's and distal posterior edge's profiles and edge angles. Next, the rejuvenation included the cutting edge's and distal posterior part's retouches. Each described tool also has characteristic minor, correcting semi-steep scars on the distal posterior edge's lower face, which appeared at the end of the tool knapping process. These tools are plano-convex in cross-section, however, each of them is of completely different design.

The analysis allowed to determine the characteristic features of artifacts included in group I. These are:

- vertical axis asymmetry (WH\_II79, WH\_142, WH\_54, WH\_52g-C13, WH\_149, WH\_WA, WH\_129),
- removal series at or near the tip, removing the tip or the tool symmetry (WH\_129, WH\_Wahlen, WH\_1969, WH\_141, WH\_II79, WH\_142, WH\_54, WH\_149),
- visible sequences removing the tool symmetry (WH\_142, WH\_52g-C13, WH\_149),
- absence of an exposed tip (WH\_1969 WH\_54, WH\_149, WH\_Wahlen),
- sinuous tool curve in its vertical axis (WH\_Wahlen),
- plano-convexity (WH\_5c, WH\_Wahlen, WH\_A827-3, WH\_II79, WH\_34a),
- considerable tool thickness (WH\_1969, WH\_129, WH\_WA, WH\_149),
- lack of sequences increasing the tool symmetry (WH\_A827-3, WH\_54, WH\_141, WH\_52g-C13, WH\_II79, WH\_149),
- asymmetry in the edges treatment (all of them),
- distal posterior part formed with semi-steep or steep removals onto one of the faces (WH\_5c, WH\_Wahlen, WH\_WA, WH\_129, WH\_141, WH\_II79, WH\_142, WH\_52g-C13, WH\_149),
- entire cutting edge retouch, the opposite edge only at the tip (WH\_5c, WH\_1969 WH\_WA, WH\_II79, WH\_34a, WH\_142, WH\_52g-C13, WH\_149),
- visible rejuvenation sequences (WH\_5c, WH\_Wahlen, WH\_1969, WH\_A827-3, WH\_129, WH\_141, WH\_II79, WH\_34a, WH\_142, WH\_54, WH\_52g-C13, WH\_149),
- after the tip fracture, the repair does not remove the fracture scar (WH\_34a, WH\_52g-C13),
- irregular knapping, the cutting edge as the only one knapped regularly (WH\_1969),
- fracture scar at the tip, from before knapping commencement; not removed during tool knapping—absence of care for the tip (WH\_A827-3),

- knapping focused on the tool edges, with the exclusion of the tip and the base (all except for WH\_5c, WH\_WA, WH\_129),
- lack of intensive thinning attempts at the tool base (WH\_WA),
- tool reorientation (WH\_34a, WH\_54 (?)),
- base formed by using a natural transversal fracture or with a vertical removals which formed a transversal surface (WH\_141, WH\_149, WH\_II79, WH\_129, WH\_A827-3, WH\_Wahlen, WH\_52g-C13).

Among all the tools counted in the group, only the flake form WH\_X-3 displays features which may point to care for the tool symmetry. These features would be:

- individual sequence of small removals near the tip which caused tip exposure and thinning,
- edges knapping resulting in tip exposure,
- knapping sequences form a symmetrical tool shape.

At the same time, though:

- tool was blunted at the base with a series of vertical removals onto the lower face
- removal series on the edges are irregular and imprecise, hinged,
- only edge I seems to be finished, it is more straight than the second one, and more accurately knapped,
- tool has considerable thickness and was not thinned,
- tool is bent (the tip bends upwards).

The symmetry of this tool may be associated with a very high angular hinged removal, performed at the tip on the upper face. It probably caused switching further utilization to the second edge. A series of semi-flat thinning removals performed onto the second edge was, however, unsuccessful and resulted in high hinges formation. The tool was also probably submitted to repair attempts by its reorientation and edge I retouch at the base. Hence, one of the last removal series concentrate at the base, but they only blunt it, without leading to tool thinning.

## Group II

Another separate group of tools are the tools which exhibit traces of their intentional breaking at the base during the manufacturing process (Fig.122). These artifacts were referred to as leafpoints fragments in publications, however, as demonstrated by analyses results, a number of features indicates that symmetry was not the factor conditioning their production and rejuvenation process. This group includes five tools (WH\_C16, WH\_130, WH\_56, WH\_4c and WH\_X608). Another characteristic feature of these tools is their biconvexity (except WH\_C16).

On these tools, one can distinguish three major techno-functional units:

**A) Cutting edge.** Formed mostly with flat or semi-flat precise retouch on both faces. Only in case of the WH\_C16 tool, the cutting edge's retouch is semi-steep, which may be associated with the biplan character of raw material from which the tool was made, and its production technology (see below).

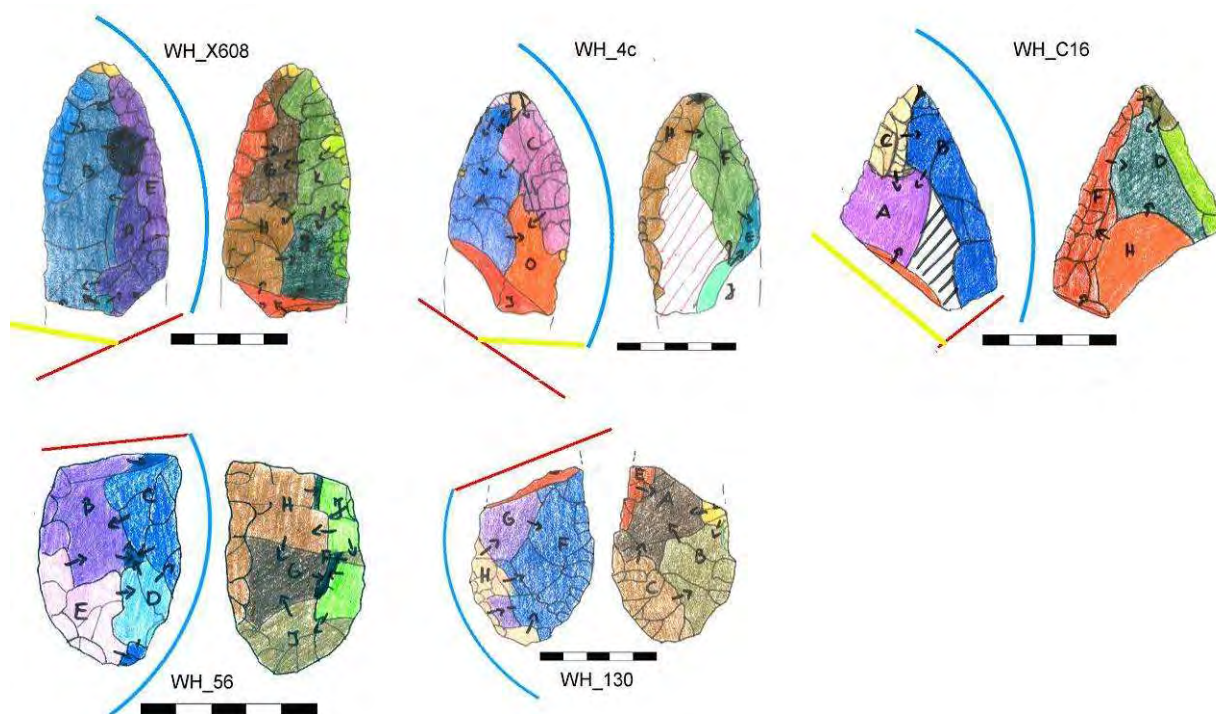


Fig.122 Techno-functional units arrangement on Wahlen group II tools. Blue marks cutting edge, red marks initial breakages, yellow marks the second/additional transversal breakage at the base.

**B) Distal posterior part.** Long, occupies the entire edge opposite the cutting edge. The retouch, however, includes only the near-the-tip part, due to which the edge is less precisely knapped and more sinuous in profile than the cutting edge.

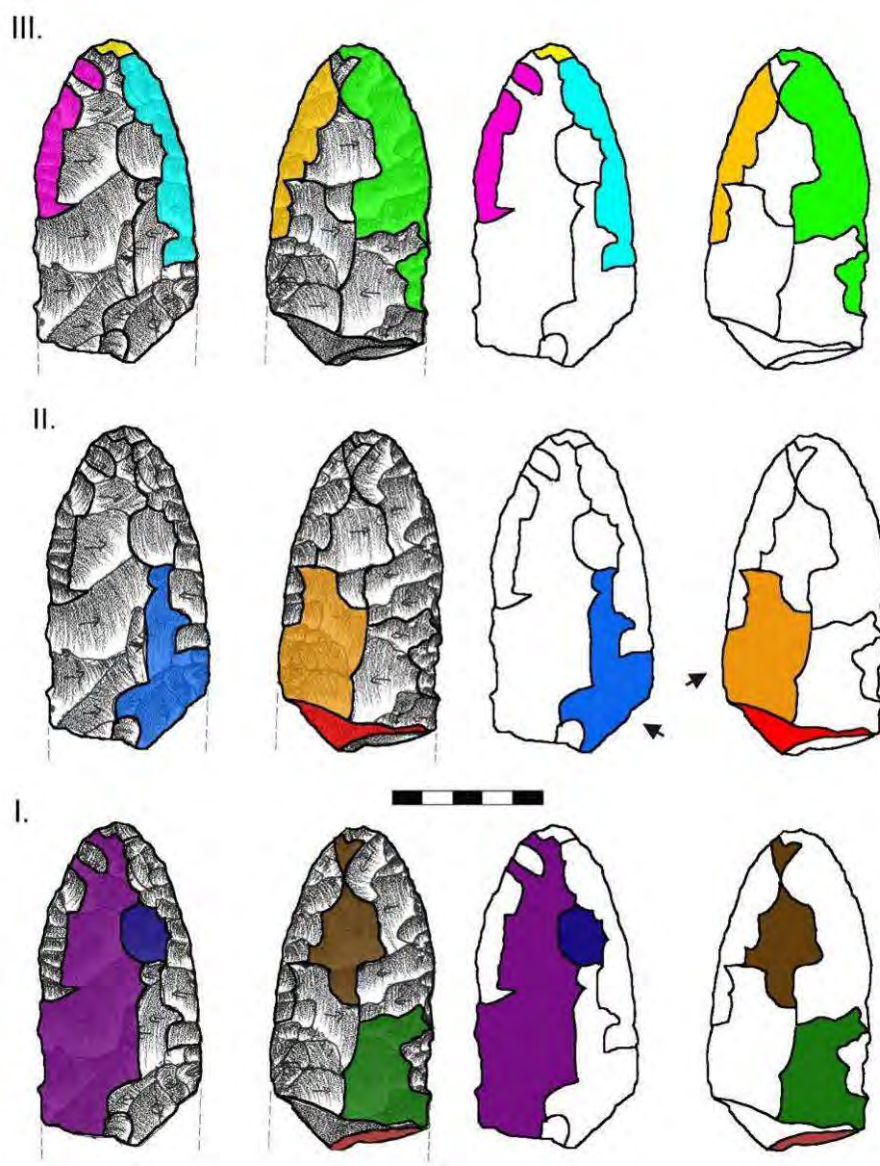
**C) Base.** Formed with a transversal breakage (Fig.122), made during the manufacturing process (WH\_56, WH\_X608), or after it had been finished (WH\_130, WH\_C16, WH\_4c). The fracture's intentional nature is reflected in the presence of two breakage scars on the base (WH\_C16, WH\_4c, WH\_X608). The second fracture occurs in those tools, in which the first fracture was not transversal but angular in relation to the tool axis.

In the production scheme of the described tools at least three stages can be determined, with the finishing two occurring in any order.

**I. Surface formation.** At this stage, the tool is formed via a series of extensive, flat and semi-flat removals. Knapping is done in a surface surrounding scheme, however, due to the overlapping of further scars, it is difficult to reconstruct the entire cycle and all the sequences succession after one another.

**II. Fracture preparation and fracture itself.** This step in the WH\_X608 tool includes two series of removals on the distal posterior edge, on both faces, forming a kind of a notch (Fig.123). In case of the WH\_X608 tool, from this notch a removal is performed in order to correct the previous fracture, which was angular to the tool vertical axis. In other cases, the fractures are derived directly and there are no signs of preparing the notches. In case of the artifacts with two breakage scars at the base, the chronologically second fracture is derived from one of the edges. The nature of the first scar is difficult to decree about because of its discontinuity. The WH\_56 tool has one scar of transversal fracture, which was probably





*Fig.123 Subsequent phases of knapping the WH\_X608 tool. Numbers from I to III correspond to description in the text. Black arrows show notch creating sequences.*

created as a result of a percussion introduced in the middle of the lower surface. The WH\_130 tool has an angular fracture caused by a percussion derived onto one of the tool edges.

This tool has additional two series of small steep removals, blunting the edge at the fracture angles, proving that the tool was still used after its breakage.

**III.Edge formation.** The tools have an alternate retouch on the cutting edge and the distal posterior part. In case of WH\_C16, it was created due to the use of an alternate scheme of knapping (Fig.124). The retouch on the cutting edge is semi-steep, whereas the retouch on the distal posterior part is limited to the near-the-tip part and formed by small semi-flat removals. The cutting edge is located on the upper face's left side, which may suggest left-handedness of the person producing and using this tool (Urbanowski, 2004 p. 112). In other tools, the edges were formed by removals derived on one, and after that on the second face, yet not in an alternate scheme of knapping, but in an edge/surface analogical or surrounding

scheme of knapping. In case of the WH\_130 and WH\_56 artifacts, due to greater convexity of both edges, and insignificant tip exposure, the retouch overlaps the tip as well. Removal series are also derived from the tip's edge which forms their specific shape and makes the artifacts look more like tool bases. This suggests that the tip and its exposure were not an important element of these tools.

It is interesting to notice that the WH\_56 tool together with WH\_X608 are, in terms of subsequent removal sequences arrangement, mirror images of one another (Fig.122). Those tools, in this respect, look like two parts (tip and base) of one broken tool, and each of the removal sequences on the first of them has its analogy on the second of the tools.

One may conclude that the two artifacts (WH\_X608, WH\_56) **were designed as tools with a transversely formed base**, since the transversal breakages were created during the manufacturing process or even before its commencement. What is more, each of the **tools is characterized by different treatment of both edges and more precise knapping of the cutting edge**.

For the WH\_130 tool, the repair sequences derived after its breakage suggest that it had been used in the form in which it was found. Lack of an exposed tip and precise knapping of one of the edges are additional characteristics of the tool. Nonetheless, there is a possibility that the tool had a symmetrical shape before the fracture (resembling the shape of the forms from Szeleta-group I), but in the entire collection of Wahlen no specimen is of similar shapes. What is more, an artifact of identical shape and morphology, WH\_56, suggests that also this tool was broken on purpose.

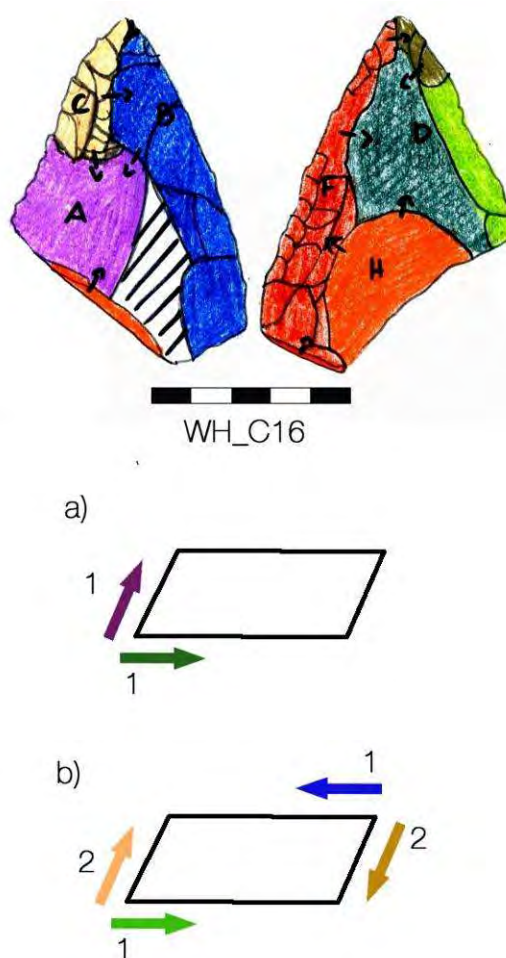


Fig.124 Knapping scheme of WH\_C16 tool shown in cross-section. An alternate scheme of knapping.



Two other tools of the described group (WH\_C16, WH\_4c) have two fracture scars each, which suggests that these tools were broken intentionally. Or, at least after the first fracture it was decided to repair them and continue their exploitation. Both tools have, however, a very strongly expressed asymmetry in the treatment of both edges. The profile of one edge is straight and retouched meticulously, whereas the second one is sinuous and retouched only at the tip. These tools resemble the artifacts with a broken base from the Lenderscheid site (group I).

### Group III

The third group of artifacts includes the two tools WH\_49 (Fig.125) and WH\_IIIa and perhaps the WH\_107 preform which exhibits some features similar with the other two. These tools are characterized by **symmetrical design, and symmetry in the treatment of both edges which are straight and convergent towards the tip**. The tip, even though it is exposed, was not retouched more accurately than the rest of edges. Additionally, the tool **has a base in the form of transversal surface formed with a single transversal fracture**. In publications, these tools were described in as the tips of leafpoints (Fiedler, 1994, Abb. 105; Junga, 2009, Taf. 41).



*Fig.125 WH\_49 tool. a) breakage scar in the tip part, visible breakage surface smoothening, b) breakage surface in the tip part in a side projection, c) breakage scar on the base, rough, non-smoothed breakage surface visible; the arrow marks observable percussion point, d) base breakage surface in a side projection, e) tool upper face after joining the two fragments.*

The artifacts have two techno-functional units treated differently:

**A) Cutting edges.** Both are treated uniformly and formed with alternate sequences of semi-flat and flat removals. The WH\_IIIa tool, because of its considerable thickness, was formed with semi-steep removals and the retouches near the tip are also small, semi-steep removals.

**B) Base.** Formed by a transversal breakage with an impact point in the middle of one of the surfaces. In case of the WH\_49 tool it was additionally polished to enhance its regularity after the fracture.

The most interesting of the discussed tools is WH\_49. In publications, the tool was treated as the tip of a broken leafpoint. The collection contains a transversally broken base which refits the broken tip. This base was removed from the tip at an early knapping stage, after forming the tool shape, but before final edge formation. The percussion point is clearly visible at the base, in the middle of the upper face, which constituted the point of impact while separating the base from the tip. More interestingly, the fracture scar was rough due to the nature of raw material used for tool manufacturing (it is a badly calcitated sandstone). The base of the tool's tip, however, is perfectly flat, which indicates that the tool was polished after the fracture, so that the roughness and irregularities of the base surface could be smoothened. The abrasions on the removed base fragment's upper face, which caused the obliteration of removals, as well as the fragment's biplan character, may prove that the upper face of the broken base was used to polish the fracture scar on the tip.

After the tip removal, which, judging by polishing traces (Fig.126), was intentional, further tool knapping was conducted. First, two series of thinning removals on the upper face were done. Next, a series of small removals on both faces, aimed at correcting both edges profiles. As a result of all those actions, a tool in the form of a highly elongated triangle was created, with convergent edges and a transversal, flat base surface. The tool in this shape is 12.4cm long.

The second tool included in this group, of a very similar shape, does not have an exposed tip. The tool has fracture traces at the tip. The breakage appeared at early tool manufacturing stages, during surface formation or before its exploitation began. There is also the possibility that the tool was reshaped into its contemporarily observed form after the fracture, and that beforehand it had looked completely different. Nevertheless, when analysing the removal sequences visible on the tool, one can conclude that edge knapping was done in order to form a symmetrical tool with convergent edges. The tool does not display traces of intensive work aimed at removing the fracture scar at the tip, which results in the creation of a tool with convergent edges and a blunted tip. The edge formation process with repeated faces change suggests, though, that edges profile and their symmetrical character were important in the production process. After a transversal fracture which occurs at the end of the production process, an additional retouch which increases tool symmetry is derived near the base. Based on this tool's manufacturing process it may be concluded that the edges and their profile were of more importance than the exposure of the actual tip which remained blunted.

The knapping scheme had been very similar for both tools described, though it is conceivable that the WH\_IIIa artifact was not remodeled from another tool. However, it seems that the WH\_49 tool was planned to be so from the very beginning, and the final result does not stem from its rejuvenation, on the contrary, it is the final result of its knapping.

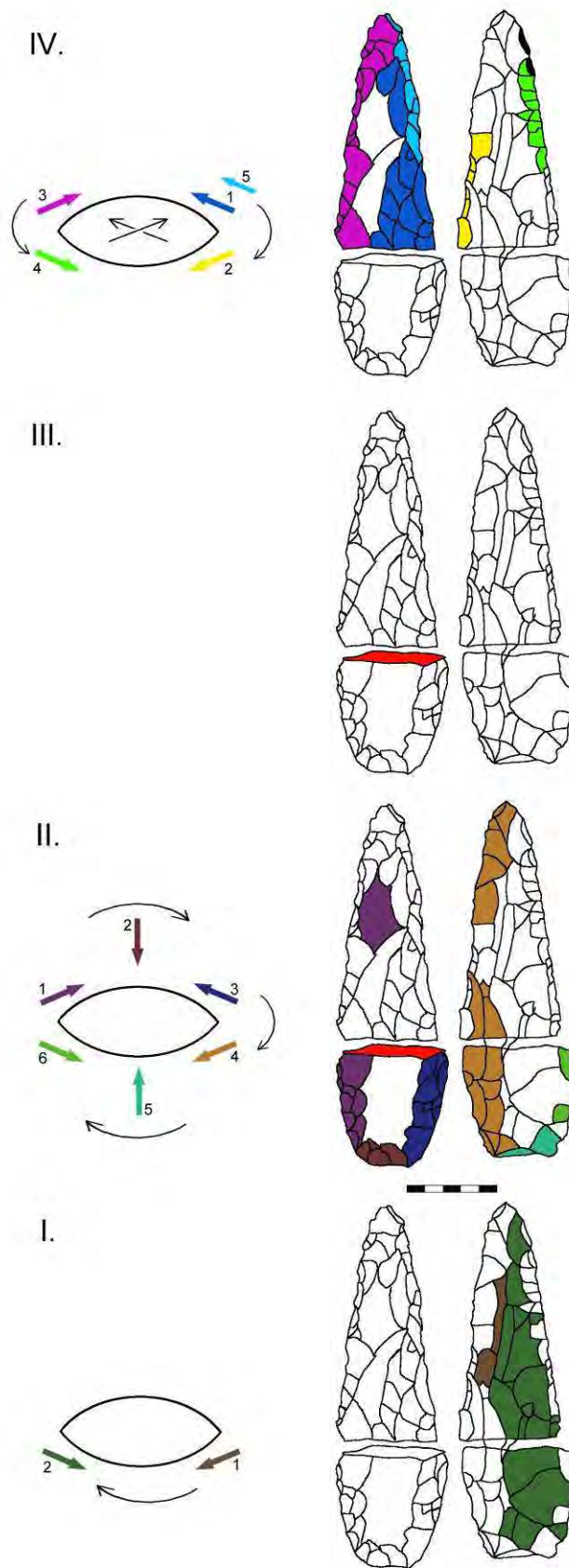


Fig.126 Group III tools knapping scheme on the example of WH\_49 artifact shown in cross-section. Numbers I to IV correspond to knapping stages described in the text.

This process can be divided into three stages:

**I. Surface knapping.** Done in a surrounding scheme; starting from two series of flat removals on the lower face through removals onto the upper face from one edge, then removals from the base and closing the stage, removals onto the upper face from the second edge.

**II. Tool thinning.** Probably constituting part of an earlier production stage. It consisted of two sequences of flat invasive removals onto the lower face, separated by a series of steep removals onto the base. This arrangement of sequences once again points to the fact that the base is an integral tool part, and is formed at the stage of particular surfaces formation (Fig.126).

**III. Base surface formation.** It was formed by a percussion introduced onto the middle of the upper face. The percussion caused splitting the tip from the base. It is not known whether the base was removed because of its thickness and errors (hinged removals), which would complicate further tool thinning in this area. It is also possible that the tool was originally meant to have a base formed with transversal breakage. The second solution may be indicated by the existence of numerous other tools on the site, with bases formed through transversal fractures.

**IV. Edge formation.** Made with a series of fairly invasive first, and then gradually smaller flat removals. These sequences are designed not only to correct the edge profile, but also to shape the edges and increase the tool symmetry (this is pointed to particularly by the E and I sequences—Pl.176, which, located alternately to one another, constitute the last stage of symmetry correction.

The WH\_107 tool was included in this artifact group due to a fairly typical initial knapping scheme observed on the WH\_49 tool, which, at the initial stage, was knapped by deriving sequences from one edge, then a sequence from the base and next, a sequence from the second edge. The same knapping scheme is visible on the WH\_107 tool, both on the upper, as well as lower face. However, the attempts to thin the tool with even more invasive semi-steep removal series were futile, and the tool was not finished. In addition to that, it was broken at the tip. Perhaps this is a deliberate breakage trace, aimed at tip removing and its further utilizing; as well as eliminating the base part which was impossible to be further knapped.

## Group IV

The last group is made of tools which resemble the artifacts from group III. Their characteristic feature is a triangular shape, symmetrical straight convergent edges, an exposed tip and a base formed with a transversal fracture (Fig.127). What distinguishes them from the tools of the previous group is their plano-convexity and different treatment of both edges. One of them is retouched and rejuvenated with great precision, whereas the second is formed via a series of semi-steep, blunting removals, and it has no retouch. This group includes two tools: WH\_52g and WH\_37a.

On the tools from this group, one can distinguish the following techno-functional units (Fig.127):

**A) Cutting edge.** Formed with series of flat and semi-flat removals on both faces. The final retouch is performed onto the upper face, it forms a straight edge.



**B) Back/distal posterior edge.** Formed either with a series of semi-steep or semi-flat removals onto the upper face, with or without a retouch restricted to the area at the tip solely, the process being characterized by low regularity. As a result, the edge has a sinuous profile.

**C) Base.** Formed with a transversal fracture. The fractures appeared either at the end of the tool manufacturing process, or the tools are the tip fragments of broken, larger cutting tools. However, the collection of Wahlen lacks tools that could be considered as unbroken forms, corresponding in their shape and morphology with the tools of group IV. Thus, it seems justified to define those tools as finished forms with a base deliberately formed by a transversal fracture.

Tool knapping ran similarly as in case of the remaining described artifacts from Wahlen. On this basis, it was possible to specify three stages:

**I. Surface formation.** The tool surface was formed with series of flat removals. In the case of the WH\_37a artifact, probably the oldest sequences constitute traces of a surrounding knapping scheme which proceeded the tip fracture.

**II. Edges formation.** It was performed in a surrounding scheme of knapping. The sequences were adjusted to the character of edge under creation. In case of the WH\_52g tool, the removals at the tip are always much smaller and more precise than further on the edge. An exception to this is a retouch series of the cutting edge. This series of flat, long removals rejuvenated the entire edge. It is possible that the more precise character of removals near the tip proves an attempt to maintain tip symmetry, achieved even at the expense of irregular, hinged removals derived on the distal posterior part's edge onto the upper face near the tip.

**III. Base formation.** If the described tools are to be seen as forms finished, and not accidentally broken, then the vertical fractures constituting the tool base should be treated as separate base-forming sequences. There are no traces of preparing the fracture via notches formation, or traces of edge retouches after breaking the tool.

The tools are thus characterized by symmetry in vertical axis, the presence of a base formed with a transversal fracture and the retouch of only one of the edges.

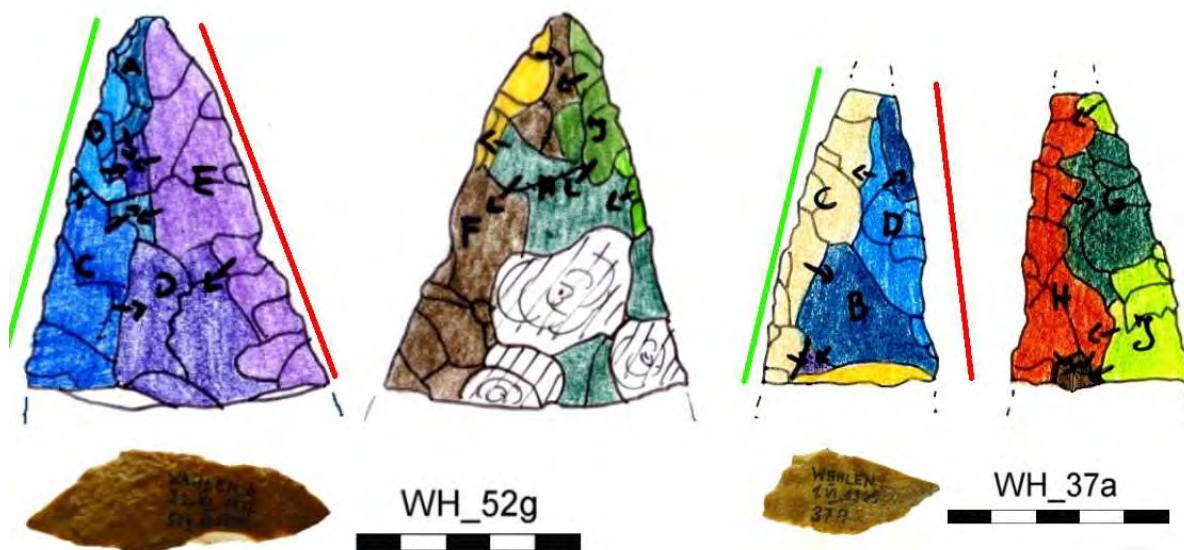


Fig.127 Techno-functional units arrangement on group IV tools. Red marks cutting edge, green marks distal posterior edge.

The examined Wahlen artifacts show a great technological discrepancy. On one hand, the tools of group III not only display shape symmetry, but they also have sequences targeted at a deliberate increase of the tool symmetry. They are also characterized by uniform treatment of both edges. The artifacts of group IV show symmetry in shape, though both edges are formed differently, and only one has retouch sequences.

As to the remaining tools, they are characterized by:

- **asymmetry in tool vertical axis,**
- **different treatment of both edges**, of which one is carefully retouched, and the other blunted,
- no exposed tip, or lack of care for the tip, i.e. performing rejuvenation sequences from the tip, or moving it off the axis,
- greater care for the edge than the tip,
- **deliberate base blunting** and low-precision knapping of the back edge and the base.

It must be noted, however, that not all of the described tools from groups I and II bear all the described features.

Artifacts from Wahlen also show no standardization of their production scheme, which is visible in their shapes variety. In general, their production process was done in a similar manner, through the formation of: basic surfaces, particular tool working edges considering their final specification, and eventually, if this was necessary, deriving rejuvenation series on the cutting edge and the distal posterior edge. Knapping was usually done in a surface scheme, an edge scheme or a surrounding scheme. Only in one case, at the stage of edges formation and retouch, an alternate scheme of knapping was dealt with (WH\_C16).



### 3.2.1.4. Greece

#### 3.2.1.4.1. Kokkinopilos

Eight artifacts from the Kokkinopilos site were analysed. It was possible to access all the artifacts from the study conducted by Higgs (Dakaris, Higgs & Hey, 1964; Higgs & Vita-Finzi, 1966) and Runnels (Runnels & Van Andel, 1993), which are stored in the collections of the Archaeological Museum of Ioannina. The 3638 and 3622 tools are the only artifacts which come directly from B Zone layer in the testing trench opened on Kokkinopilos  $\beta$  site (Dakaris et al., 1964, Fig.12.j). Six artifacts also come from studies from the 60's, however, these were found on the surface (Dakaris et al., 1964, Fig.21.56–60). These were the only bifacial forms found in a collection composed of several thousand artifacts.

Among the artifacts, the bifacial tool discovered by Runnels in 1993 (Runnels & Van Andel, 1993) and identified as a Micoquian handaxe was not found. A broken, bifacial piece coming from the Kokkinopilos  $\beta$  site and published with the analysed 3638 tool (Dakaris et al., 1964, Fig.12.j) could neither be found in the analysed collection. Among the revised artifacts stored in the Archaeological Museum in Ioannina, also no flakes were found, which could be clearly defined as originating from bifacial tools production. The Kokkinopilos collection, however, is marked by the presence of numerous flat, small Levallois cores, Levallois points and flakes. Among the flake inventory, side scrapers retouched on one edge are predominant. All the analysed bifacial tools were published under the name of leafpoints (Dakaris, Higgs & Hey, 1964).

The tools can be divided into three groups.

#### Group I

Group I consists of bifacial artifacts in the form of side scrapers retouched on one edge only (Fig.128). This group can include the unpublished pieces: 3622 (from site  $\beta$ ) and 64.56.B:4 (from surface collection). The 64.56.B:4 artifact is preserved only partially. Both of these tools are characterized by the presence of one straight retouched edge. The other edge is S-shaped and thinned on the lower face with flat, deep removals. These tools show concern for the profile of one edge solely. Additionally, the 64.56.B:4 tool shows no concern for the tip and its scarce exposure. Edge retouch partly overlaps with the tip. The tool, due to thinning percussions, is slightly bent upwards at the tip.

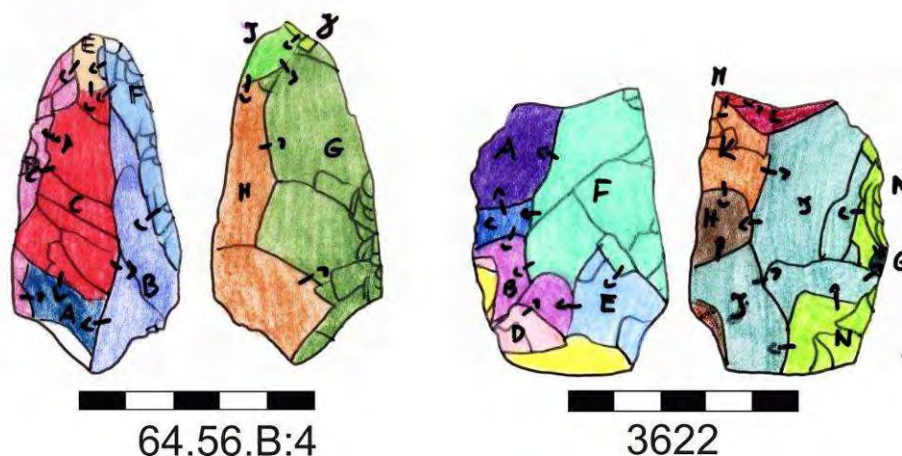


Fig.128 The analysed Kokkinopilos group I tools comparison.

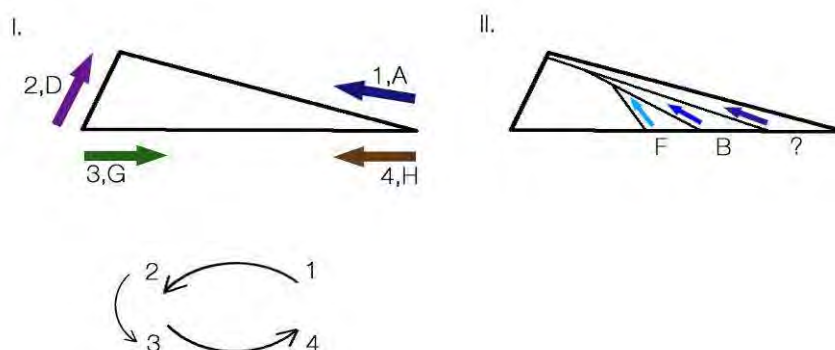


Fig.129 Group I tools plano-convex surrounding knapping scheme and subsequent cutting edge rejuvenations showed in cross-section.

The tools were formed in a surface surrounding scheme, though the 64.56.B:4 artifact shows a specific technique of edge formation (Fig.129). First of all, a flat surface of the upper face was formed on the tool through an extensive percussion introduced on the upper face (A sequence—Fig.129.I). Then, the back's edge was made with semi-abrupt removals derived from the other edge (D sequence—Fig.129.I). The third stage consisted of flat removals on the lower face, derived from both edges (G and H sequences—Fig.129.I). The result was a tool with triangular cross-section and a very acute angle at the cutting edge. Perhaps prior to deriving a series of semi-abrupt retouch (B sequence—Fig.129.II) the tool was subsequently resharpened, and with the absence of removals correcting the angle on the lower face, the tool became gradually blunted (Fig.129). The knapping of the other described artifact proceeded differently, due to fractures on both ends, which considerably reduced the retouched edge's length.

## Group II

This group consists of four artifacts: 10014, 10015, 10016 and 3638 (Fig.130), which are of small size and precise knapping. The 3638 tool has transversal breakage scars on both ends and signs of rejuvenation as well as of trials to correct the shape after each breakage. For this reason, the artifact was included in group II on technological grounds solely, not the typological ones (no exposed tip, no converging edges).

The three remaining artifacts are characterized by significant tip exposure, intensive tool shaping during several subsequent knapping phases (10014, 10015, 10016), knapping regimen modification after a committed error, if necessary, to achieve the assumed form (10016), extending tool symmetry even at the expense of edge blunting (10015), resigning from retouch near the tip to achieve symmetry (10016), tool thinning at the base (10016, 10014), tool shaping at the base (10014, 10015, 10016).

On the tools of this group, two techno-functional units can be distinguished:

**A) Edges.** Both formed as parallel by rule (exception: see the 10016 description), slightly convex, converging at the tip. The apical part marked by greater diligence in knapping. Both edges have a similar profile, which is not completely straight, but displays only slight sinuosity associated with deriving consecutive removal series which formed the edges shape on both tool faces. Although the edge formation went onto both faces, the series derived onto the lower face seem to be more flat than the ones applied onto the upper face. One can see that the percussions introduced on the lower face are aimed at either correcting the edge angle before applying the half-flat series onto the upper face (e.g. the series of S and

T and then G, I, J on the 10016 tool–Fig.130), or at minor correcting action after the upper face retouch (e.g. I and S series on the 10014 tool–Fig.130).

**B) Base.** Formed with semi-abrupt or semi-flat, thinning removals derived from the base (L series on 10014–Fig.130), or from one of the edges. In case of the 10016 tool, the angular breakage on the base was used as an appropriate platform for series of flat, angular removals which thinned and shaped the tool (P, U and G series–Fig.130).

In general, the tools were formed in a surface/edge surrounding scheme of knapping. Due to the specific knapping scheme of each tool, as well as actions undertaken during knapping, which clearly point to the created tools nature, it was decided to describe each of the artifacts separately.

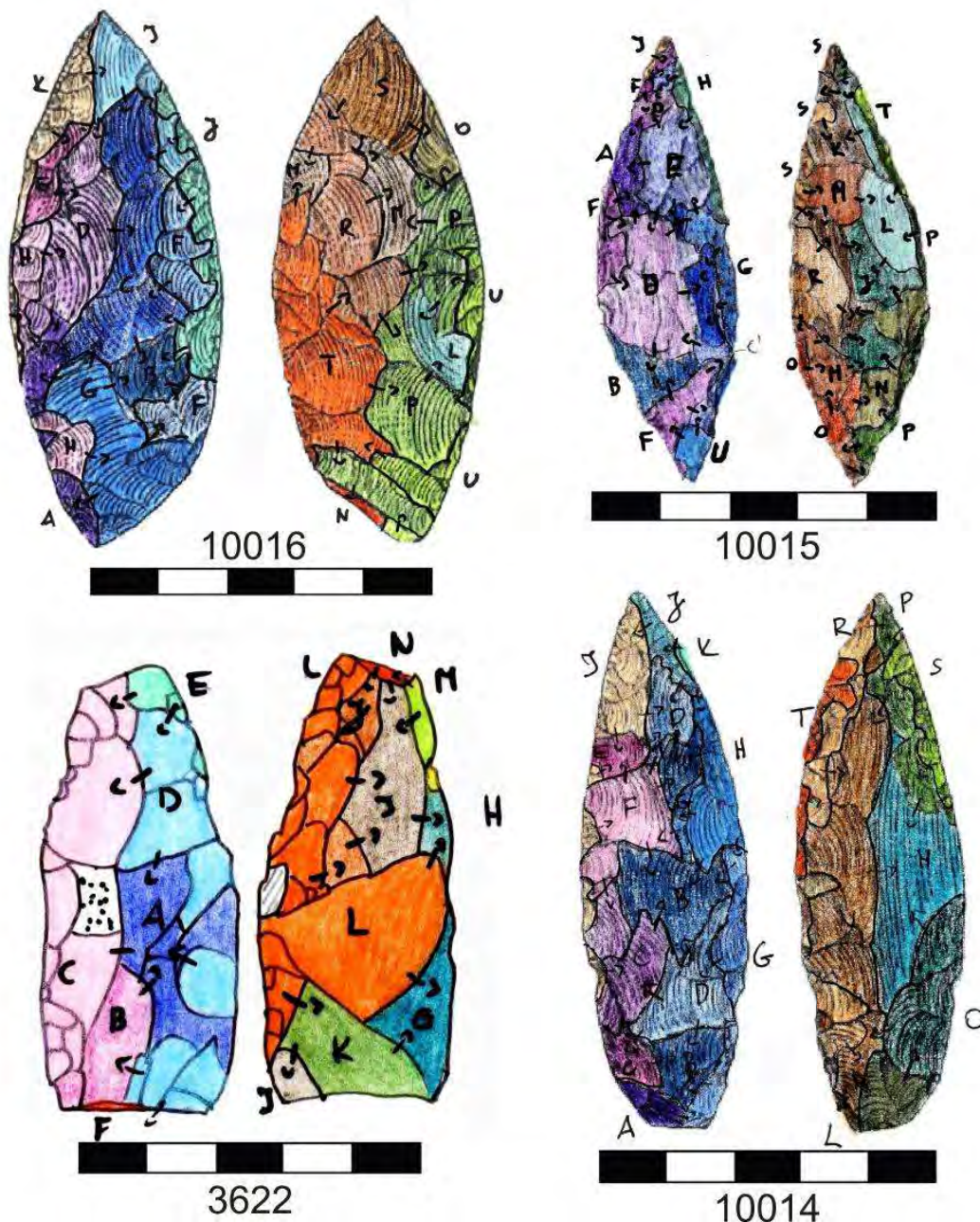
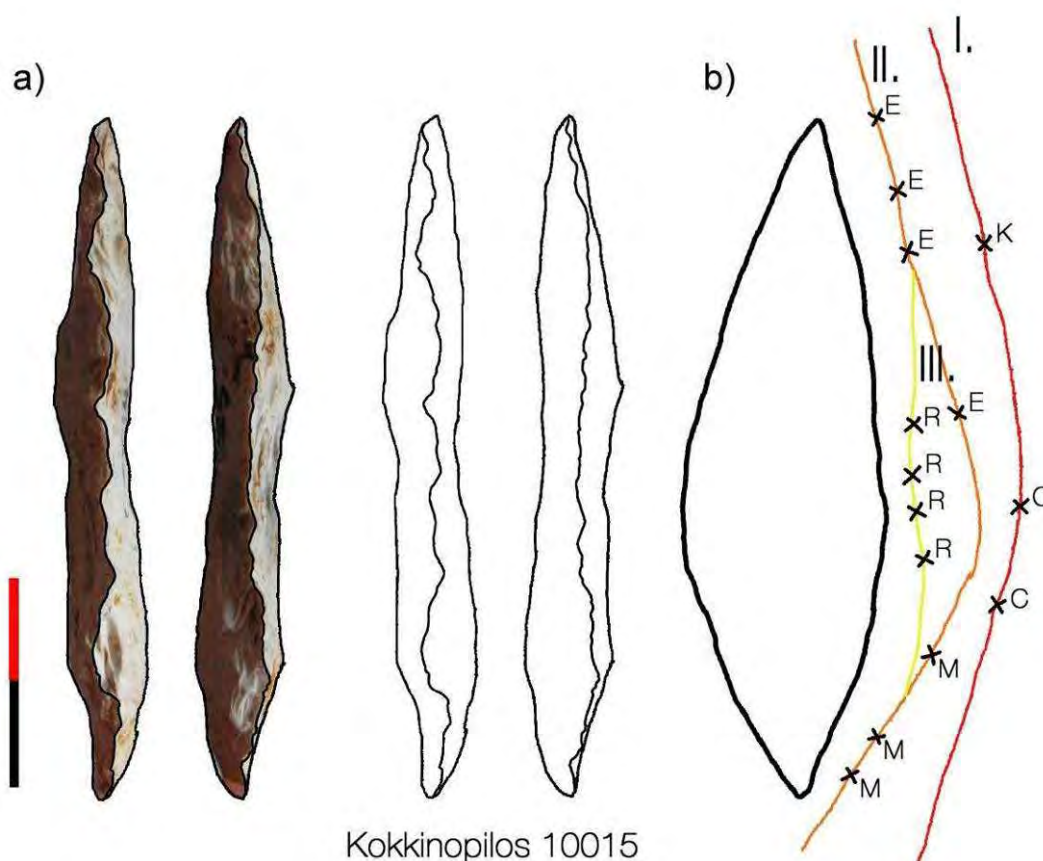


Fig.130 The analysed Kokkinopilos group II tools comparison.





*Fig.131 Tool 10015 a) edge outline; b) shape reconstruction showing tool shape correction on one of its edges.*

A good example depicting a shaping scheme is the 10015 artifact. After initial surface formation, the next stage included deriving removal series, angular to vertical axis, both at the tip (L and E series–Fig.130) and at the base (N, M series–Fig.130). At the same time, series of flat removals were derived onto the face opposite to that which received angular percussions (D and R series–Fig.131b). They were aimed at correcting the edges outline and shape in the tool's middle. Both edges were formed alternately at this stage, which resulted in biconvex cross-section. At the last stage, shape correction took place, first at the base, and then at the tip. These marginal removals often blunted the edge (U, H, T series–Fig.130) for the sake of obtaining its straight outline. Consequently, a small-sized tool with a sharp, exposed tip was created (Fig.131b). The tool is not quite symmetrical, though, and one of the edges is more convex than the other one. None of the removal series on the tool is a typical retouch, understood as removal series aimed only at edge sharpening and its formation. The derived removals, especially at the last knapping stage, are not regular, they are often hinged and do not form straight edge profile (Fig.131a).

The 10016 tool displays series of actions undertaken to achieve the desired tool shape despite the committed error of performing high hinged percussions at the tool tip. At initial stages, the artifact was formed in a surrounding, plano-convex scheme observed on other tools. In the course of tool shaping and thinning on the upper face, at the tip, removals were derived, which did not cross the centre, but wedged themselves out close to edges in the form of hinges (D and E series–Fig.130). At this stage, the tool had already had an angular fracture at the base, which prevented potential artifact orientation change. It was decided then, to undertake an attempt at forming the tool through intensive knapping of the opposite edge, so

that further knapping of the edge with hinges would become unnecessary. At first, the tool's shape on the broken edge was corrected, and next, knapping was continued on the opposite edge with series of flat, extensive removals onto the lower face. One of the flat removal series (S-Fig.130, Pl.215) was designed to cross the entire tool width and remove as much as possible from the other, damaged edge (this operation was successful). During final edge shape formation, it was also decided to derive a semi-abrupt, extensive percussion at the tip, in order to correct symmetry at the tip (instead of marginal retouch series, such as on 10014). At the very end, the knapper came back to the damaged edge at the tip and formed it with a series of small, semi-abrupt, tip-forming removals.

This artifact constitutes an excellent example of a tool, which illustrates the desire to achieve the presumed shape, and the change of scheme or typical behaviours so as to achieve the intended purpose, which, in this case, was a symmetrical tool with slightly curved edges converging at the tip.

A similar pattern of actions can be observed on the 10014 artifact. In this case, however, intensive knapping of one of the edges was related not so much to the damaged state of the opposite edge, as to the desire to maintain a straight edge profile at the angle with a ventral surface (in this case a flake tool is being dealt with). In order to retain the ventral surface at one of the edges (which guaranteed straight edge profile), intensive knapping of the opposite edge was necessary, at which probably also the flake's butt and bulb were present. After the formation of initial tool shape in a surrounding scheme, and after thinning the tool's upper face, the formation of edge at the flake's ventral surface was commenced, followed by intensive knapping of the second edge onto both faces. It was probably a mistake to form the entire edge at the ventral face, including the retouch at the tip, because it prevented symmetry correction during the retouch derived on the other edge. As a result of the adopted scheme, a tool with a slightly bigger bend at the edge and at the tip placed off tool axis was created.

Such tip lifting off the axis resembles Ripiceni Izvor tools (e.g. MIV.3856 or MIV.3859) which, after repeated rejuvenations at the tip, acquired a similar final shape. However, the 10014 form of Kokkinopilos is characterized by the presence of two edges with a straight profile, where the profile of the edge formed as first, at the angle with the flake's ventral surface, is somewhat more straight than the opposite edge's profile, which bears traces of repeated shape forming knapping series. It is also worth mentioning that the edges display signs of shape formation on their entire length.

The last of group II tools has transversal breakage scars on both tips. First, tool base was broken, and later its tip. After each breakage an attempt to repair the tool was undertaken through deriving series of thinning removals aimed at breaking and removing the scars. While in case of breakage at the base, only edge outline was corrected, all the same the broken tip required being formed anew. In order to repair it, two alternate removal series at the breakage were derived (M and E series-Fig.130), but after that further rejuvenation was abandoned. The artifact is also marked by no retouch on any of the edges.

The artifacts of group II are characterized by **devoting attention to tool shape at subsequent knapping stages**. There is a visible adjustment of the knapping regimen to the specific conditions, with constant striving for achieving the presumed shape. The artifacts **have an exposed tip** (failing to form it results in abandoning the tool). **Both edges are treated uniformly** by deriving analogous removals. There are no observable differences in the ways of knapping them, which is a feature characteristic of knives.

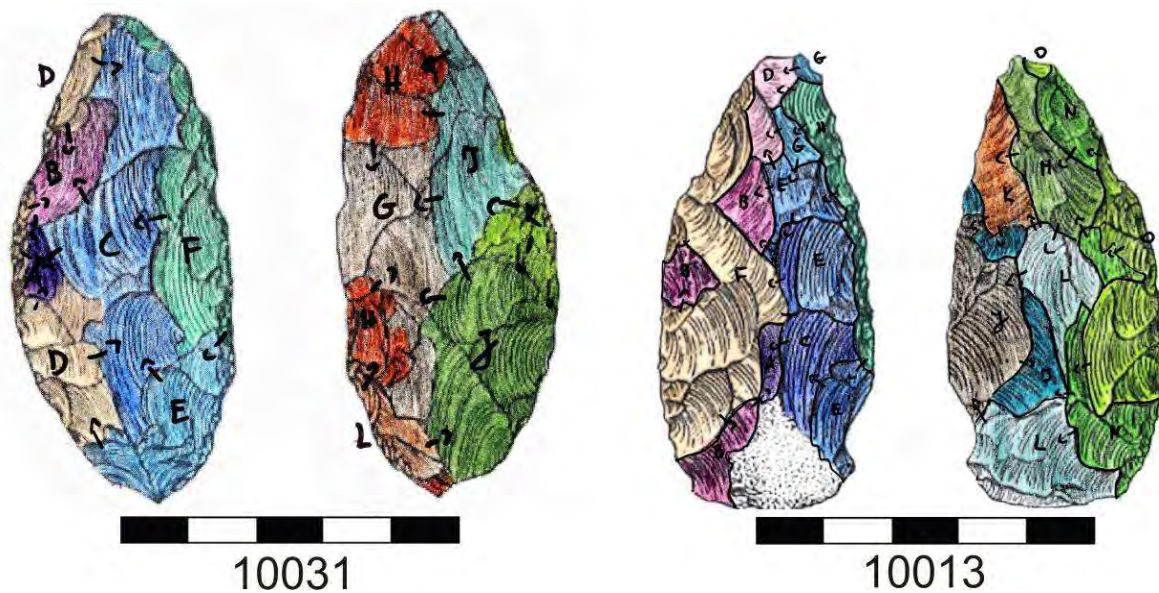


Fig.132 The analysed Kokkinopilos group III tools comparison.

### Group III

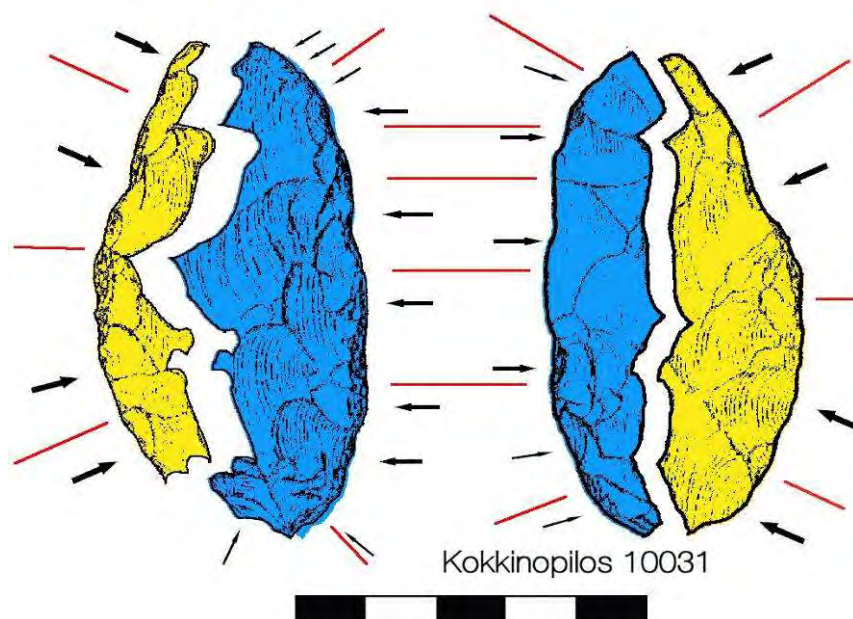
The third group consists of two artifacts, 10031 and 10013 (Fig.132). These tools are characterized by single, straight cutting edge (Fig.133–blue and brown) and another, convex edge which is retouch-free (Fig.133–purple and green). In addition to this, there is no work applied to tip exposure on these tools, and some percussions actually result in its removing. The base is left unknapped and has traces of cortex (10013), or is formed as a separate surface (10031).

The 10013 artifact is particularly interesting, with its flat removals derived alternately in relation to each other, and extensive removal series which formed its surface. This tool was formed in an edge scheme of knapping, but it should be noted that later removals on the cutting edge might have covered the earlier scars, thus resulting in such knapping scheme interpretation. After the formation of the lower face's surface, the tool was rejuvenated several times with angular removal series derived from the angle at the tip, flat on the lower face and semi-flat on the upper face. These actions led to the formation of an edge positioned angularly to tool axis. As it was already mentioned, subsequent series, which were probably traces of edge rejuvenations, might have been connected with gradual rejuvenation of the opposite edge. Still, the scars could have been covered by later removals which were derived at the end of knapping, in the form of flat removals which were extensive at the beginning, and became marginal towards the end. A specific feature here is lack of percussions onto the cutting edge's lower face, which allowed to maintain straight edge profile. Tool thinning was done with series of angular removals onto the lower face.

The second of the tools included in this group also **shows lack of concern for the tip and has a straight, retouched edge**. In contrast to the one described earlier, it has a base formed with semi-abrupt percussions.

A characteristic feature of Kokkinopilos bifacial tools is performing flat, extensive removal series on both faces, most often alternately. This feature, in some cases, very much resembles the manner of removing the Levallois flakes, which in Kokkinopilos were removed from very thin core/nodule with a curved lower surface and flat flaking platform. Perhaps the gradually overlapping, flat, extensive removal series should be taken as a feature specific of the analysed assemblage.





*Fig.133 Group III tools techno-functional units arrangement based on the 10031tool. Distal posterior part marked in green on the lower face and in violet on the upper face. Blue marks cutting edge on the upper face and brown on the lower face. Additionally, removal directions forming each edge were also marked. Visible asymmetry in both edges treatment.*

### 3.2.1.5. Hungary

#### 3.2.1.5.1. Jankovich Cave

The twelve analysed artifacts from the Jankovich cave site definitely do not constitute a representative group. This is so since it was impossible to examine the artifacts from the permanent exhibition at the National Museum in Budapest, which are leafpoint forms, most representative of the described site. Nevertheless, it was possible, due to the courtesy of the National Museum in Budapest, to access the artifacts stored in the Museum. The analysis entailed 12 bifacial forms, all of which display edge symmetry. Among the analysed artifacts, all are referred to in the literature as leafpoints (Allsworth-Jones, 1986; Gábori-Csánk, 1993; Mester, 2008).

For reasons mentioned above, the analysis results may not be conclusive and representative for the entire site. As well, they are only a starting-point for the discussion on the production technology of bifacial tools from Jankovich cave.

The tools are made on liver-coloured or olive-green radiolarite. Only one artifact (94.915.40) is made of flint. The artifacts made of radiolarite give the possibility of a very precise analysis, since all interscar ridges are very clear and readable in terms of chronology.

The analysed Jankovich artifacts are generally characterized by small size. Their maximum length is 6.8cm (mean length 5.28cm), maximum width 3.8cm (average width 3.02cm), while at the same time being of very small thickness (maximum thickness–1.1cm, mean thickness–0.94cm).

As a result of edge treatment, the described artifacts can be divided into two groups.

#### **Group I**

Group I had nine artifacts included in it (94.915.13, 94.915.15, 94.915.16, 94.915.40, 13.917.1, 13.917.2, 61.925.2, Pb559 and Pb560). These are artifacts with a rounded base, usually blunted with a steep retouch, and two converging edges, both retouched on the upper face or alternately (Fig.134). Intensive retouch occurs on the edges near the tip, which thus becomes more exposed, and sometimes it even creates a kind of protrusion (94.915.15, 94.915.13 and Pb559). The artifacts show rejuvenation signs, most often of both edges.

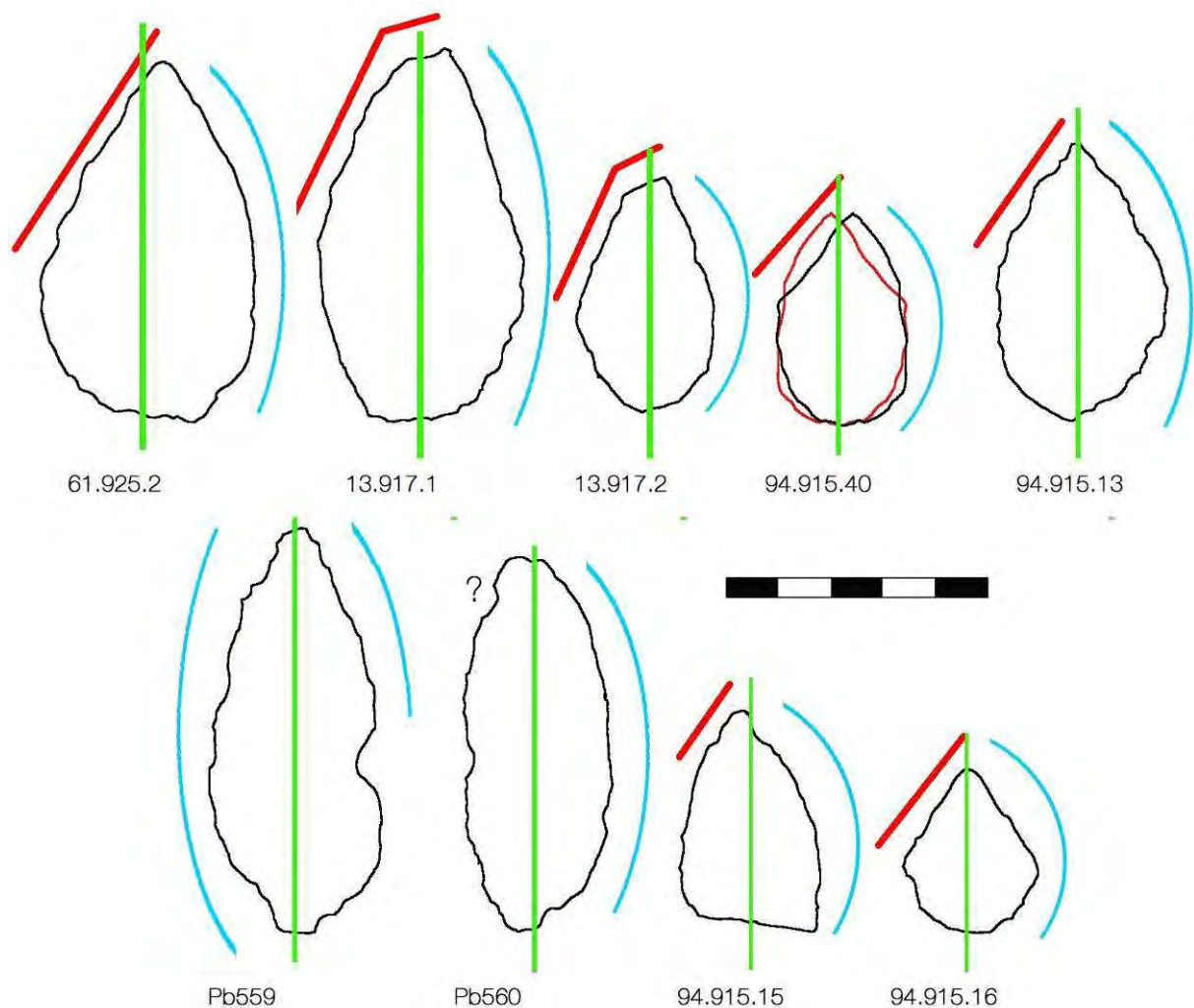
On the tools of this group, three techno-functional units can be distinguished (Fig.134):

**A) Cutting edge.** Most often straight, retouched on the entire length on the upper face. On the lower face, only flat and semi-flat edge angle correcting removals are derived. In most cases, this edge (except 61.925.2), has traces of at least few rejuvenation stages focused around the tip.

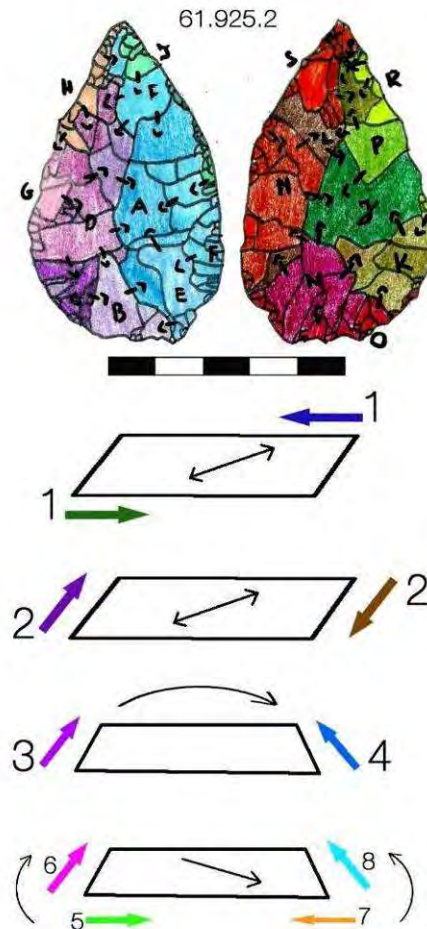
**B) Distal posterior edge.** Positioned more angularly to the cutting edge, which in most artifacts of this group causes the tip to move out off tool vertical axis in the direction of cutting edge. This edge, if it bears any retouch sequences, has them placed closer to the tip. A marginal retouch is then performed on the upper face in most cases. An exception here is the 94.915.40 tool, which has overlapping series of flat thinning removals introduced on the distal posterior part's lower face. Retouch and removals on the distal posterior edge are less regular than the ones on the cutting edge and relate only to selected edge parts (usually the apical ones). This edge bears rejuvenation traces, performed through removal series on two faces. Two artifacts (13.917.2 and 13.917.1) have fracture scars on the distal posterior edge after applying semi-abrupt angular removals from the tip onto the upper face at final tool

rejuvenation stage. Most likely, this action resulted in eliminating the exposed tip, probably formed like that during subsequent rejuvenations. It also allowed for effective tool thinning at the tip. Thus, the later derived retouch on the cutting edge is less abrupt and does not blunt the edge completely.

**C) Base.** Formed into a rounded edge, transversal to tool vertical axis. The base is shaped with angular removals derived from the distal posterior part; as well as with separate sequences of flat removals derived from the base. The edge itself is eventually blunted with an abrupt marginal retouch series. The base, during subsequent rejuvenations, can also be corrected (94.915.16). Contrary to group II artifacts, the base edge retouch is not precise enough to consider it as the tool's functional edge. The 94.915.15 artifact is an exception; it was broken at the base and has numerous rejuvenation sequences there. The sequences are aimed at removing the angles near breakage, or flattening the fracture scar. Despite these operations, the transversal breakage scar was not fully removed.



*Fig.134 Group I tools from the Jankovich cave: techno-functional units arrangement. Red marks distal posterior edge, blue—cutting edge. Green marks tool vertical axis. The 94.915.40 artifact was presented in mirror reflection in order to present analogies in edges arrangement (black contour). Red presents the artifact in its initial projection.*



*Fig.135 The 61.925.2 artifact knapping scheme presented in cross-section. It pictures tool formation in plano-steep scheme first, and in biplane scheme at further stages.*

Group I artifacts show no standardization in the adopted knapping and rejuvenation schemes. However, this may be related to several rejuvenation phases, overlapping on tools' surface. These make it difficult to determine full knapping schemes. Still, there is an observable tendency to rejuvenate tools in an edge analogical scheme of knapping, where first preparatory and correcting removals were derived on the lower face of distal posterior edge. This was followed by a retouch on the upper face of that same edge. After repairing the distal posterior edge, this procedure was repeated on the cutting edge, also in a bottom-top scheme (Fig.135). Such scheme can be observed in rejuvenation phases of the 61.925.2; 13.917.1; 94.915.13; 94.915.40 artifacts.

Most artifacts have numerous rejuvenation traces which do not allow for the analysis of initial tool formation stages. Only the 61.925.2 artifact seems to be slightly rejuvenated and retouched again, which gives a possibility to observe previous manufacturing stages: the artifact surface formation proceeded in a fully alternate, plano-steep scheme of knapping. First, flat, extensive removals on both tool faces were derived alternately. Then, semi-flat/semi-abrupt alternate removals on the second face of each edge were derived. Contrary to bifacial tools from other sites, which had the analogous technique of nodule formation applied, for the Jankovich artifacts this technique led to the formation of extremely thin, almost biplan artifacts (Fig.135). Small artifact thickness had its drawbacks, though: they mainly manifested themselves in problems with rejuvenation and edge resharpening. Therefore, it did not make space for deriving semi-flat removals onto the lower face and

appropriate angle correcting. Thus, after several rejuvenation phases, the tools took an almost rectangular cross-section with two flat surfaces and edges blunted with an abrupt retouch.

Most of the analysed artifacts from this group have a characteristic shape (Fig.134) with a rounded base, angular distal posterior edge, vertical cutting edge and an exposed tip. The described shape is the result of applied tool formation and rejuvenation technique. This technique assumed base formation by deriving angular removals from both edges at the base, and especially from the distal posterior edge. As well, angular removals formed the distal posterior part closer to the tip. While, therefore, removals on the cutting edge were performed perpendicularly to vertical axis, the removals on distal posterior edge were angular (Fig.134), which led to the creation of specific shape repeated in subsequent shape forms. Of course, during subsequent rejuvenations, tool shape could have been changed, like in case of the 94.915.16 artifact, which is preserved in a heavily exhausted form and bears traces of multiple rejuvenations. Finally, after another base rejuvenation and retouches near the tip, due to a very small size, it acquired an almost symmetrical shape.

Pb559 is an interesting artifact, which has a very high hinge in the edge's middle, formed at the initial surface formation stage. This hinge prevented the use of edge, which ought to have been formed as the cutting edge. It resulted in changing the opposite edge into the cutting edge. Therefore, the tool bears traces of opposite edge's retouching and repairs. Only after its blunting it was decided to retouch the edge with hinge in its apical part (Pl.205).

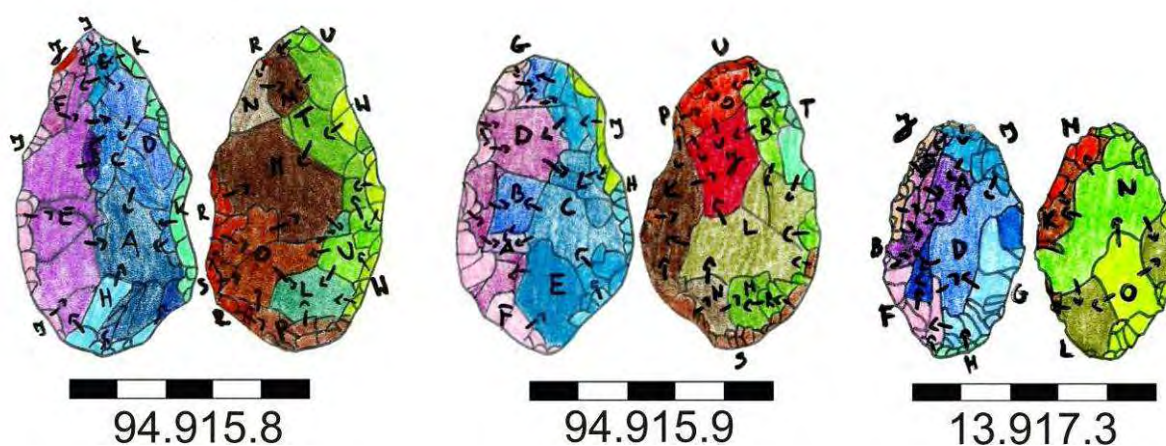
Another artifact classified as representative of group I, but still transcending the general description, is the Pb560 tool (Pl.206). The artifact has a removal which starts from the tip and as the adjacent part of distal posterior edge is parallel to the cutting edge. Generally, it resembles the negative of burin spalls. After removing/breaking the flake, the tool does not have any signs of further rejuvenations. Before last removal, though, the tool was much less symmetrical than currently. The tool probably did not have an exposed tip, yet, it bears multiple rejuvenation marks on both edges and tips, including the creation of small, semi-abrupt transversal working edge at the tip. Subsequent sequences indicate that the tool was used first on one, then on another edge, and then again on the first edge. This would explain its irregular shape.

It can be concluded that the artifacts of group I are tools with **differently treated edges, where only one edge is retouched on its entire length**. The artifacts also bear traces of **multiple rejuvenations and edge resharpening**, which usually entail the apical parts. The tools exhibit (except Pb560), **care for tip exposure and its preservation during successive rejuvenation phases**. However, as it is illustrated by 13.917.1 and 13.917.2 (Pl.207, 208), in some cases, the tip is removed with the aim of thinning the apical part of cutting edge. Subsequent formation and rejuvenation phases are not oriented at obtaining a symmetrical tool, but only at effective thinning and edge resharpening.

## Group II

The second group consists of three artifacts (13.917.3, 94.915.8 and 94.915.9) (Fig.136). Their characteristic feature is the presence of a rounded edge at the base and, in case of the 94.915.9 and 13.917.3 artifacts, also at the tip. The rounded edge is formed with semi-abrupt, regular retouch into a kind of acute working edge. These artifacts are also retouched on both vertical edges. Tools bear traces of numerous repairs. Characteristic of this group is not having traces of angle and retouch correcting removals, but using alternate edge retouching, first on one face, and in the next rejuvenation phase on the other face. Thus, the edge after several rejuvenation phases became sinuous in profile.





*Fig.136 The analysed Jankovich group II tools comparison.*

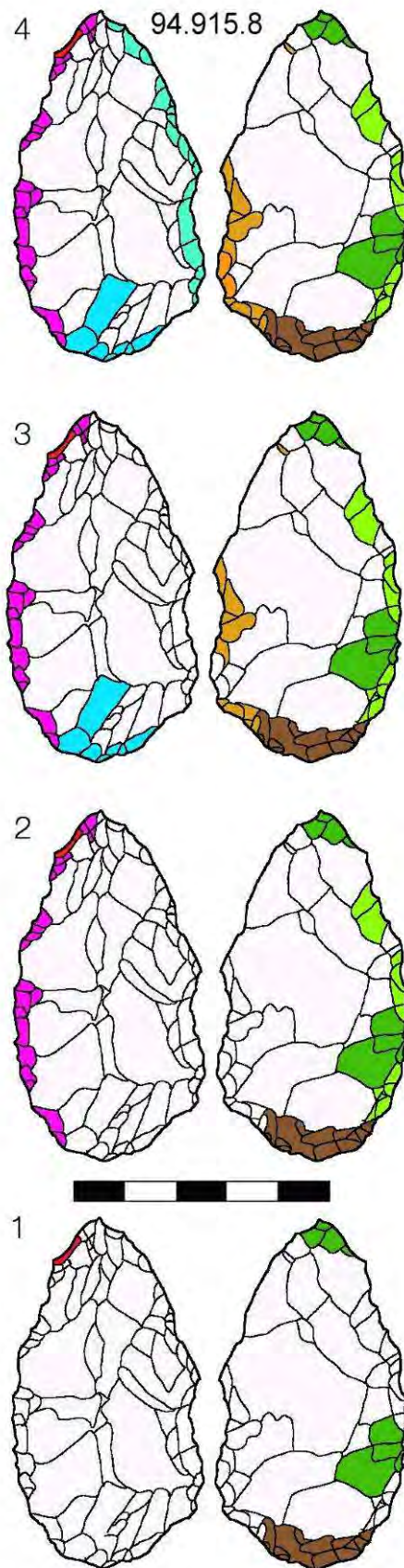
The 94.915.8 artifact has one acute working edge at the base, formed as one of the last tool rejuvenation phases. This may indicate that in this tool, vertical edges had previously played functional role, and at earlier stage of use, the artifact would have fallen into group I. The remaining two tools have two acute working edges, where one of them was formed after the other had been abandoned, which may indicate that those tools were repaired very intensively. After the destruction of particular edge, other edges were retouched and used, among them the base's edge, so as to create a sort of endscraper.

Scar pattern analysis shows that the described tools are artifacts not only rejuvenated, but also reorganized several times. Possibly, originally retouched on the vertical edge, during subsequent repairs (Fig.137) they were retouched semi-abruptly on one, and next on the second end, thus leading to the creation of an oval-shaped form.

During subsequent rejuvenations, these tools not only **present lack of care for shape and symmetry**, but also **absence of care for tip exposure and preservation**. The described tools' symmetry is related to the creation of two curved acute working edges, and not to a deliberate action of creating a tool with two converging edges. The side edges bear traces of **numerous repairs and are either blunted on almost their entire length**, or formed with semi-abrupt, alternate retouches forming a sinuous edges profile (94.915.8–Fig.137).

The analysed Jankovich artifacts have differently treated edges (group I); the artifacts have numerous edge rejuvenation/resharpening sequences and show no signs of concern for tool symmetry preservation neither during its formation nor rejuvenation. While the artifacts of group I show some care for tip exposure and preservation, in group II the artifacts have a semi-abrupt retouch at the base and at the tip (except the 94.915.8 artifact), forming here a separate working edge.





*Fig.137 The 94.915.8 artifact with several rejuvenation series on all edges. Numbers correspond to particular rejuvenation phases sequence.*

### 3.2.1.5.2. Sajóbáony Mész-tető

The analysis covered 17 bifacial artifacts from the Sajóbáony Mész-tető site. Five of them are completely preserved artifacts, and 12 are only fragments. From among the analysed artifacts, pictures of eleven appear in publications (Ringer, 1983; Ringer & Adams, 2000). Two artifacts (91.258.1 and 91.258.7) are referred to as leafpoints (Ringer, 1983 pp. 20, 24). Other forms are defined as: Babony type knives (97.2.1072–Ringer & Adams, 2000 fig. 7.2, 91.258.2–Ringer, 1983 p. 20), limaces (91.258.3, 97.10.71–Ringer, 1983, Fig.23), limandes (97.10.49–Ringer, 1983 p. 17), la Micoque-type points (97.10.63–Ringer, 1983 p. 22), la Quina-type side scrapers (97.10.50–Ringer, 1983 p. 24), bifacial knives (97.2.1970–Ringer & Adams, 2000, Fig.7.2), or biface amygdoid (97.10.16–Ringer, 1983 p. 16). It was decided to analyse the artifacts because of their bifacial knapping and nearly symmetrical shape. The artifacts are made of quartz-porphyr.

Among the discussed artifacts, several similar to each other in terms of morphology were distinguished; yet, these should not be regarded as functional forms, but as attempts at finding analogies in the artifacts' production, and possibly rejuvenation schemes.

#### Group I

It is formed by the two mentioned rectangular segments (97.2.1160 and 97.10.64) which are characterized by the presence of two transversal fractures on both ends. The tools also have two parallel edges, of which edge I retouched first is more straight, whereas edge II, retouched after the second fracture is more sinuous and has notches at fracture scars

The production of 97.2.1160 tool proceeded in the following way (Fig.138):

**I. Surface formation.** Through deriving flat, extensive removals in an alternate knapping scheme (this is the only tool on which one can observe this scheme being applied in Sajóbáony Mész-tető).

#### **II. Transversal fractures at the base**

**III. Edge I formation.** Semi-abrupt removals on the upper face, forming a notch on the lower face which might have determined the placement of another fracture.

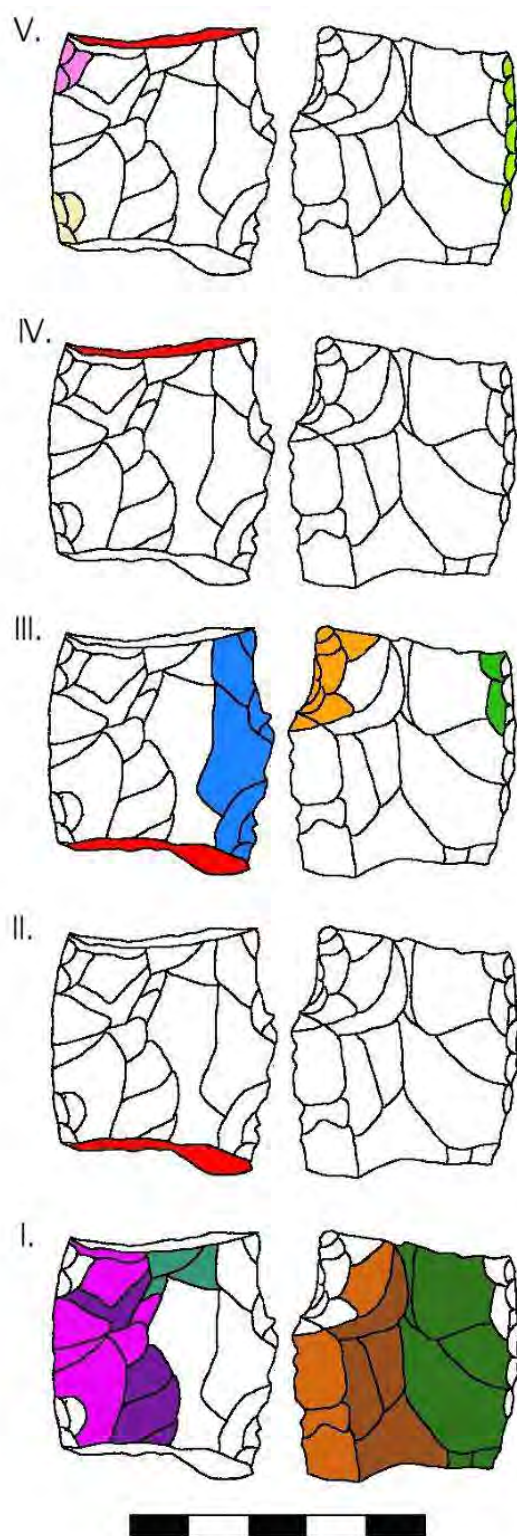
#### **IV. Transversal fracture at the other end**

**V. Edge II formation.** Minor marginal retouch on the second edge.

Thus, a **rectangular segment with transversal fracture surfaces at both ends** was created. The tool 97.10.64 has a similar morphology and its reduction sequence could have proceeded alike, although its initial knapping was done in a surrounding scheme, typical of the Sajóbáony Mész-tető site. Based on the conducted analysis, however, the chronology of second fracture in relation to the retouch of both edges cannot be determined in this case. It is known that the tool was retouched after both fractures.

Regarding the occurrence of rectangular segments and, as it can be presumed, the manufacturing scheme which uses intentional half-product fracturing, the analysed tools in the form of tip fragments with a transversely broken base appear to be very interesting. Perhaps these artifacts should be treated either as a side effect (waste) of segments formation process. They can be also seen as a waste which was re-used to create tools with convergent edges and exposed tip. Perhaps the 97.2.1821 and 97.2.1970 artifacts should be recognized as re-utilized waste from the production of segments. These either do not have an exposed tip or

it is poorly exposed. Both tools are characterized by the presence of post-fracture rejuvenation sequences, as well as thinning sequences and a retouch on the tip, the retouch forming a separate tip's edge.



*Fig.138 Group I tools subsequent knapping steps, based on the 97.2.1160 artifact. Numbers I to IV correspond to subsequent knapping stages described in the text.*

## Group II

It includes 8 items characterized by the presence of two edges converging at the edge's tip and a transversal fracture at the base (97.10.74, 91.258.7, 91.10.63, 91.258.2, 97.2.1558, 91.257.1, 97.2.1821 and 97.2.1970) (Fig.139). Some, as it had been mentioned above, can be considered waste from the production of segments; yet, they show considerable morphological consistency at the stage of abandonment. In addition to that, the presence of 91.258.7 artifact, which has a natural transversal surface used to form tool base, proves that these artifacts can be considered as a separate group. Except for the 97.10.74 tool, other artifacts were retouched at least once after breakage.

These tools, just like most analysed artifacts, are characterized by a specific production scheme.

**I. Surface formation.** It was conducted in a surrounding scheme of knapping with semi-abrupt removals on one face, and then flat and extensive removals on the other face of the same edge or surface. This procedure was then repeated alternately on the other tool edge/face. This surrounding scheme lead to the creation of cross-section biconvex tools (Fig.140). Semi-abrupt removal series allowed for the creation of an appropriate angle for further deriving of flat, extensive removals on the opposite face. This pattern can be seen on the 91.257.1, 97.2.1558, 91.10.63, or 91.257.2 tools. At subsequent knapping stages, the lower face was flattened (91.10.63–Fig.140c) or left as plano-convex (91.257.1).

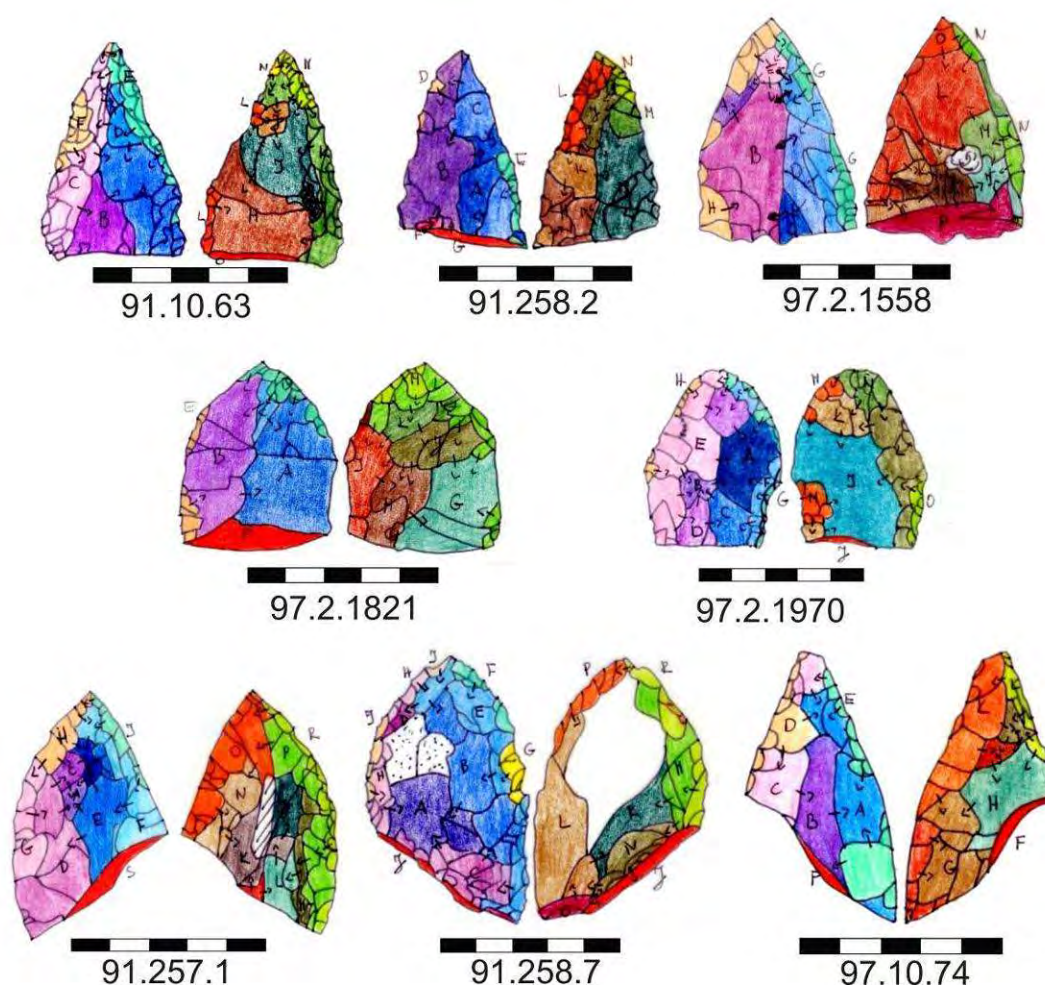


Fig.139 The analysed Sajóbáony Mész-tető group II tools comparison.



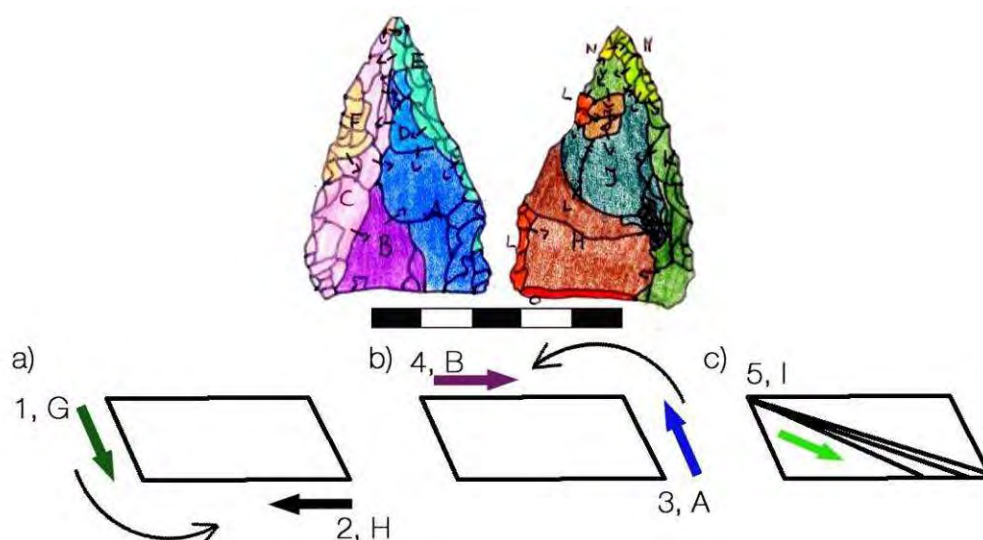


Fig.140 Plano-steep group II tools surface formation scheme, based on the 97.10.63 artifact. Scheme presented in cross-section.

**II. Edge formation/breakage/rejuvenation.** Subsequent knapping steps were based on edges formation and their retouch through performing alternate removals on both edge faces. During further knapping and rejuvenation, the plano-convex cross-section of cutting edge was preserved by applying flat removals onto the lower face from the opposite edge. In most cases, only one of the edges was retouched on its entire length. The retouch on the other tool edge was limited to the apical part. In case of the 97.2.1558 artifact (Pl.224), one is dealing with blunting the edge fragment at the breakage through a series of abrupt removals applied to the upper face. During retouch and rejuvenation, a surrounding knapping scheme was still applied, and both tool edges were rejuvenated in parallel to this. Only in case of the 91.258.7 artifact, initially the first tool edge was used and rejuvenated, and then the second one. Perhaps this had also had an effect on zero tip exposure in this case and a complete lack of interest in its maintaining (some removals during retouch are performed from the tip). For this reason, probably, this tool should fall into the third artifact group. Contrary to the examined 91.258.7 artifact, the remaining tools are characterized by significant tip exposure and care for its maintaining. This is particularly evident in case of 91.10.63 artifact, which also bears traces of several edge rejuvenation series.

**Rejuvenation traces in the form of edge resharpening retouches, introduced after tools breakage,** testify to the fact that these artifacts were used in the shape in which they were found, and are characterized by **great care for the profile of one edge, most frequently the longest one. Keeping an exposed tip, sharpening and rejuvenation were of considerable importance** for these tools, at least in case of the second edge's apical parts.

Most artifacts bear retouch traces as early as from before breakage (e.g. 91.10.63–C sequence–Fig.140–in pink, 91.257.1–F, O and P sequences–Pl.217). However, there are no obvious traces of shaping and increasing tool symmetry. Perhaps, however, this situation can be caused by analysing just fragments of tools instead of complete specimens from before breakage.

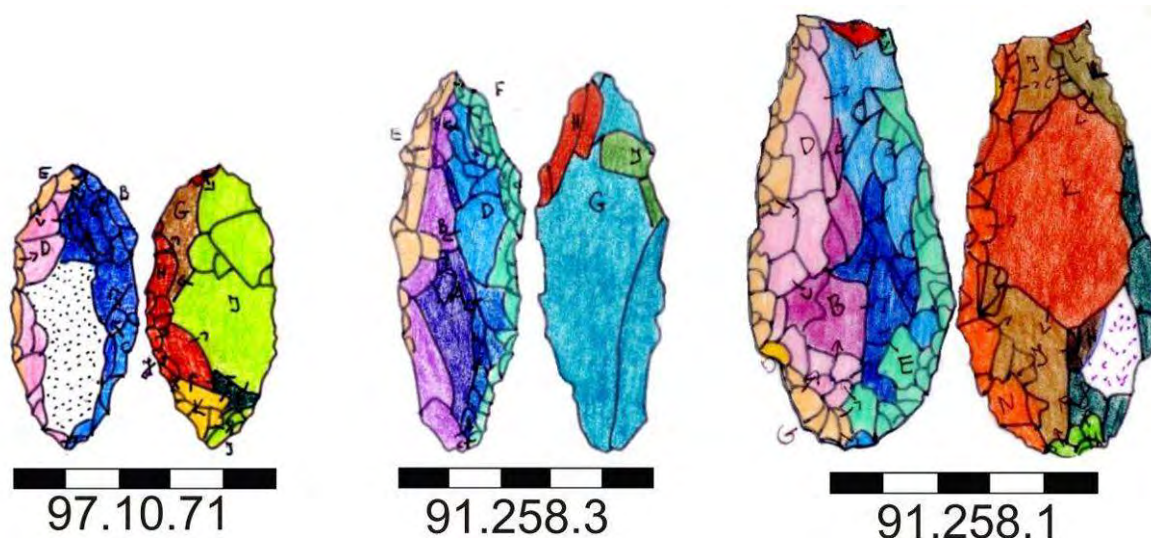
### Group III

Among the Sajóbábony Mész-tető artifacts there are two plano-convex forms retouched on both edges (91.258.3 and 97.10.71) (Fig.141). These tools, referred to in publications as

limaces (Ringer, 1983 p. 23), are characterized by absence of an exposed tip, irregular edge profile, they both carry signs of rejuvenation. These artifacts were retouched every time on the upper face, with semi-flat or semi-steep removals. On the lower face, only edge angle correcting removals were introduced.

In both cases, **the knapping process was focused on achieving a long and sharp edge, without taking the tip into account.** In case of the 91.10.71 tool, first one edge was formed and rejuvenated, and then the other one. The second edge's retouch could be done after the usage of the first edge had been finished. In case of the 97.258.3 tool, one faces a parallel retouch and subsequent rejuvenation of both edges. The symmetry of both tools is most likely connected with equal treatment of both edges. The 97.10.50 tool can be regarded as analogous, it probably being a failed or highly worn item. This artifact is biconvex in cross-section, and also characterized by lack of an exposed tip. The tool has an additional transversal breakage surface, placed angularly at the tip and overlapping with one edge. The tool, after surface formation, was repaired several times first at one edge only. After its wear, the formation and retouch of the other edge was commenced. This edge was shorter, because it overlapped with the area of transversal fracture at the tip. Ultimately, however, the second edge has a straight profile, and the first is sinuous. During edge repair, removals were each time derived on one, and then the other face of the edge.

Most likely, this group should also include the artifact 91.258.1, with its plano-convex cross-section and a broken tip (Fig.141). It is not possible to determine whether the retouch of one edge and base did not take place after tip breakage, this implying a change in tool orientation. This edge is more straight and has sequences of overlapping flat removal series which formed and sharpened it. On the tool, there are visible failed hinged removal sequences aimed at artifact thinning. This action did not go well neither on the lower face (L sequence), nor on the upper face (D sequence—Fig.141), which may have had an impact on further edge exploitation. Interestingly, this tool has a base accurately shaped and retouched on its entire length. Thus, it can be assumed that it might have been the tool's functional unit, especially after tip breakage.



*Fig.141 The analysed Sajóbábony Méhész-tető group III tools comparison.*



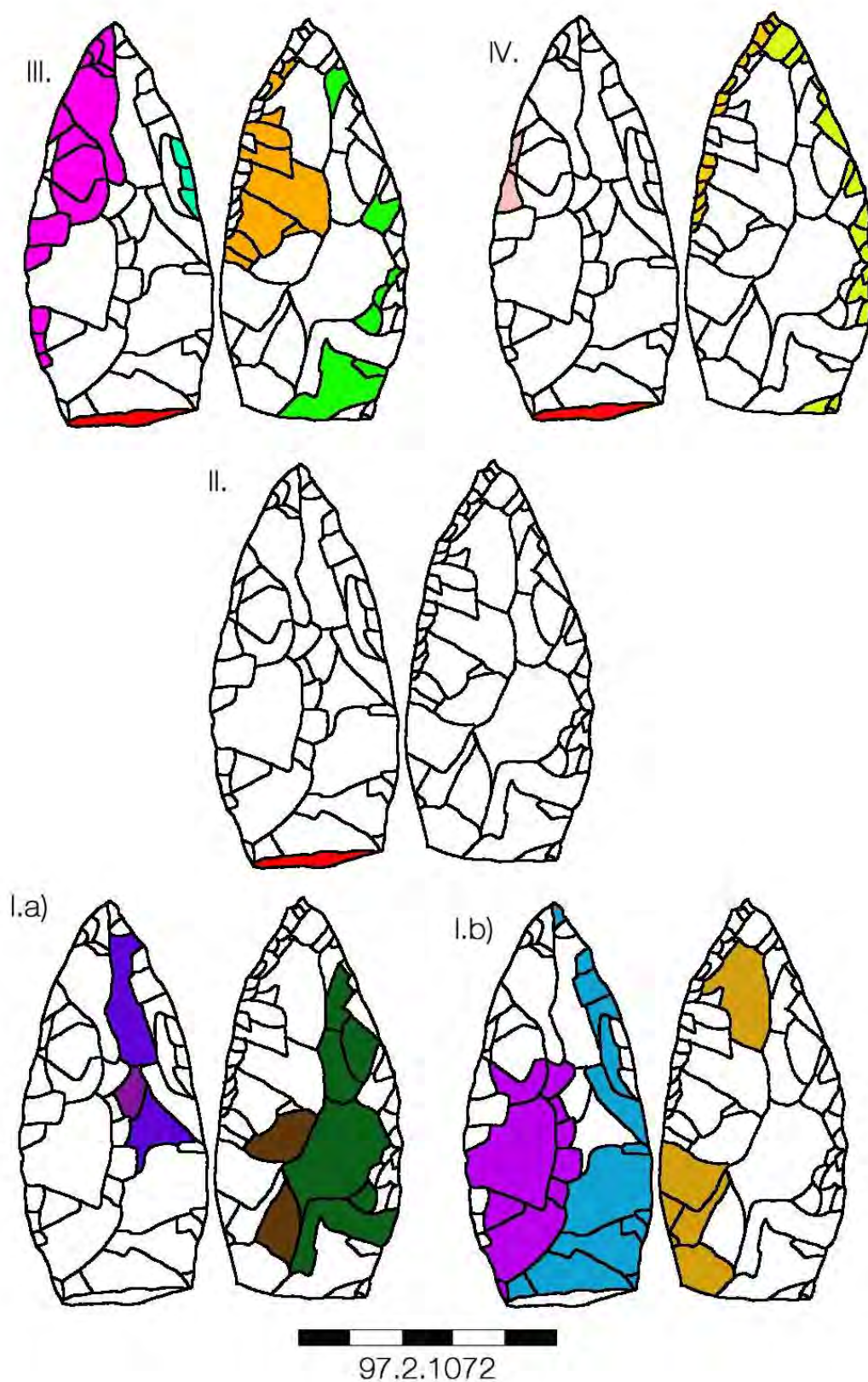


Fig.142 Knapping scheme of 97.2.1072 artifact. Numbers from I to IV correspond to formation stages described in the text.

The 97.10.16 should probably be considered as a failed form, characterized by considerable thickness (2.7cm thickness with 6.7cm length). This tool, probably unfinished, was made on a thick raw material slab (there are traces of cortex on both tool faces). At first, there were attempts at reducing artifact thickness. Nonetheless, the method of introducing steep removals on one tool face, and then flat removals on the other, did not bring the desired effect. The removals went too steep and the tool acquired a discoidal shape. The artifact was knapped in a surrounding scheme, also characteristic of other tools from Sajóbáony Műhelytő, but after another unsuccessful thinning attempt (E, G, M sequences–Pl.227), the tool was abandoned.

The last artifact which deserves the greatest attention is the 97.2.1072 form (Fig.142). This tool, biconvex in cross-section, has a transversal fracture surface at the base. The tool was broken in its 1/5 approximately. The artifact has a well-exposed tip and is symmetrical in vertical axis; at the same time, one of the edges (edge II) is slightly more convex than the other one. Both edges have a straight profile.

The tool was formed in the following way (Fig.142):

**I. Surface formation and shaping.** It proceeded in a surrounding scheme of knapping, in a plano-steep manner. Flat removals were applied on one face and semi-abrupt ones on the other face in order to maintain an appropriate edge angle for further removals. After the completion of first surrounding scheme (A, B, I, J sequences–Fig.142.Ia), knapping direction was reversed, and the surrounding scheme was probably repeated. Subsequent removal series, less extensive than the previous ones, that focused on areas requiring thinning or shape correction, were applied. Hence, the sequences on edge I focused on the base and near-the-tip areas (Fig.142.Ib–in blue and brown), whereas sequences derived on edge II were performed in the middle of the edge's length (Fig.142.Ib–violet).

**II. Transversal breakage.** (Fig.142.II) It could have been the result of intentional or accidental action. On the scar, one cannot see the point of percussion; however, the breakage is of transversal nature.

**III. Edge formation and shaping.** A series of flat removals onto the lower face near the fracture scar (Fig.142.III–in green), as well as, alternate series of semi-flat and flat removals located near the tip, positioned angularly to tool vertical axis (F and L sequences–Fig.142.III–in pink and orange).

**IV. Edge retouch.** A fine, marginal retouch on both sides. In case of edge II, focused on the edge's middle part (Fig.142.IV–in green and pink). In case of edge I, located on the edge closer to the tip, on the lower face (Fig.142.IV–in yellow).

The character of breakage, as it had been already mentioned, is difficult to speculate on, perhaps it was the result of accidental breakage. From the perspective of manufacturing, it is interesting to observe the activities which took place immediately after breakage. After breakage, a series of flat removals were derived on the lower face near the base. The series formed the convex shape of the edge near the fracture (Fig.142.III–in green). Later, two series of semi-flat, alternate removals were applied; they were angular to vertical axis and shaped the tool near the tip (Fig.142.III–in pink and orange). The artifact displays traces of **equal edges treatment. Marginal retouches only occur at the tip and are designed to correct edges profile** (Fig.142.IV). Based on the traits mentioned, this tool can be referred to as point with a base in the form of transversal breakage surface.

Knapping scheme results show that in most cases, transversal breakages occur in the middle of the whole *chaîne opératoire*, which means that the tools were re-worked after breakage, or else, the breakages are intentional elements of tool formation. Two elements point to the intentional character of at least some fractures:

- natural transversal surface parallel to breakages, forming the transversal base surface in the 91.258.7 tool (the 91.257.1 tool is analogical, for instance),
- percussion point visible on some of the fracture scars and located in the middle of one of the surfaces (97.2.1558).

Additionally, the 97.2.1160 and 97.10.64 tools have two transversal breakages on both ends, and the edges were retouched between breakages and after them. If, then, the tools show signs of post-breakage knapping, regardless of the fracture's nature, they should be treated according to the form in which they were found, so as functional tools. Due to possible tool resharpening and rejuvenation, this group is characterized by high morphological inconsistency.

The analysed Sajóbáony Mész-tető artifacts can be basically divided into two groups. First group includes artifacts characterized by:

- care for edges and their retouch,
- lack of care for the tip and its exposure,
- forming one edge first and later the other one.

One can also include here group III and I tools.

The second group's typical features are:

- care for edges; the retouch was not a necessary element,
- care for tip exposure and preservation,
- parallel formation and rejuvenation of both edges.

This group may entail group II artifacts as well as the 97.2.1072 artifact.

### 3.2.1.6. Romania

#### 3.2.1.6.1. Ripiceni Izvor

A total of 25 artifacts were analysed from the Ripiceni Izvor site. The artifacts are from the collection of the Institute of Archaeology "Vasile Pârvan" at the Romanian Academy of Sciences in Bucharest. Five artifacts come from the Mousterian level V (MV), the other 20 from Mousterian level IV (MIV). Due to very high technological similarity, the artifacts from levels MIV and MV will be described together.

22 of the analysed tools were defined by the site's explorer, Alexandru Păunescu, as leafpoints (Paunescu, 1993). Apart from the artifacts referred to as leafpoints, in Mousterian levels a considerable collection of bifacial knives was found. It was decided that three such artifacts (MV.2259, MIV.3855 and MIV.U11) will be analysed as well. Those knives were chosen because of their vertical axis symmetry, in order to compare them with leafpoint-like tools in terms of technology and manufacturing schemes.

The analyses allow to conclude that all the tools belong within one artifact group and are linked together due to their very coherent preliminary idea of creating a tool with a retouched and subsequently rejuvenated cutting edge, and the other edge being the place for cutting edge angle correcting removals, also thinning the tool during subsequent rejuvenations. Among the analysed tools, two main types can be distinguished, of which one has one edge retouched on the upper face (group I), while the second is characterized by the presence of two alternately retouched cutting edges converging at the tip (group II).

#### Group I

This group entails 23 artifacts (MV.2266, MV.2276, MV.2277, MIV.3573, MIV.3827, MIV.3832, MIV.3855, MIV.3856, MIV.3857, MIV.3859, MIV.3865, MIV.3866, MIV.3867, MIV.3870, MIV.3872, MIV.3873, MIV.3875, MIV.U11, MIV.V8, MIV.V9, MIV.W7(a), MIV.W7(b) and MIV.Z9) (Fig.143, 144, 145, 146), characterized by plano-convex cross-section, straight profile and the retouch of one edge only. The base is formed as a separate edge transversal or angular to tool vertical axis. A characteristic feature is the absence of back and a long distal posterior part used to derive flat, tool thinning removals onto the lower face during subsequent rejuvenations. The tools also carry numerous rejuvenation traces, which usually was not limited to resharpening the cutting edge, but consisted of a thinning removal series, which rejuvenated the distal posterior part, and eventually the cutting edge as well.

Three techno-functional units can be distinguished on the described tools (Fig.147):

**A) Cutting edge.** (Fig.147–blue and brown) In 22 cases placed on the right side of the (convex) upper face. Only the MV.2266 tool has a cutting edge on the left, which is related to its reorientation during one of the rejuvenations. The cutting edge displays series of overlapping sequences: from removals reaching far into the upper surface, to marginal retouch. Rejuvenation series were derived mainly on the upper face, and only minor correcting percussions may have been performed onto the lower face, these being typically connected with the apical parts. The cutting edge's lower face was formed with extensive, flat removals derived either at the beginning of tool production (e.g. MIV.3855, MIV.3875), or when the surrounding scheme of tool rejuvenation was commenced (MIV.3859, MV.2277). Very often, a cutting edge fragment located near the tip was removed from the lower face through angular removals derived from the distal posterior edge (including MV.2277, MIV.3875, MIV.3866, MIV.3865, MIV.Z9, MIV.V8 and MV.2266). Such diverse knapping

of both cutting edge surfaces led to obtaining and maintaining, in the rejuvenation process, a straight cutting edge profile and its plan-convex cross-section.

**B) Distal posterior edge.** (Fig.147–violet and green) On the Ripiceni Izvor tools, the distal posterior edge constitutes an entire edge opposite to cutting edge. It is therefore usually located on the left side of the upper face. This edge is plano-convex just like the cutting edge, but usually has no traces of retouching or it is restricted to apical part only. The distal posterior edge has two function in the tool. The first one is deriving flat removals on the lower face, which thin the tool and reduce the cutting edge angle. Flat removals are applied along the entire edge, then this edge remains straight through the entire process of tool utilization (MIV.U11, MV.2277, MIV.3875, MIV.3873, MIV.3866, MIV.3865, MIV.Z9, MIV.W7(a), MIV.V9 and MIV.3855) (Fig.145, 146), or during its rejuvenation, only closer to the tip (MIV.V8). Then, long removals are derived angularly to artifact vertical axis. They reach far into the lower face and sometimes reaching the opposite tool edge. This process, as mentioned, allowed to thin the tool and maintain an acute cutting edge angle (Fig.147). The second role of distal posterior edge is tip correction. This was achieved through removals on the upper face, which led to tip exposure and maintaining its sharpness if this was only possible (e.g. MIV.3859, MV.2277 and MIV.3573).

**C) Base.** (Fig.147–red), The tools from Ripiceni Izvor have no back but separately treated base edge, often positioned angularly to tool vertical axis overlaps with the distal posterior edge (MIV.3859, MIV.3875, MIV.3866 and MIV.V9). The base either remained cortical and unknapped (MIV.V8–Fig.143), or was formed with abrupt, blunting removals (MIV.3855, MIV.3873, MIV.3875), or else it was formed with removals derived along tool vertical axis (MIV.3866, MIV.3865). In some cases, the base edge was reshaped during one of subsequent rejuvenations, so as to adjust its profile to changing tool size and shape (MIV.3865, MIV.3875 and MIV.3866). Four of the analysed tools do not have a base, since these are tools with changed orientation (MIV.3867, MV.2266, MIV.3832, MIV.W7(b)–Fig.144). In their case, one is dealing with tools equipped with two tips. As to their original base, it was removed during tool reorientation.

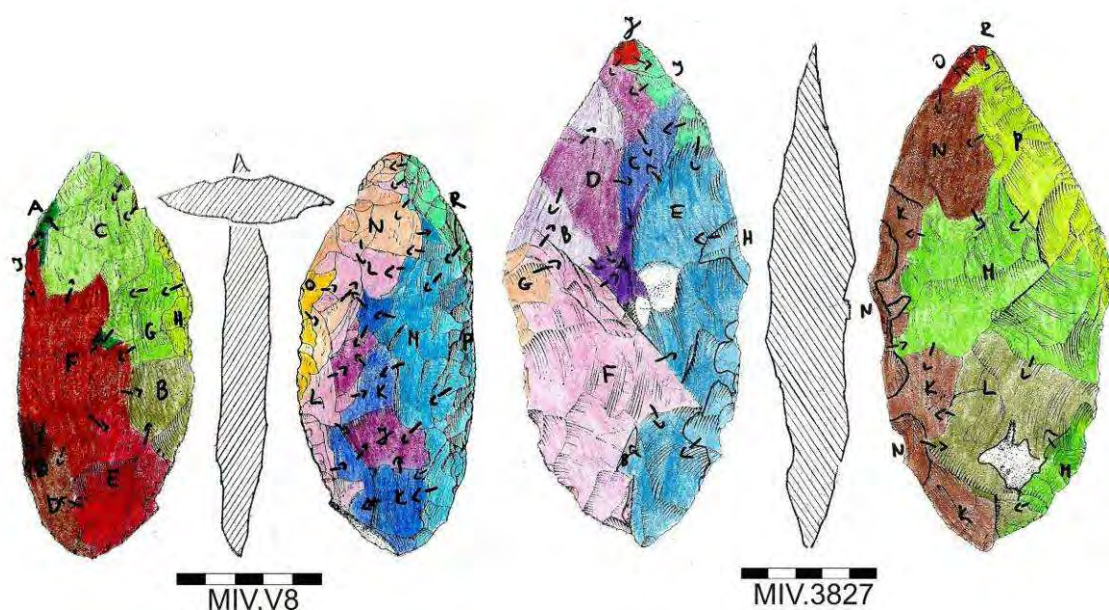


Fig.143 The analysed Ripiceni Izvor group I tools comparison; preforms



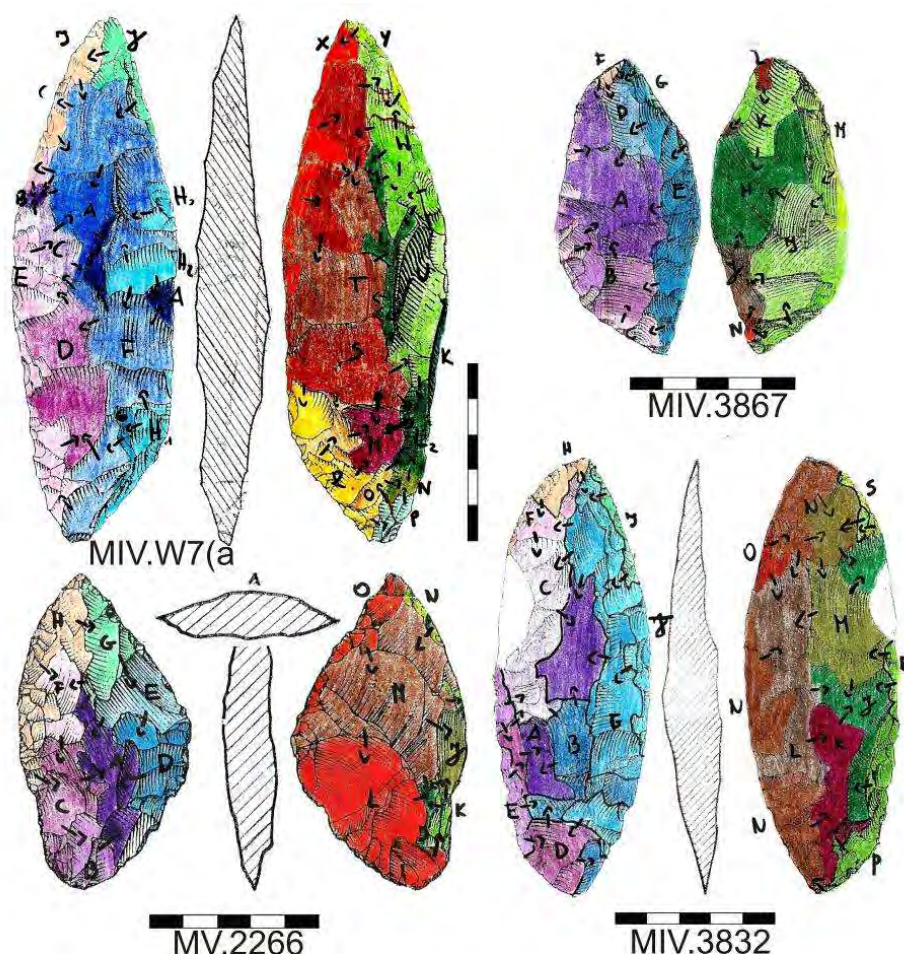


Fig.144 The analysed Ripiceni Izvor group I tools comparison; tools with changed orientation.

As it had been already mentioned, the Ripiceni Izvor tools bear signs of numerous rejuvenations. In most of the analysed tools, it can be assumed that almost all removal sequences visible on the tool originated from successive tool rejuvenation phases and cover sequences prior to them. Hence, the reconstruction of manufacturing process is impossible in most cases. Only in one case there is a tool that has no rejuvenation signs and was abandoned after a single cutting edge retouch (MIV.3827–Fig.143). This tool resembles a preform because of its relatively large size (17.4cm long, 9cm wide, 3cm thick), and its imprecise and extensive removals on both faces. Perhaps this is an unfinished form, which was retouched *ad hoc* on one edge only. Edge retouch is preceded by a surrounding knapping scheme, commencing from removals on the opposite edge. This scheme is characteristic of rejuvenation process which equals edge remodeling.

The manufacturing process of this tool was based on shaping it first by performing angular removals at each of the tips, onto both edges. Knapping at this stage was performed in an edge surrounding scheme, initiated from the lower face. At this stage, extensive, flat and semi-flat removals were derived. The next stage was based on a more precise edge shaping. Here, knapping proceeded in an edge scheme, starting from the upper face. Flat removals' size was adjusted to the correction required (Pl.238–N sequence). The final stage of knapping was the formation of cutting edge with semi-flat removals on one of the edges at the tip, through deriving a series of small removals onto the opposite edge.



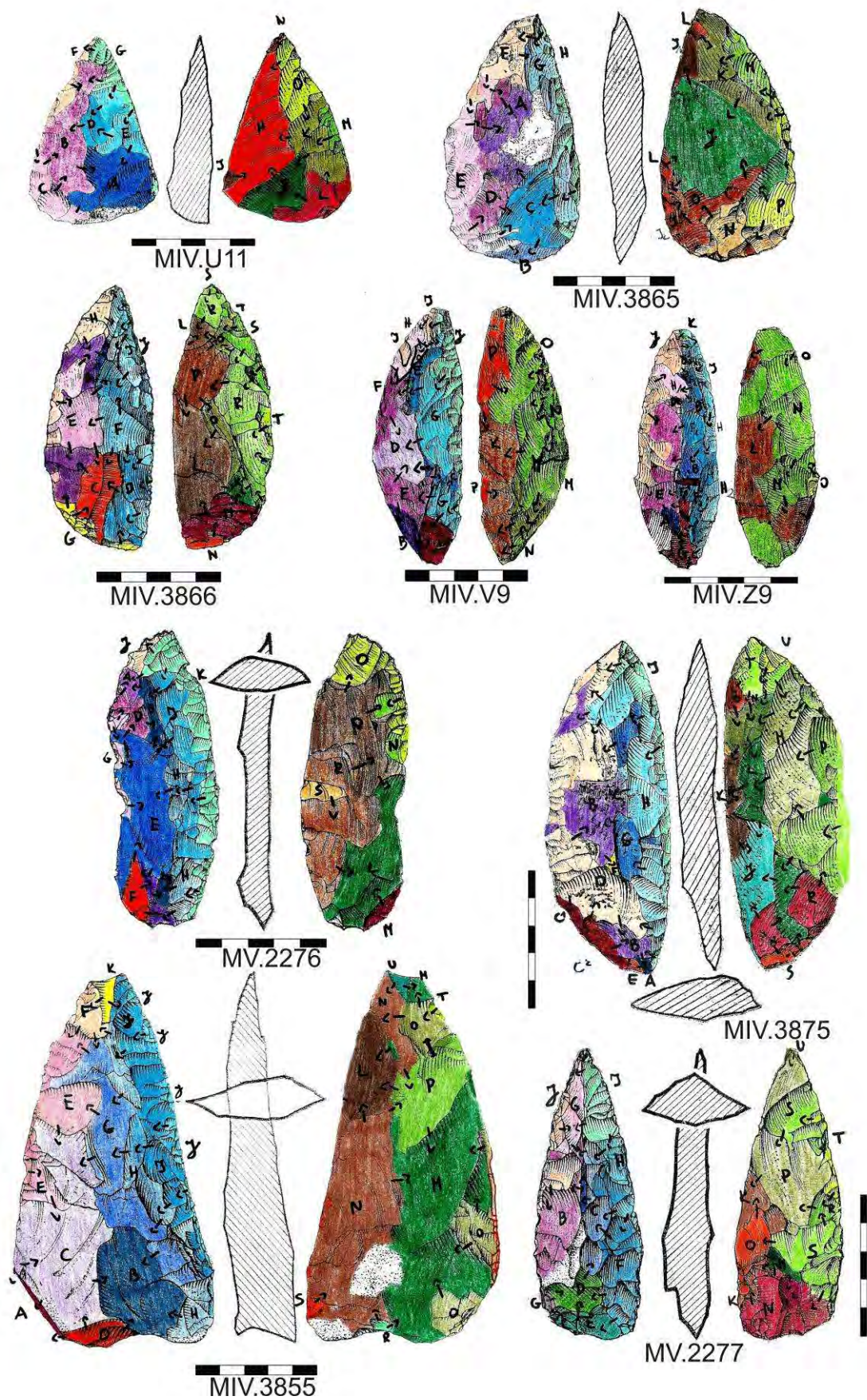


Fig.145 The analysed Ripiceni Izvor group I tools comparison; tools with intensive thinning on the lower face from distal posterior edge (sequences in green)



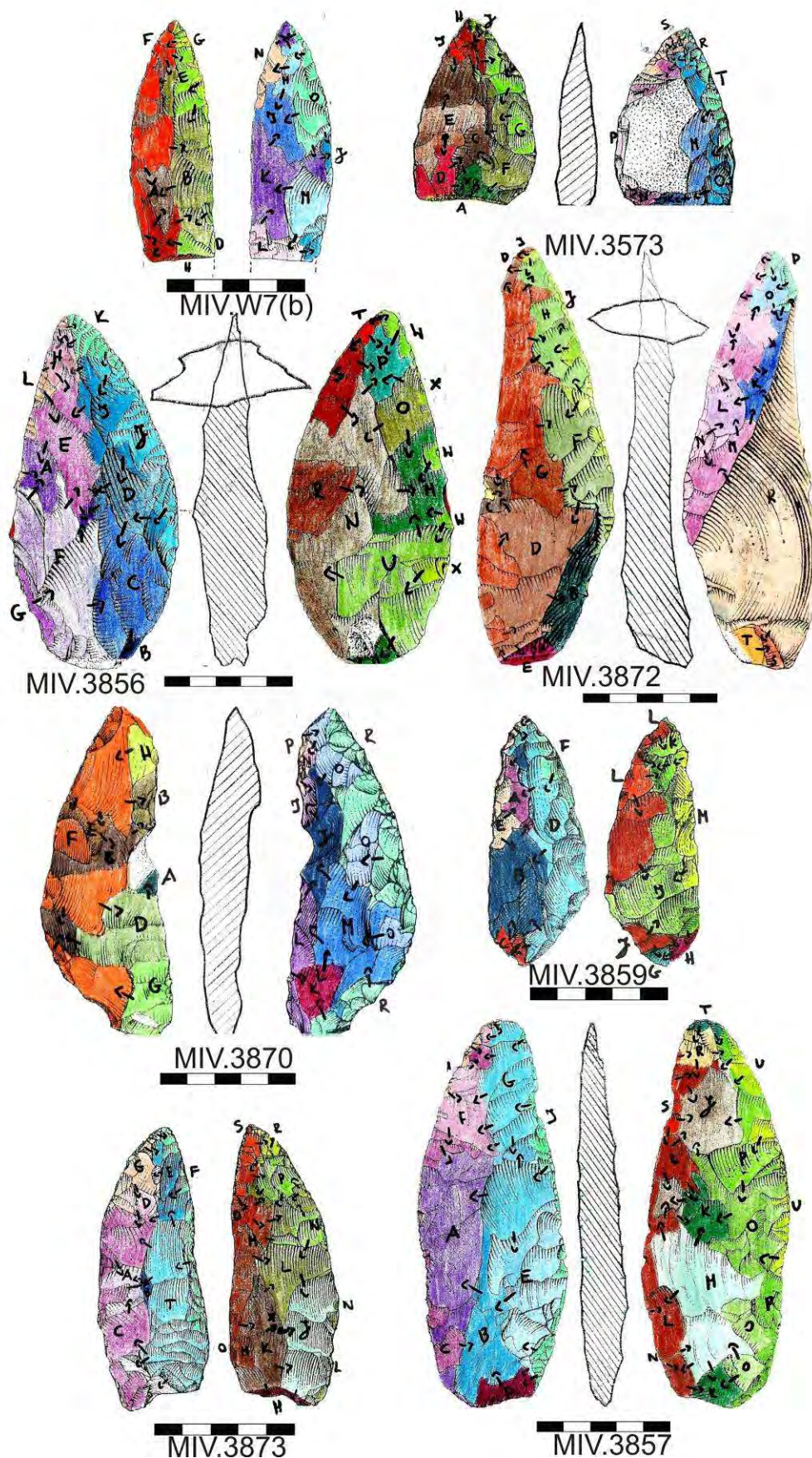
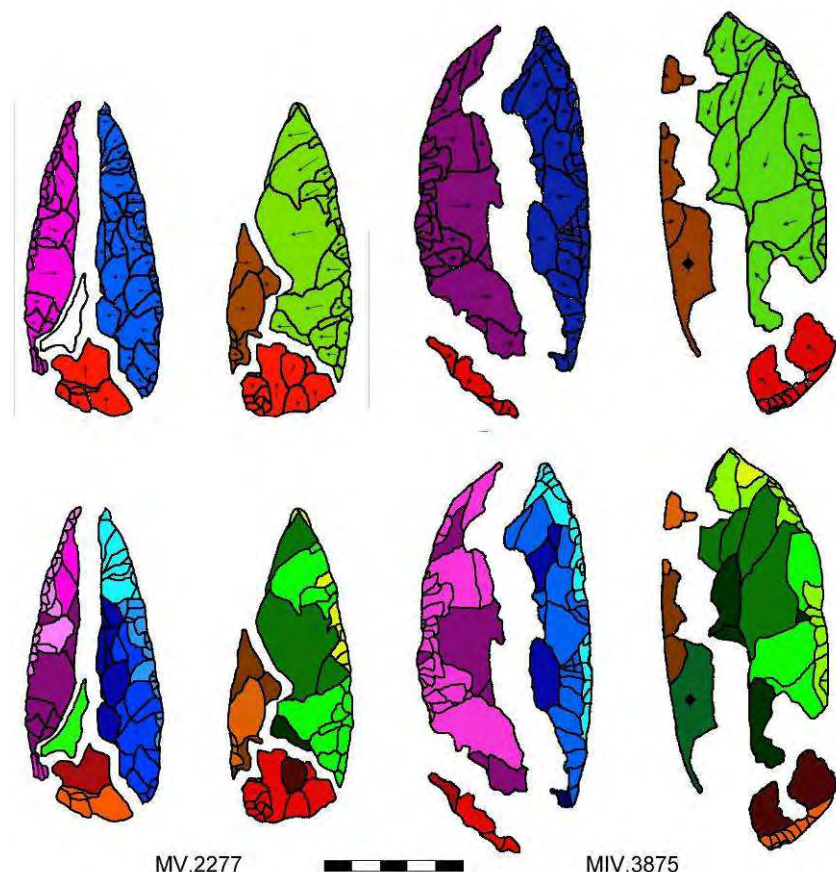


Fig.146 The analysed Ripiceni Izvor group I tools comparison; tools without intensive thinning on the lower face from distal posterior edge (sequences in green)

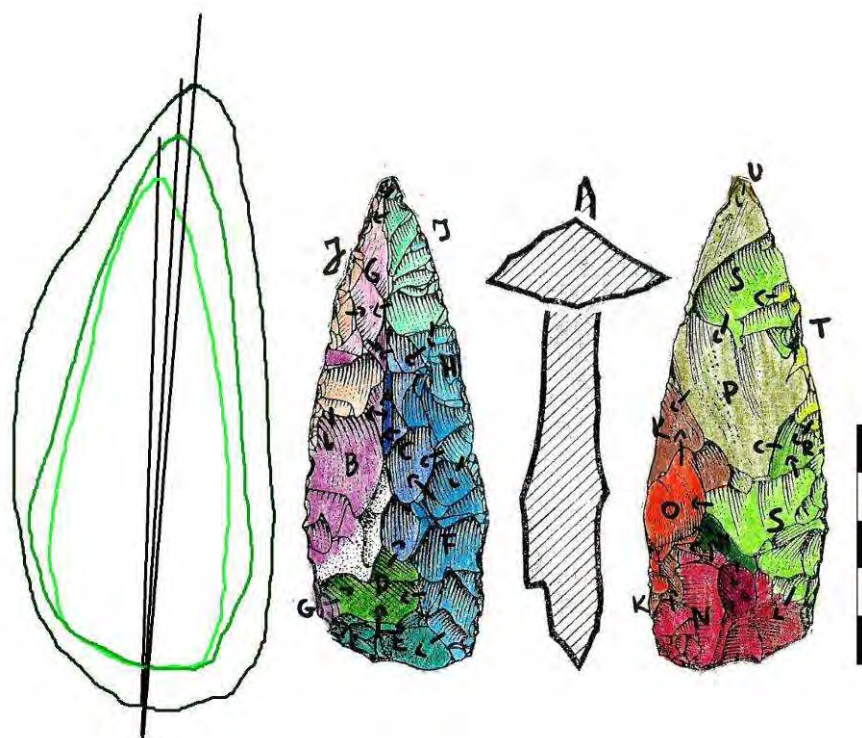


*Fig.147 Ripiceni Izvor group I tools design, with division into techno-functional units and marked removal directions. Blue marks cutting edge on the upper face, brown marks cutting edge on the lower face, violet marks distal posterior edge on the upper face, green marks cutting edge on the lower face, red and burgundy mark removals on the base. The schemes below depict edge sequences chronology. The darker the colour, the older the sequence.*

The extensive use of tools is reflected by three artifacts, which bear traces of overpassed removals (MIV.3870, MV.2276 and MIV.3872). In two cases, such removal was derived from the cutting edge onto the upper face (MIV.3870, MV.2276) and was probably supposed to form or rejuvenate the cutting edge. Owing to a mistake, the percussion overlapped with the other edge, and not only did it remove a considerable part of cutting edge, but also of distal posterior edge, reducing tool thickness at the same time. Both examined tools were later rejuvenated at least several times. The MV.2276 tool, like MIV.3870 also displays three rejuvenation phases. The third of analysed tools (MIV.3872) has a scar of an extensive, overpassed removal, which was derived from the distal posterior edge, probably also during edge rejuvenation. This removal took almost 9/10 of cutting edge's length. After this error, the tool was abandoned. Previously, its shape could have resembled that of the MIV.3856. tool

It is interesting that the artifacts, which were repeatedly thinned by flat, angular removals near the tip derived from the distal posterior edge, have a straight cutting edge profile, almost parallel to artifact axis. Some of these artifacts also have a significant vertical symmetry, associated with further corrections on the distal posterior edge. Tool shape reconstruction at various rejuvenation stages shows that some of the tools have become symmetrical only at the final stage of their use (Fig.148). Therefore, the symmetry in their case was a side effect of edge rejuvenation process.





*Fig.148 An example of tool vertical axis modification during subsequent rejuvenation phases of the MV.2277 tool.*

The tools, which were not rejuvenated on the lower face from the distal posterior edge or such removals did not overlap much with tool surface, usually have a convex cutting edge, which is associated with further resharpener removals of the cutting edge, which lifted the tip off the axis with no possibility of correction from the distal posterior edge (MIV.3859, MIV.3856). These tools had to be rejuvenated by flat removals onto the lower face, derived from the cutting edge. In several cases, failure to rejuvenate and thin the tool's lower face during subsequent repairs caused the subsequent retouches of the cutting edge and the distal posterior part to make the edges increasingly abrupt, until they became blunt (MIV.Z9). This artifact has a thickness of 1.7cm and a width of 3.2cm.

Not deriving any removals on the lower face could be related to small tool thickness at the tip and, therefore, lack of necessity to thin this part (MIV.3857), or inability to derive removals conveniently (MIV.3870, MIV.3573).

Among the analysed artifacts, four show signs of reorientation during one of their successive rejuvenation phases (MIV.3867, MV.2266, MIV.W7(b) and MIV.3832) (Fig.144). Two of the examined artifacts have a very similar shape (MIV.3867, MV.2266). All of them have a specific angular distal posterior part profile and no base, which was removed during tool reorientation (Fig.149). The reorientation was done by rotating the tool and further using the same edge as a cutting edge. As a result of edge orientation change, the base had to be made into a distal posterior edge by performing angular, flat removals onto the lower face (MV.2266, MIV.3867) (Fig.144). These objects bear traces of multiple repairs on both tips. Interestingly, during the orientation change, the cutting edge arrangement also changed, which went from right to left or inversely. It can be surprising, especially in the light of knives construction concept, whose plano-convexity might reflect fitting them to one's hand, and thus resulting in the position of right upper face reflecting the user's right-handedness. In case of Ripiceni Izvor artifacts, the reorientation causing the knife to become "left-handed"

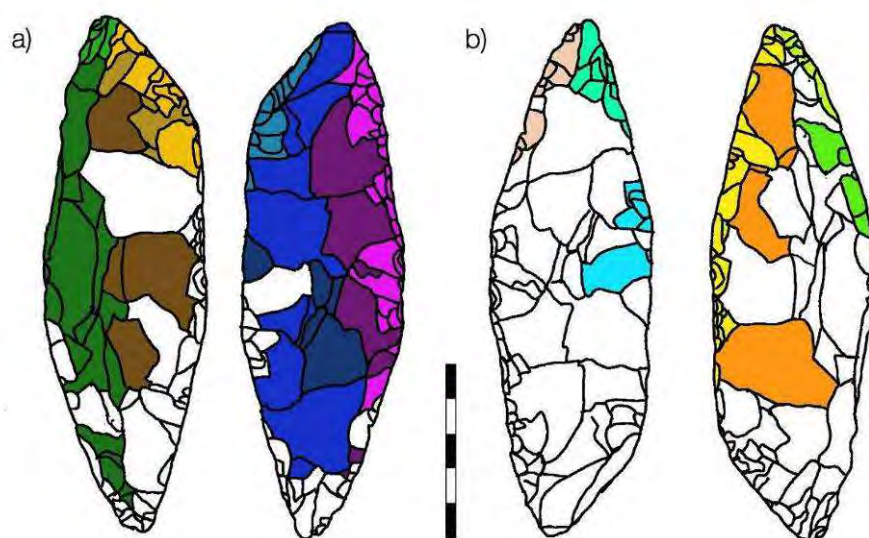


seems to contradict the possibility that the cutting edge arrangement could have been related to the user's "handedness", or his convenience (Urbanowski, 2004 p. 28). On the other hand, most of the analysed tools confirm the pattern of cutting edge placement on the convex upper face's right side.

Such intensive rejuvenations of the examined tools might suggest that the user could choose to change the tip and, therefore, also the cutting edge arrangement (thus sacrificing his convenience), if the rejuvenation could not have been continued on the selected tool tip because of a hinge on the cutting edge's lower face—MV.2266, hinged removals on the distal posterior edge (MIV.3867).

It appears as interesting that the reorientation does not result in the cutting edge's relocation to the opposite edge (Fig.144), which would result in the maintenance of the actual tool parameters. This was probably due to the different functions performed by the two edges. The difficulty might have been connected with creating a straight cutting edge profile on an edge which was S-shaped or had no traces of prior reduction. This is probably why it was decided to use the same edge as a cutting edge, even during tool reorientation.

The schemes of knapping applied during successive rejuvenation phases correspond to tool concept, in which the most important role is assumed by the cutting edge, and its most important parameters, which were kept with utmost care, were a straight cutting edge profile and its acute angle. The entire knapping, and then tool rejuvenation was aimed at preserving these two parameters and obtaining a maximally long cutting edge. As a result, knapping was usually done in a surrounding scheme, starting from flat, extensive removals on the cutting edge's lower face (if not necessary, this step was skipped). Then, long, flat and not so extensive removals were derived on the distal posterior edge. These removals were perpendicular to the edge and most frequently angular to tool vertical axis, thus reaching the cutting edge on the lower face. Next stage involved a correction on the distal posterior edge, and eventually, a marginal retouch of the cutting edge. During subsequent rejuvenation phases there were moments when it was necessary to correct the cutting edge after the marginal retouch. Then small, flat removals were applied onto the lower face from the cutting edge.



*Fig.149 The MIV.W7(b) tool orientation change during one of subsequent rejuvenations; a) removal series before orientation change, b) removal sequences after orientation change.*

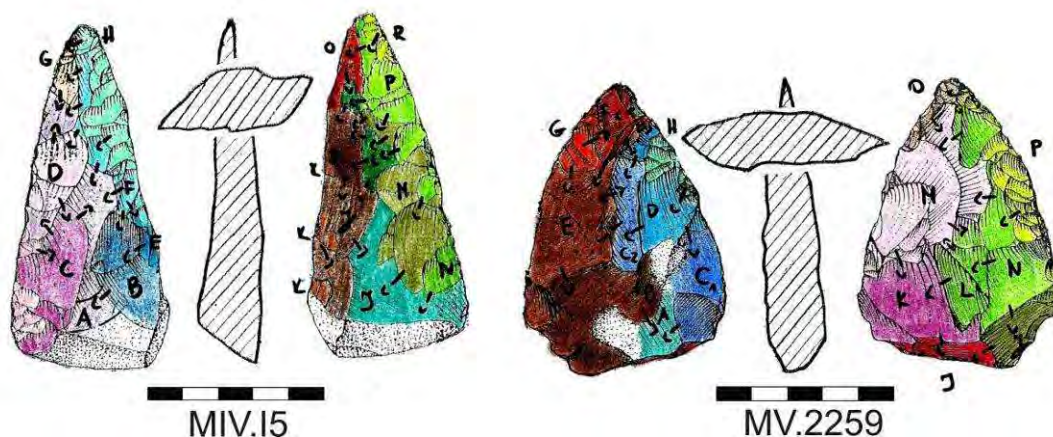
Some stages could be omitted, if unnecessary at a given stage. All the coincidences, however, were focused on forming a tool with a **single, long, straight, sharp and sharply retouched cutting edge**. Whereas all other knapping actions were adjusted to the ultimate purpose. **The tools do not reflect any care for tool symmetry**. However, some of the forms, during subsequent repairs, became more and more symmetrical (Fig.148), which was connected with the applied scheme of both edges rejuvenation.

## Group II

The second group consists of two artifacts (MIV.I5, MV.2259) (Fig.150), which are characterized by the presence of two symmetric cutting edges, converging at the tip, formed and rejuvenated alternately. Both tools under discussion are made on flakes and have a cortex base (MIV.I5) or base formed with vertical removals being the remnants of a massive flake's butt, on which the tool was made (MV.2259). The artifacts are marked by vertical axis symmetry and cross-section biconvexity. Both tools have an alternate retouch on both edges. The edges were formed and rejuvenated by performing removals angular to tool vertical axis on one face, and a marginal retouch on the other tool face. This procedure was repeated alternately on the other edge, which led to the creation of forms with biconvex cross-section. These artifacts have an exposed tip. Both of them, though they have the same preliminary idea of their design, were made in two different schemes. First of them (MIV.I5) was formed in a surrounding scheme and its edges were rejuvenated in this same scheme. This artifact has a plano-steep biconvex cross-section, where, surprisingly, each edge has a retouch onto the flat face, and the correcting removals are derived semi-abruptly (Pl.251).

The second tool (MV.2259) was formed in a fully alternate knapping scheme. The formation of edges, which can be also a trace of edges rejuvenation stage, was done in a surrounding scheme of knapping. The last stage of repair was identical with stage I and was done in a fully alternate scheme.

These tools, due to triangular shape, thick, blunted or cortical base, and despite edge symmetry, cannot be termed as leafpoints. Although they are characterized by the presence of **two alternately retouched cutting edges, none of them has signs of tool shaping sequences**. These tools owe their shape and symmetry to the applied **alternate treatment of both edges**. Both edges also bear **rejuvenation traces near the tip**. Additionally, in case of MV.2259, the tip was lifted from the axis due to a failed series of hinged removals derived at the tip which were aimed at tool thinning, just like the F and G sequences (Fig.150).



*Fig.150 The analysed Ripiceni Izvor group II tools comparison.*

In none of the analysed tools were there any traces of working on tool symmetry. In addition to that, the profile of one of edges is straight in all artifacts, and the other one's profile is S-shaped, as a result of the chosen tool formation scheme and concept, which assumed the creation and maintenance of one (or two) sharp cutting edges during subsequent rejuvenations.

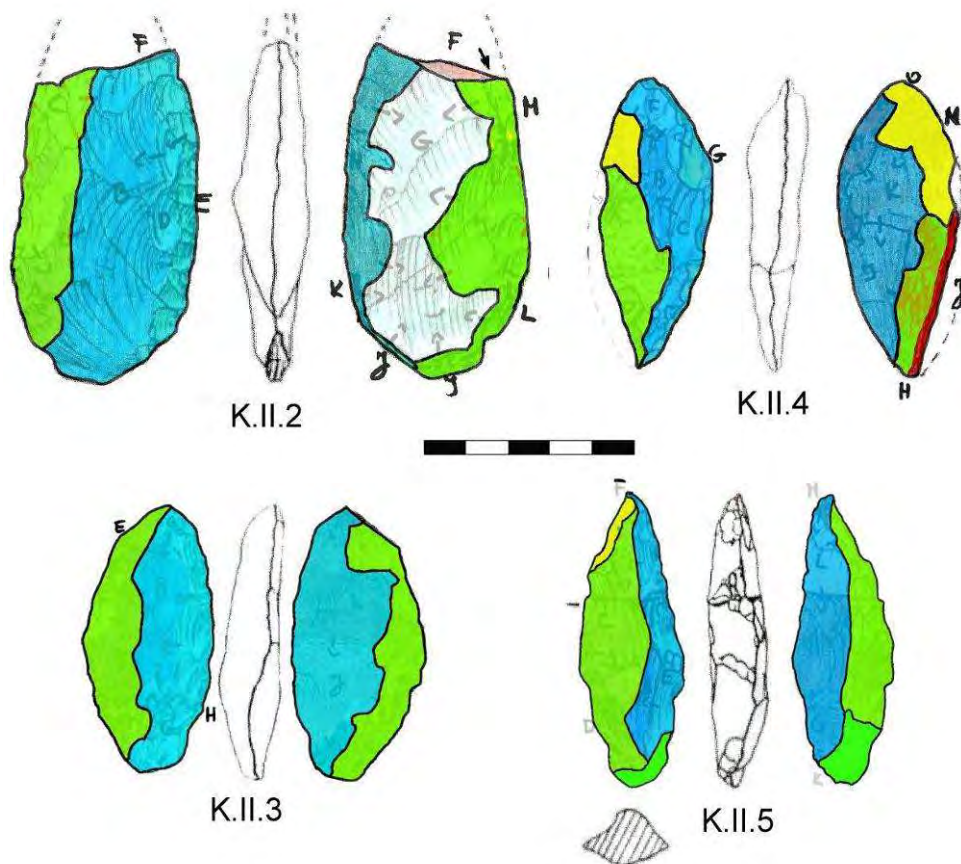
### 3.2.1.7. Ukraine

#### 3.2.1.7.1. Korolevo

##### 3.2.1.7.1.1. Korolevo II

The analysis covered six items from level II in Korolevo. The artifacts come from the collection of the Institute of Archaeology, Ukrainian Academy of Sciences in Kiev. Their characteristic features are bifacial reduction scheme, symmetry in vertical axis and absence of tip exposure (except for the K.II.5 artifact). For the purpose of this dissertation, the artifacts were given ordinal numbers. Artifacts from K.II.1 to K.II.5 are defined in the literature as leafpoints (Gladilin, Slitlvyj & Tkachenko, 1995; Demidenko & Usik, 1995). The K.II.6 form was not published. Only one form is entirely preserved. The other ones are refitted of two broken pieces. One of the artifacts has an additional refitting of two flakes coming from the earliest knapping stages visible on the surface.

All analysed artifacts are technologically consistent but represent different stages of manufacturing process and use, from the stage of preform (K.II.1), via the initial stages of rejuvenation (K.II.2) and various stages of use (K.II.3 and K.II.4), up to intensive wear (K.II.5) and numerous post-breakage rejuvenations (K.II.6), which allowed to reconstruct the entire reduction sequence including the rejuvenation process.



*Fig.151 Techno-functional units arrangement scheme on Korolevo II tools. Blue marks cutting edge, yellow marks back edge, green marks removals which might have constituted distal posterior edge, pink marks removals which might be treated as base-forming.*



Level II tools from Korolevo, during their use and rejuvenation had the following techno-functional parts (Fig.151):

**A) Cutting edge.** Formed in a plano-convex scheme and each time retouched on the upper face. The lower face, formed at the beginning with flat, extensive removals remained non-rejuvenated, or single, flat removals near the tip allowed for edge angle correction. This was followed by a series of semi-flat removals retouching the edge onto the upper face. The cutting edge was retouched on its entire length.

**B) Back edge.** Opposite to cutting edge, formed in a plano-convex scheme at the beginning of manufacturing process. During subsequent rejuvenations, correcting, most frequently semi-abrupt or semi-flat removals were applied on the upper face. The K.II.3 tool has a transversal breakage scar on the back's edge. The tool was additionally rejuvenated and retouched after the breakage. The K.II.2 tool has a burin spall performed from the transversal breakage scar (Fig.151). The burin spall appeared to be an overpassed percussion that removed most of the tool in its base part. The tool was abandoned after that percussion, but both parts were found during excavations and refitted. This action may point to the intentional formation of back edge closer to the base through the use of breakage surfaces. Or else, it may well point to intentional tool fracturing. The K.II.6 tool may have also been broken deliberately. The percussion point located on the fracture scar (L sequence), led to the assumption that the impact was introduced from the middle of the upper face. The K.II.5 tool has on the back's edge, closer to the base, a series of semi-steep, blunting removals derived on the upper face. This action, just like using vertical breakage surface, had served the formation of transversal back surface. The semi-abrupt removal series at the base caused the tool to become more symmetrical (Fig.151).

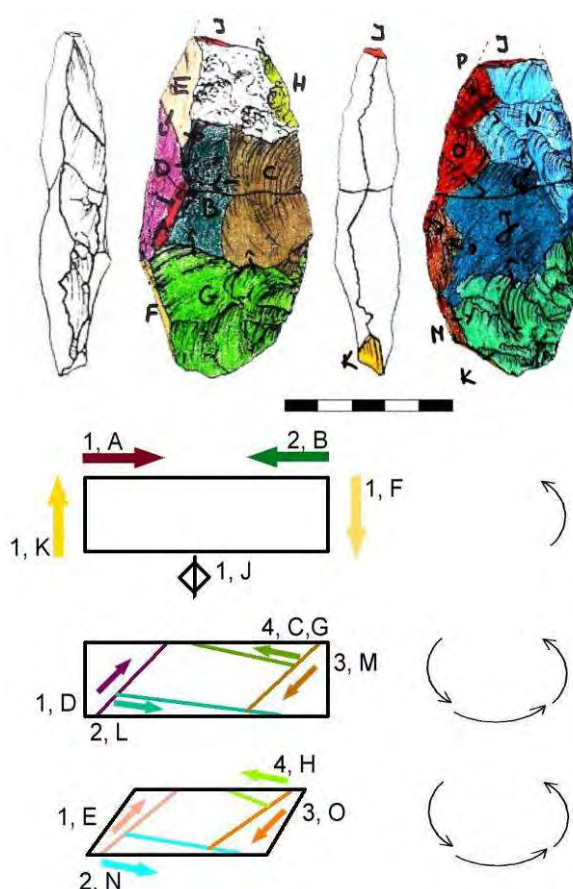


Fig.152 Surface formation scheme on Korolevo II tools, based on the K.II.1 preform shown in cross-section. Plano-steep, surrounding scheme of knapping.



Due to lack of removals on the back's edge near the tip, the tools are characterized by the absence of an exposed tip. Also, the retouch on the cutting edge does not always reach the very tip.

The tools were knapped in a consistent alternate scheme, in a plano-steep manner. Knapping proceeded in the following stages:

**I. Surface formation.** Included the formation of two transversal surfaces on both tool faces and, from their angles, the application of flat, alternate removals which formed the lower and upper tool face (Fig.152). At the next stage, the angle of the abruptly formed edge was reduced with semi-abrupt, and then semi-flat removals. At the end of this stage a biconvex, alternately formed tool was acquired, with one edge being semi-abrupt on particular face, and the other one flat on this same face (Fig.152). The semi-abrupt alternate removals on both faces allowed to maintain the angle for further flat, extensive surface forming removals. At the end of this stage, flat, extensive removals were introduced on the lower face from the future cutting edge (K.II.3, K.II.4). These removals were aimed at flattening the lower face's surface and reducing the angle of the cutting edge as much as possible. This edge was later rejuvenated several times, which caused its blunting over time. These removals are not to be found in K.II.2, which was retouched immediately after the initial stage of surface formation.

**II. Edge retouch.** After the stage of surface formation, one of the edges was retouched in a semi-flat manner on the upper face. The opposite edge may hold traces of correcting removals, but generally it is devoid of retouch and more sinuous in profile.

**III. Repairs.** At this stage, all activities are suited to current situation. If it was necessary to correct the cutting edge's angle, then flat removals onto the lower face of that edge were performed, and only after that it was there retouched (K.II.5). In some cases, the repair proceeded in a surrounding scheme (K.II.3) or relied solely on a repeated cutting edge retouch, which was then more steep than previously. As a result of several rejuvenation series, the cutting edge might have become blunted (K.II.5).

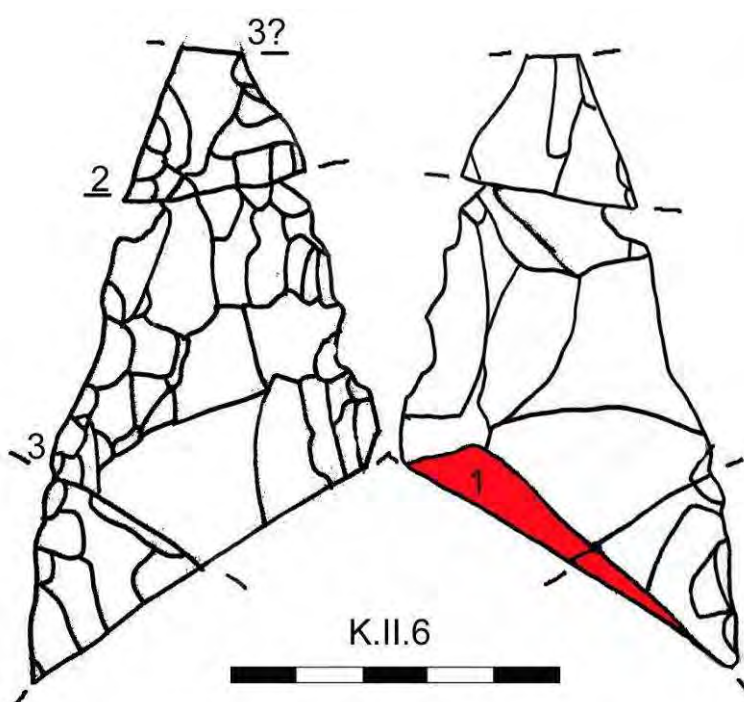


Fig.153 Breakages arrangement on the K.II.6 tool, with marked breakages consequence.

An interesting example is the K.II.6 tool, which has four breakage scars, of which perhaps the first–base fracture, was derived intentionally (Fig.153). The second breakage (Fig.153.3), an angular one, might have also been intentional and aimed at forming the base and eliminating the sharp angle formed as a result of the first fracture. Subsequent breakages at the tip could have been incidental by nature (Fig.153.2). The tool, after fracture at the tip, was still repaired and retouched again. At one point, the opposite edge was retouched and became the cutting edge. During subsequent rejuvenations, removals were also derived onto the cutting edge gradually blunting it. The blunting removal series at the base near the back's edge improved tool symmetry, even though it was rather not a deliberate action.

Korolevo tools from layer II show **no signs of care for symmetry or the tip**. Knapping is focused completely on forming the longest possible and straight cutting edge, and then its rejuvenation and long preservation of its straight profile. The retouch does not always overlap with the tip, and subsequent rejuvenations **are designed to obtain a sharp edge, not to maintain tool shape**. In addition to that, these tools **have several rejuvenation series and were abandoned at a heavily exhausted stage**.

### 3.2.1.7.1.2. Korolevo V

A total of eight artifacts from Korolevo level V were analysed. The artifacts come from the collection of the Institute of Archaeology, Ukrainian Academy of Sciences in Kiev. The tools are made of andesite, only one of them (K.V.2100/4559) is of flint. The analysis covered more or less symmetrical artifacts which bear traces of bifacial knapping. Two forms have not been published yet (K.V.2100/4556 and K.V.2100/4555). Among the published pieces, four forms are referred to as “leafpoints” (Gladilin, Slitlvyj, & Tkachenko, 1995, Fig.8.2, 9.1,4–5), and two other as “biface”, (Gladilin et al., 1995, Fig.8.1, 6.2). One artifact comes from level VI (K.V.2100/4560), (Gladilin et al., 1995, Fig.6.2).

The tools vary greatly among themselves in terms of size. The largest of these (K.V.2100/4559) has the length of 14.9cm, while the smallest (K.V.86)–3.6cm. The characteristic feature of analysed artifacts is the presence of transversal fracture surface or cortical surface, transversal to vertical axis and forming tool base for the tool. Further on, this element will be described more accurately. Due to tool form, its formation and rejuvenation scheme, the tools can be divided into three groups.

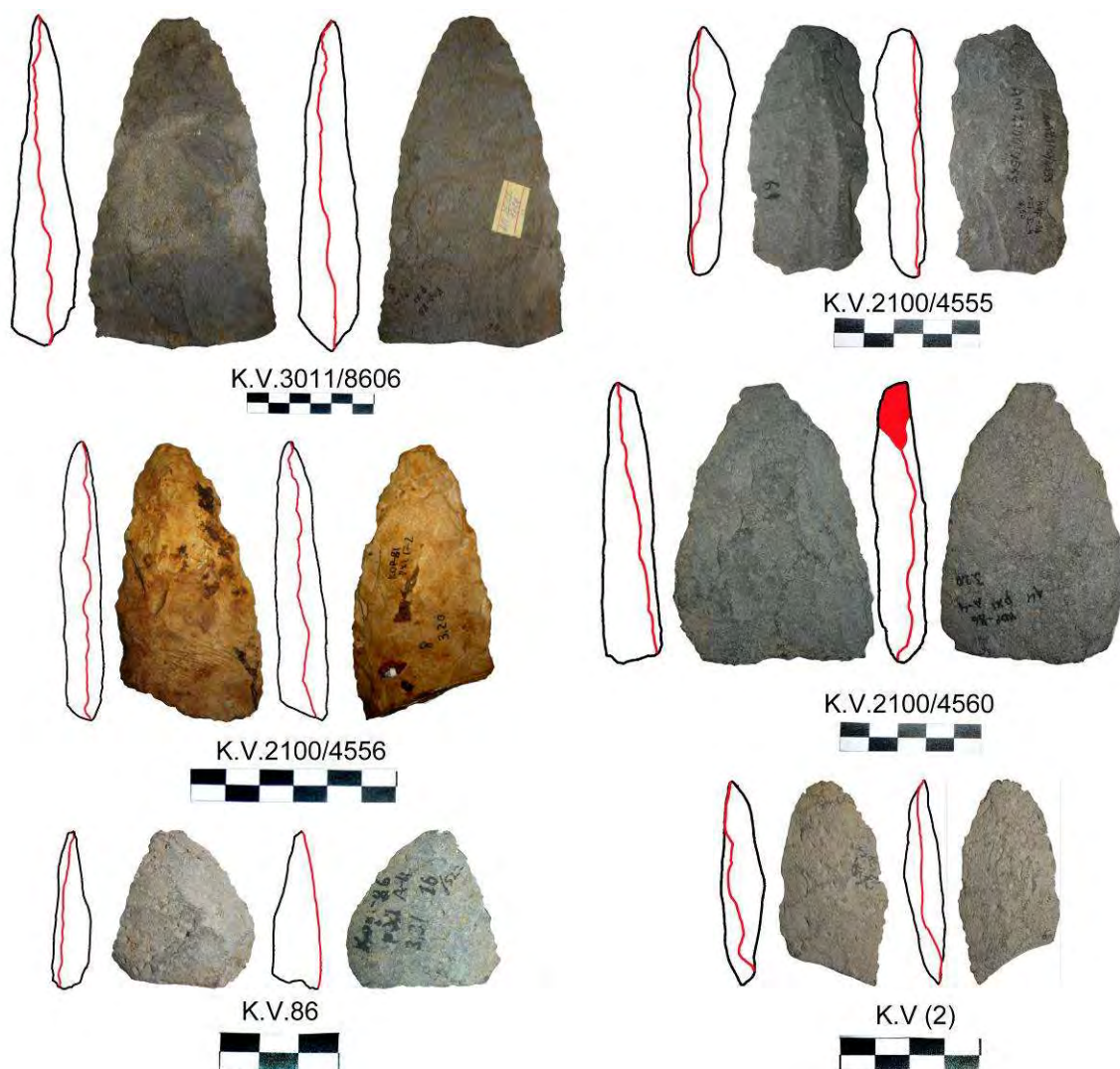


Fig.154 Group I tools shape classification with marked both edges profile.

## Group I

The group consists of four artifacts nearly triangular in shape, with a transversal base surface, formed with a breakage scar or left unknapped as a natural surface (K.V.2100/4556, K.V(2), K.V.2100/4555, K.V.3011/8606) (Fig.154). The tools have no or scarcely exposed tip, which cannot be rejuvenated and has no traces of tip-forming removals. The tools have two edges converging at the tip, of which one is more curved than the other one. Each of the tools included in this group was dropped at a different knapping stage. The K.V.3011/8606 artifact is a large preform, which was broken in its half after a percussion introduced in the middle of its upper face (which may suggest the fracture's intentionality). The artifact has no retouches, but only removals from the stage of surface and edge formation. Some of the removals were performed already after tool breakage.

The second tool (K.V.2100/4556) has a natural transversal base and traces of at least two edge rejuvenation phases. Rejuvenation marks are also present on the K.V.2100/4555 artifact, which has an unexposed tip and a transversal fracture at the base. The fracture scar was retouched with flat removals on the fracture and semi-abrupt ones on the edges when the tool was broken. The K.V(2) tool was broken as a result of percussion introduced on the side of tool's edge (perhaps during rejuvenation). The tool bears signs of post-breakage rejuvenation.

The artifacts are marked by the fact that during subsequent rejuvenations, one of the edges is outlined and maintained as more straight than the other. The second edge is S-shaped, and the removals on it are less precise and regular, sometimes semi-abrupt (K.V.2100/4555). Retouches do not usually include the apical sections and are evidently intended to sharpen the edge, not to maintain tool shape. The K.V.2100/4556 tool solely was retouched near the tip. The retouch overlaps with the very tip, blunting it partly since last removals were derived from the tip, parallel to tool vertical (Fig.154). As a result of a few resharpening series, the cutting edge is more convex than the opposite edge, and moves from the axis. This is due to absence of corrections in the form of removals derived from the distal posterior edge. Hence the poor tip exposure as well.

An interesting problem is the recurring presence of transversal base surface (Fig.154). In each of the tools that surface is formed differently and much as it might be supposed that these artifacts are examples of tools fractured during their manufacturing process, their rejuvenation or use, which were then re-retouched and later transformed into cutting tools; all the same, the K.V.2100/4556 artifact, equipped with a transversal base surface, left as a natural surface, requires considering the sense of referring to remaining artifacts as broken and repaired forms.

It may be, however, that here, artifacts with intentionally shaped transversal base surface are being dealt with. If possible, natural surfaces were used for this purpose, if not, the tool was broken transversally in its half. Such action may be indicated by transversal fracture present on the K.V.3011/8606 preform, with a percussion point visible in the middle of the upper face. The nature of breakage on the K.V.2100/4555 tool cannot be determined due to later repairs and surface erosion. In case of the K.V(2) artifact, the fracture is the result of percussion introduced on the edge which could be a part of B sequence (Pl.264). The intentionality of this procedure is difficult to judge upon. However, perhaps the tool was originally supposed to look differently, and so it was repaired after breakage.

Based on the K.V.3011/8606 artifact, early tool formation stages can be reconstructed. Knapping can be divided into two phases:

**I. Surface formation.** Flat, extensive removals, perpendicular to tool vertical axis. At this stage, knapping proceeded in a surface surrounding scheme, commencing from the lower face.

**II. Edge shaping.** At this stage, an edge scheme of knapping was applied. First four series on edge I were derived alternately onto the lower and upper face. Edge I, which was formed first, became almost parallel to tool vertical axis. After forming edge I, the knapping of another edge was started, by performing alternating removals onto the upper and lower face. One removal series on the upper face is made of flat, really extensive removals aimed at tool thinning. Further removal series are concentrated in the apical sections. These are semi-flat removals, not reaching far into any surfaces. They are derived perpendicularly to the edge, which results in slight convexity of the two edges converging at the tip. The tip itself is broken transversally, perhaps as a result of post-depositional fracture (the fracture scar is less eroded than the remaining tool surface). Edge formation might have occurred already after tool's breakage in its middle.

Tool edges were not formed at the same time, which caused the tool not to be symmetrical and one of the edges to be more convex. At the same time, the more convex edge is also more S-shaped in profile, which can attest to the fact that this edge was supposed to later serve as a back, not as a cutting edge. The tool has no rejuvenation signs, and the edges are left without retouching. At the same time, large tool size (14.1cm length; 7.7cm width, 2.9cm thickness), significantly different from the average size of remaining tools (especially in terms of thickness; average thickness being 1.22cm), reflect that that tool was abandoned as a preform, as early as before the commencement of its use.

Much as in the production process, one can see tool shaping, later, in the process of tool retouching and rejuvenating, the **shape and edge profile do not seem to be significant factors and do not affect the undertaken actions**. This is proved by the **asymmetry of tools which bear traces of rejuvenation**, as well as **lack of attention devoted to tool tip**.

## Group II

Group II includes two tools of shape similar to group I tools, which are equipped with a base formed through a transversal breakage scar. These tools, however, differ from the previously described ones in both their manufacturing scheme and a characteristic abrupt retouch on one of the edges, near the breakage angle. The K.V.2100/4555 tool (group I) has traces of this kind of abrupt retouch as well, which can additionally mean that these tools could be considered as a whole. The presented division, though, is based not on functional, but on technological analysis.

The artifacts are marked by triangular shape, edge asymmetry, of which one is more vertical, and the second is more angular to vertical axis.

Both tools have three significant techno-functional units:

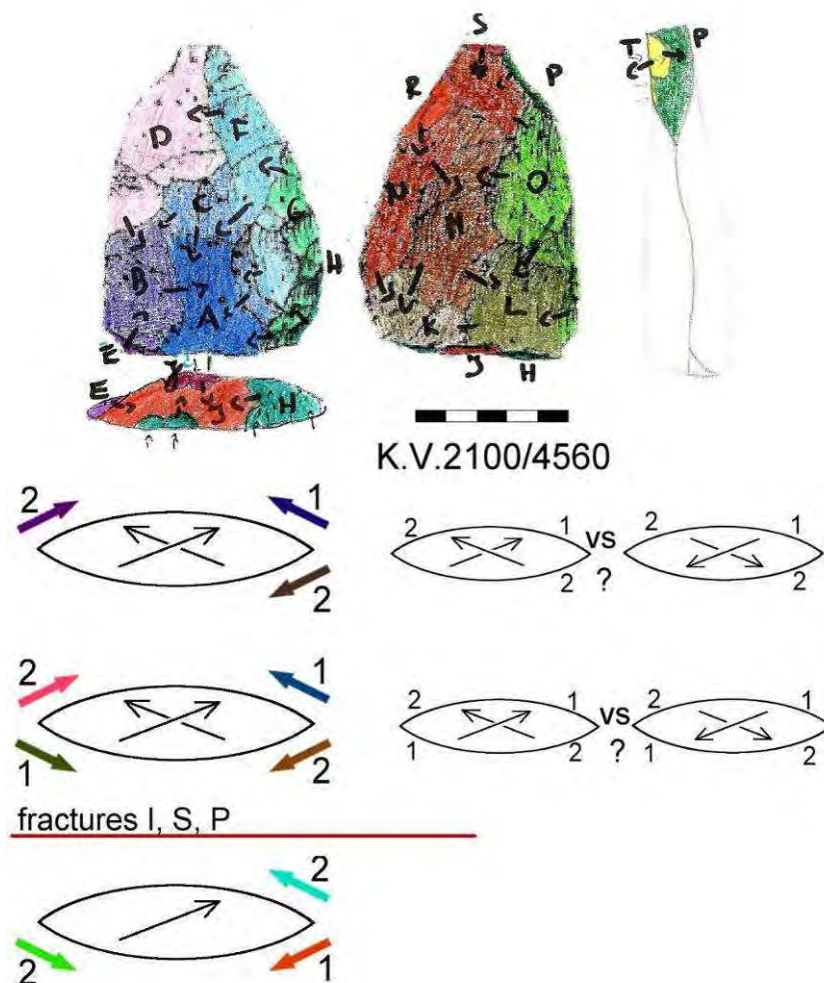
**A) Base.** Formed with a single transversal fracture scar. In both cases, it cannot be determined where from the percussion was introduced. The K.V.2100/4560 tool has a series of flat, small removals on the fracture scar as well as percussions removing the fracture angle near the edge.

**B) Cutting edge.** An edge with an acute angle, formed with semi-flat removals onto the upper face and a fine retouch onto the lower face. In case of K.V.2100/4560, retouch does not reach the tip as there is a transversal fracture scar, angular to vertical axis, which shortens



the cutting edge by almost 1/3 of its length (Fig.155). On the K.V.86 tool, the retouch reaches the tip. This edge is more vertical than the opposite edge.

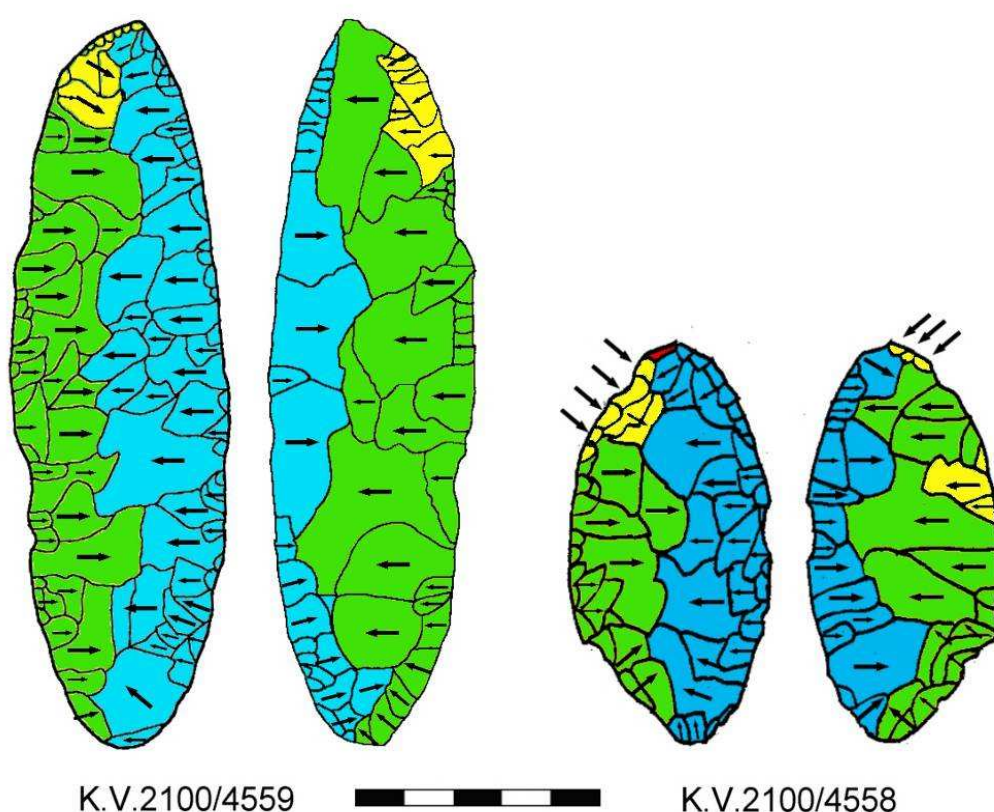
It is also worth noting that the K.V.2100/4560 tool has a transversal fracture surface not only at the base, but also at the tip. The latter, just like the adjacent angular fracture surface near the tip (Fig.155), was not removed during tool formation and rejuvenation. This fact indicates lack of interest in tip exposure.



It is not possible, on the basis of conducted analyses, to determine whether the steeply formed edge had any functional significance, or whether the procedure was aimed at blunting the base's edge. However, these tools were certainly **broken at some knapping stage**, and were **then formed so as to have one edge straight in profile**, retouched alternately with abrupt removals.

### Group III

The third group includes two artifacts (K.V.2100/4559 and K.V.2100/4558). Both are characterized by lack of transversally formed base. Both also have two converging edges, one of which is straight and is almost parallel to tool vertical axis, while the other is convex, both closer to the tip and the base. Such asymmetrical edge profile causes the asymmetry of tip placement towards vertical axis, moving the tip in the direction of vertical edge. The K.V.2100/4558 tool additionally has a transversal, tip-blunting surface which is possibly a leftover of a breakage scar. During subsequent rejuvenation phases, removals go further onto the transversal surface, removing it slightly. However, the surface does not become removed by the end of its utilization process, causing the tip of this tool to remain blunt and unexposed. One of the tools (K.V.2100/4559) is plano-convex, large (14.9cm length) and made of flint, while the second one is biconvex, small (7.9cm length) and made of andesite.



*Fig.156 Group III tools comparison with marked techno-functional units and removal directions on both edges. Blue marks removal series which formed cutting edge, green marks removals on distal posterior edge, red marks breakage scars, yellow marks back edge scars.*

On the tools, one can distinguish three techno-functional units (Fig.156):

**A) Cutting edge** (Fig.156–mark in blue). Long, straight, reaching from the tip to the base, retouched on the upper face with flat, correcting removals onto the lower face. At early knapping stages, removals on the lower face were extensive and flat (N sequence in K.V.2100/4559–Pl.269). During subsequent rejuvenations, angle correction was necessary, though the derived removals were not so extensive anymore (O and M sequence in K.V.2100/4558–Pl.268).

**B) Distal posterior edge** (Fig.156–mark in yellow). Formed angularly to vertical axis, convergent with the cutting edge at the tip. During subsequent rejuvenations, correcting removals were applied onto the upper face. The K.V.2100/4559 tool has a marginal retouch as well, perhaps a usewear retouch. The distal posterior edge is very short and changes into the back further along the edge. Angular removals, which were applied both onto the lower and upper face of distal posterior edge are mainly aimed at maintaining straight cutting edge profile. Due to those removals, the cutting edge does not move from vertical axis during subsequent rejuvenations, which was the case of group I tools.

**C) Back** (Fig.156–mark in green). An edge parallel to tool vertical axis in its middle part, angular at the base. Near the base, series of semi-flat (K.V.2100/4559). or semi-abrupt (K.V.2100/4558) removals onto the lower face were applied. They formed characteristic tool shape and a characteristic angular base. This edge has no retouch, and the derived removals are less regular than on the cutting edge, which resulted in its S-shaped profile.

Both tools were rejuvenated. K.V.2100/4558 wears traces of at least three rejuvenation phases. Only K.V.2100/4559 provides basis for manufacturing process analysis. On its surface, there are visible scars from the following tool formation stages:

**I. Surface formation.** First, flat, extensive removals were derived on the lower face. At this stage, removals were derived perpendicularly to tool vertical axis (Fig.156). The tool had to have its axis shifted slightly to the left first, and only then a series of flat N, J removals formed the current tool axis (Pl.269).

**II. Shaping.** After forming the lower face's flat surface, removals on the upper face were derived, first on the back's edge, then onto the cutting edge. The remains of sequence B (Pl.269), consisting of semi-flat, regular removals, might suggest that this was the very first cutting edge retouch phase; whereas the next stages bear witness to tool rejuvenation. At this stage, no removals were perpendicular to axis, but they were perpendicular to edge profile, which allowed for tool shape formation. Then, the two removal series were repeated, so once again semi-flat removals were derived from the back, removals which shaped the back edge. Also, this semi-flat removal series retouched the cutting edge. After retouching the cutting edge, the back's edge was again rejuvenated, and eventually, its final shape was formed, which resulted in removing the back edge's convexity. Despite of deriving four removal series on both faces, the back edge remained S-shaped in profile. On the K.V.2100/4558 tool, removal series forming back edge near the base was derived during one of the subsequent tool rejuvenation stages.

**III. Rejuvenation.** Covered only the apical part. Conducted in a surrounding scheme. Began with removals on the distal posterior edge's lower face, then on its upper face, and finally onto the cutting edge. The rejuvenations of K.V.2100/4558 proceeded in a similar, surrounding scheme.

These tools **do not show, both in the process of manufacturing and rejuvenation, much care for tool symmetry**. Subsequent rejuvenation phases rather cause the elimination of symmetry (K.V.2100/4559–F and H sequence–Pl.269). At the same time, **both edges were**

**treated differently**, and only the cutting edge and the distal posterior edge have a retouch. The characteristic procedure of forming the back edge angularly to the base increases tool symmetry, but does not seem, though, to be aimed at doing so.

The analysis of Korolevo level V artifacts showed that the *chaîne opératoire* includes **no care for symmetry or the tip**. More often than not, these artifacts have transversal surfaces on the tip, which do not become removed in the process of tool formation and rejuvenation. In addition to that, the artifacts show asymmetry in their manner of both edges treatment and outlining. It manifests itself in edges line asymmetry. The cutting edge became more curved, if during rejuvenation no removals correcting its profile were derived from the other edge's direction. Otherwise, the cutting edge remained more vertical, if the tool had a back's edge which serves to correct the cutting edge's profile and kept it vertical (straight).

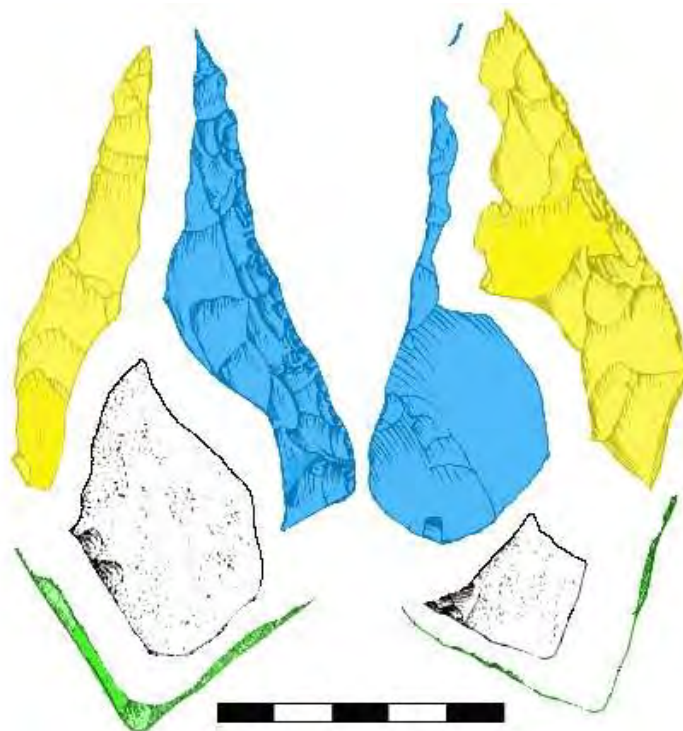
## 3.2.2. Comparative sites

### 3.2.2.1. Klausennische

Fifteen artifacts from the Klausennische site underwent analysis. The artifacts can be currently found in the collection of Archäologische Staatssammlung in Munich. In the thesis, their actual inventory numbers are being used. Three of them have the same inventory number of 1957\_464. In this case, the artifacts were given additional inventory numbers. Therefore, these have additional reference numbers 1957\_464(1) etc.

Among the analysed specimens, all were described in the literature as “knives” (Obermaier & Wernert, 1929; Obermaier, 1927; Bosinski, 1967; Birkner, 1914; Birkner, 1916). It was decided to incorporate the Klausennische knives into the analysis. This was due to their specific morphology in the form of usually symmetrical, long and convergent cutting edges and an exposed tip, which are features untypical of backed knives. It was noticed that analysing the production of this knives type will allow for a better understanding of the leafpoints morphology themselves. Actually the obtained leafpoints analyses outcomes have made the Klausennische knives examinations seem even more interesting.

The artifacts from Klausennische are usually characterized by an elongated shape, two converging retouched edges, an exposed tip and an unworked near-the-base part. One of the analysed tools has a vertical surface which forms a back on the entire edge (1914\_1057). Among the elongated knives one can also find a less numerous triangular knives group (1957\_447, 1957\_464(3), 1957\_457). However, the analyses showed that their shape results from their intensive usewear, repeated rejuvenations as well as tip fracture (1957\_464(3), 1957\_457).



*Fig.157 Edges arrangement scheme on the Klausennische artifacts using the 1957\_443 tool example. Blue marks distal posterior edge manufacturing sequences, green marks base manufacturing sequences, yellow—cutting edge's.*



The tools are plano-convex in cross-section except for 1914\_1048 which is a biconvex, massive and large knife (17.7cm length, 7.3cm width) knapped on a thick nodule (3.8cm).

A typical feature of all the analysed tools is their noticeable technological coherence. As the analyses have shown, the shape variety stems from repeated tool rejuvenation. Due to different styles of each tool knapping and rejuvenating, one may notice the following technological parts:

**A) Cutting edge.** Usually straight or slightly concave, long and reaching the tool base, formed with removals performed to the lower and next to the upper face. In the general knapping scheme one may notice a tendency to avoid removals onto the cutting edge's lower face on behalf of flat removals series derived angularly from the distal posterior edge (Fig.157). Due to such treatment, the cutting edge remained straight (a sinusoid edge profile was avoided). If the edge was not straight enough, after a flat retouch on the upper face, a series of small profile-correcting removals were derived on the lower face. The cutting edge on each of the tools has traces of at least several retouch series that prove its rejuvenations.

**B) Distal posterior edge.** Straight or convex edge converging with the cutting edge at the tip. Usually of the same length or longer than the cutting edge. The distal posterior edge has a slightly more S-shaped profile but it looks very much like the cutting edge. For this reason, the morphology of Klausennische tools may suggest that they have two cutting edges. Although it was retouched, this edge's function differs from that of a cutting edge. Apart from (probably) a being functional, it might also have had a technical role. From this edge a series of flat, broad removals onto the lower face were derived, extending outside the tool axis and, at the tip, crossing the entire width of the lower face. Their function was thinning the tool during its rejuvenation. The removals were usually performed angularly to the artifact vertical axis. If the edge angle made it impossible to perform flat removals, the edge got slightly blunted with a series of semi-steep removals onto the upper face (1957\_464(1)–A sequence–Pl.282, 1914\_1049–D sequence–Pl.273). After each rejuvenation the edge was retouched onto the upper face with an optional correction performed onto the lower face.

**C) Base.** This part was knapped in three ways. The most common one was to form it with two vertical removals positioned at angle towards each other. Natural nodule surfaces were sometimes used for this purpose. The base was also knapped with a single removal transversal to the tool axis (1957\_447, 1957\_457, 1957\_440, 1957\_467). Another way to do it was to leave an unworked nodule or flake fragment (1957\_439, 1957\_464(1), 1914\_1052). In two cases, the base displays signs of removals performed onto both faces which formed a transversal sharp edge at the base (1957\_464(3), 1957\_468). Nevertheless, at least in case of the 1957\_464(3) artifact, one can assume that the base was made into a cutting edge once it the tip had been broken. In some tools, the edges reach the base angle and prolonging them was connected with subsequent tool rejuvenation stages (e.g. 1957\_464(3), 1957\_464(2)). Some tools have removal series in the angle between the base and the edges which reflect the base angle rejuvenation (e.g. 1957\_447, 1957\_457, 1957\_440).

Following the sole production technology is not an easy task as almost each of the analysed artifacts has traces of several rejuvenation series. Only two of the analysed tools have no signs of rejuvenation and allow for tracing the tool knapping process. This is a large 1915\_1048 tool, made from the 1914\_1052 flake. Although they are different in size, their characteristic feature is identical both edges formation. Due to this, they have almost ideally triangular shape. In both tools two main tool knapping stages can be distinguished.

**I. Surface formation.** At the beginning a series of broad surface-forming removals were performed which possibly predefined the tool shape. Series of such removals were performed either in a surrounding scheme (upper face–lower face with an edge rotation) (e.g.

like the 1914\_1052 tool) or in an edge scheme of knapping, each time starting from one face (top–bottom; top-bottom). The knapping concentrates on the parts near the tip and leaves the base unworked. In case of the 1914\_1048 tool, these will be two vertical surfaces set at a right angle towards each other. In case of the 1914\_1052 tool, this is the flake's distal cortical part.

**II. Edges formation.** After surface knapping, the edges formation stage followed. Here the knapping run separately for each edge. A series of top-bottom removals were performed, optionally once again onto the upper face. The 1914\_1048 tool has one more phase of subsequent small removals that shaped the edges. Probably the repeated edges manufacturing concerns their rejuvenation or a final sharpening attempt (the last removals are tiny sequences W, G, and U concentrated around the tip–Pl.272).

Both of the described tools are symmetrical and additionally, both edges were treated symmetrically during knapping. The term “symmetrical edges knapping” is to be understood as an identical knapping and absence of edges differentiation concerning their varying technological functions or differing removal types.

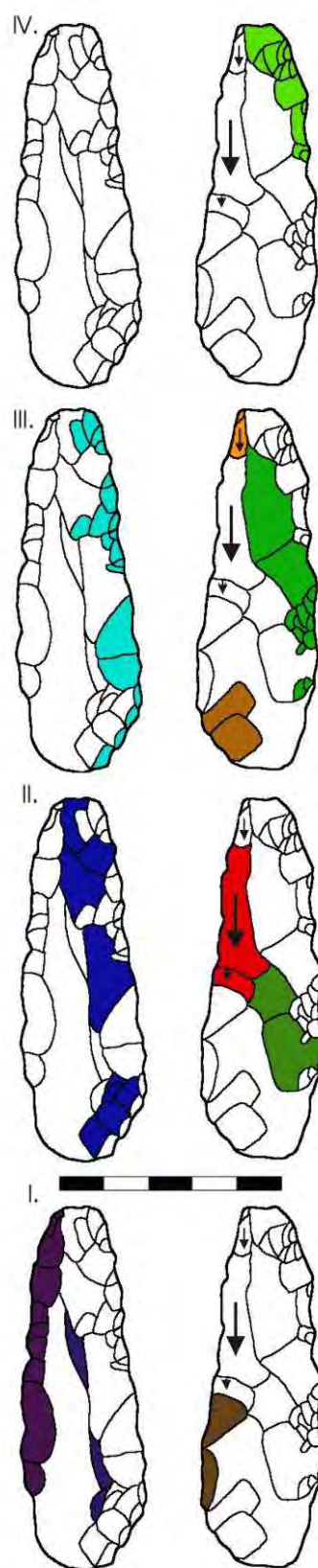
The tips of both tools are not exposed. The 1914\_1028 tool has a transversal breakage scar at the tip, which was neither retouched nor rejuvenated. The break moved the tip towards one of the edges, moving it off the vertical axis. The second tool (1914\_1052) has a removal sequence derived from the tip onto the lower face. The sequence also moved the tip off the axis towards one of the edges. The sequence was done during edge knapping but it might be an attempt at repairing the broken tip. If this is the case, then subsequent edge retouches should be treated as tool rejuvenation sequences.

**III. Corrections.** The objective of tool rejuvenation was to resharpen the cutting edge. However, the following rejuvenations should not blunt the edges and at the same time the cutting edge should remain straight. To get the aimed result, a scheme of thinning the tool's lower face with flat, extensive removal derived from the distal posterior edge was used. The tools were usually rejuvenated in the scheme lower face–upper face, starting from the cutting edge removals and finishing with the correction of distal posterior edges' upper face (1957\_440, 1957\_443, 1957\_439, 1957\_464(2), 1957\_468).

One of the tools (1957\_464(1)) has a very interesting rejuvenation scheme done by first introducing flat removals onto the lower face from the distal posterior part. Next step concerned removing a long flat flake percussed at a tip and located along the cutting edge (a pradnik type removal but on the lower face) and, eventually, the cutting edge retouch on the upper face (Fig.158). One can see two full subsequent rejuvenation phases on the tool and a third one, probably the earliest, only partly visible.

During the following rejuvenation series the tool changed its shape. Among the analysed tools one several shape change schemes are observable. Most often, this was done through gradual rejuvenations directed towards the edge at the tip, which resulted in its exposure into a sort of a spire. Such situation can be observed in the 1957\_443 or 1957\_440 tool (Fig.159). The 1957\_457 tool probably looked very much like 1957\_443 but its tip suffered a break and the tool was retouched again. Still, the knapping scheme, or even subsequent rejuvenation schemes remained almost identical

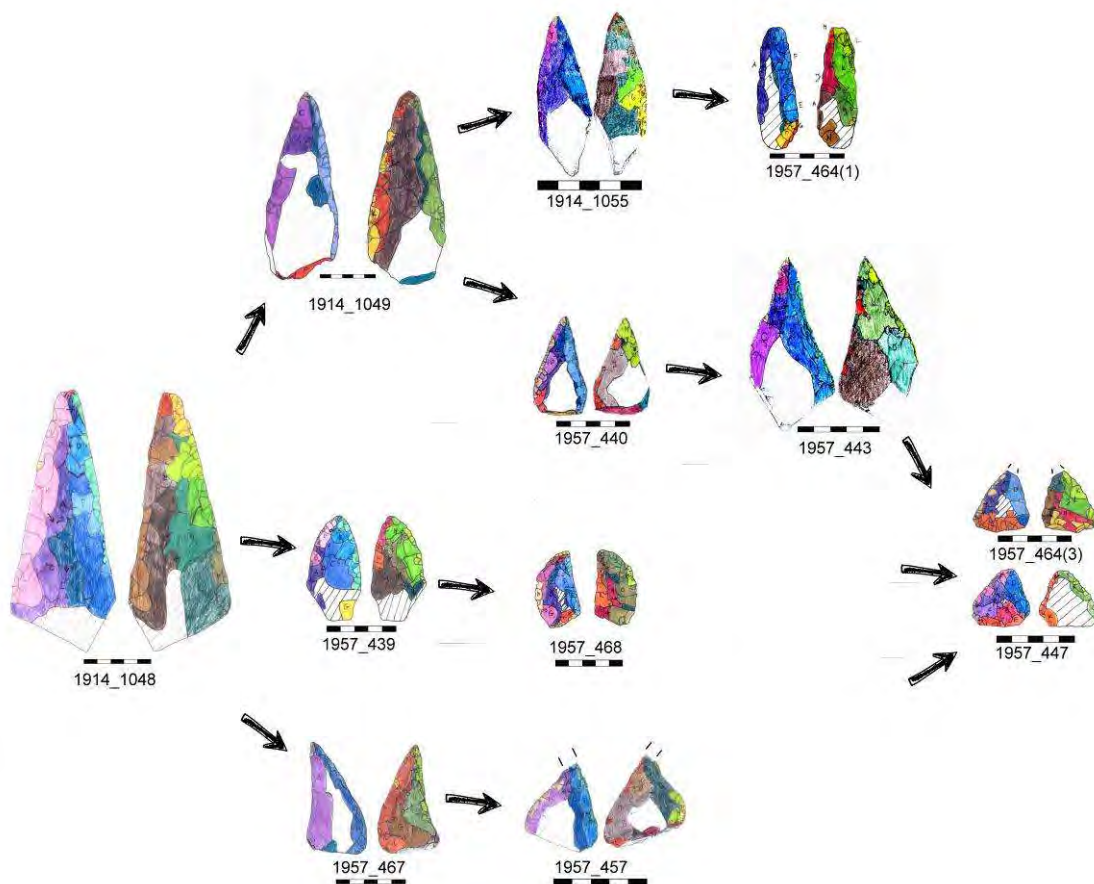
The second option was lifting the tip from the vertical axis by introducing removals onto the distal posterior part from the tip. Via such knapping, the distal posterior edge became more convex–unlike the cutting edge which became straight and parallel to the tool vertical axis. The same situation is encountered in the 1957\_468 and 1957\_464(2) tool which in literature was termed as a leafpoint. However, the analysis clearly shows that it is a highly worn knife with a rejuvenation scheme identical with the remaining tools.



*Fig.158 Tool rejuvenation scheme 1957\_464(1) with flat, long thinning removals performed from the tip to the lower face.*

The third pattern of shape modification during subsequent rejuvenations is represented by triangular tools (1957\_464(3), 1957\_447). First of them has a broken tip, which may suggest that before the breakage it looked more like the 1957\_443 and 1957\_457 artifacts. Even so, the 1957\_464(3) tool was rejuvenated in a different way than the latter artifacts. The edges rejuvenation of triangular tools took place in a surrounding scheme of knapping. First removals were introduced from the lower face and next from the upper face. The tool was retouched onto the upper face on both edges. Neither edge, however, was treated in a different way. These tools were abandoned at a heavily exhausted stage of their use. This might have caused dropping the idea of further thinning the cutting edge from the distal posterior edge, and only concentrating on edges retouching and correcting during the last rejuvenation stages. Additionally in the 1957\_464(3) artifact, the tool orientation was probably changed, since after the tip breakage one of the edges and the base edge get retouched.

Two of the analysed tools have different schemes of rejuvenation. This fact is connected with different edges treatment. One of them has a vertical back edge on the entire tool length which affected further tool manufacturing. As it was impossible to introduce flat, long, thinning removals from the back's edge, the rejuvenation took place via series of removals—first onto the lower face, than onto the upper face of the cutting edge. Only small, tool-thinning removals to the lower face were derived from the back edge. An analogous rejuvenation and knapping scheme was observed in the 1957\_467 tool, even though it does not have a vertical back edge, but only a series of semi-steep removals on one of the edges. Nevertheless, the rejuvenation series were analogous in this case and maybe, due to the adverse distal posterior edge angle, it was decided to rejuvenate the cutting edge without introducing thinning removals from the distal posterior edge.



*Fig.159 Hypothetical scheme of Klausennische tools shape modification throughout subsequent rejuvenations.*

It is hard to conclude if the production process of other tools was analogous to the one presented for the 1914\_1048 and 1914\_1052 artifacts, as subsequent rejuvenation sequences cover previous tool manufacturing stages. Nevertheless, if this thesis is accepted, it has to be stated that the tool production process led to creating a symmetrical tool with two long cutting edges. It was only the subsequent edge retouching and in consequence its blunting which enforced a change in the uniform treatment of both edges. This triggered gradual tool thinning in the rejuvenated sections, so especially in the tip sections. It is only here that one can observe different treatment of both edges and focusing the entire process on the aim of keeping a sharp, straight and long cutting edge. One should notice the tendency to expose the tip whose role might have also been functional (this can be supported by the example of tools with a transversal breakage near the tip). The other edge was therefore retouched in the rejuvenation process, and kept as straight as possible. Nevertheless, this tool feature (distal posterior edge sharpness) might have been abandoned in further rejuvenation phases. The base did not usually undergo knapping. Only the corrections of the base angle near the edges point to near-the-base part shape formation. However, one should notice that the base had some preferred parameters, which were its blunting; or even better, forming it into two vertical surfaces positioned towards each other at angle close to the right angle. If the parameters were changed, the base could also be rejuvenated, which can be observed in the 1914\_1049 or 1957\_440 tool, or it was transformed into a cutting edge (1957\_464(3)).



### 3.2.2.2. Königsau

Seven artifacts from the Königsau site, which can be found in The Landesmuseum für Vorgeschichte Sachsen-Anhalt in Halle, underwent analysis. The artifacts come from the archaeological level A dated back to the beginning of OIS 3. The artifacts are included in the backed knives group and were analysed with regard to their symmetrical shape. Just like in the case of the Klausennische artifacts, the aim of symmetrical knives analysis was to distinguish actions which led to extending tools symmetry, and to verify whether the symmetry was aimed at or if it was a side effect of the tool production or rejuvenation.

Due to limited access to the exhibited artifacts, it was decided that two original forms (27.3, 29.3) and 5 copies (26.1, 27.1, 27.3, 27.3, 28.2, 28.5) shall be analysed (Fig.160). The copies, however, were so precise, that they proved to be suitable for scar pattern analysis. Nonetheless, after the analysis and as far as possible, the correctness of scar chronology estimation was checked on the original forms exhibited in the museum's showcases.

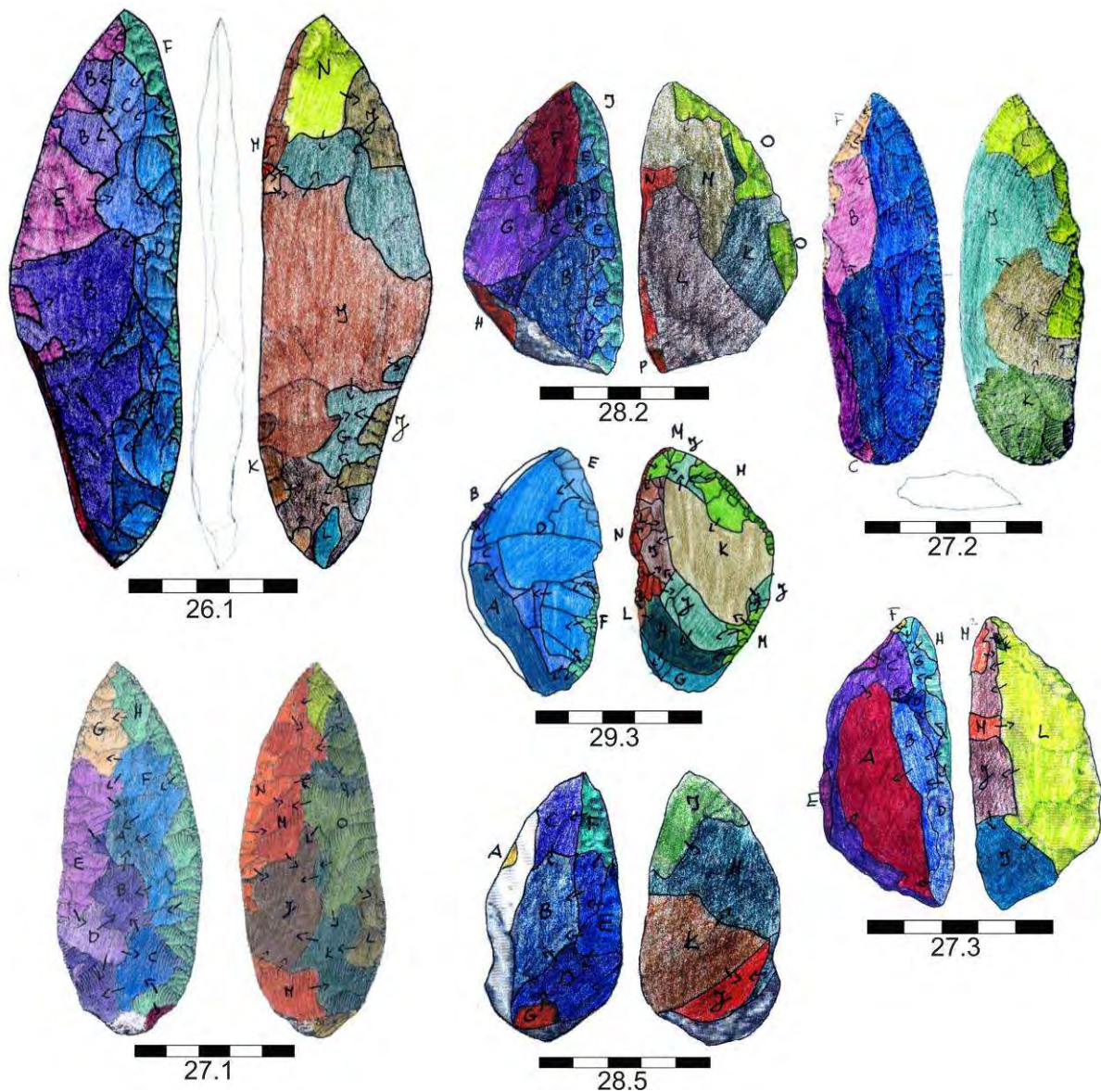
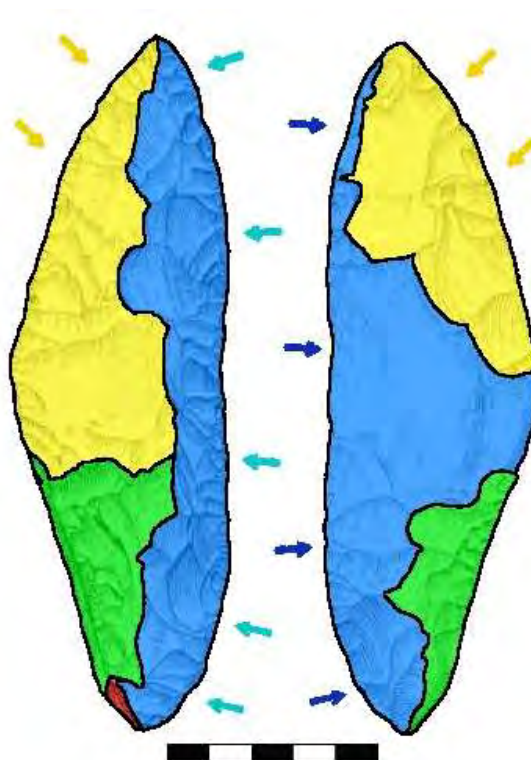


Fig.160 The analysed Königsau tools comparison.



*Fig.161 Edge arrangement scheme in Königsau artifacts, on the example of tool 26.1. Blue marks cutting edge treatment, green depicts distal posterior part manufacturing sequences, red marks base manufacturing sequences and yellow depicts back treatment.*

The Königsau tools, despite significant differences in dimensions and shapes, make a highly coherent tool group from the point of view of technology or, to be more precise, the ideal type. The artifacts are plano-convex, and usually of a prolonged shape. The tip is exposed as a rule (except for the 29.3 artifact—this case will be described later). The tools have a long straight cutting edge and a back edge which changes into a distal posterior edge converging with the cutting edge at the tip (Fig.161).

Among the analysed tools one may find a few separate techno-functional units which were treated differently in the course of knapping and correcting:

**A) Cutting edge.** Straight, usually retouched on its entire length up to the base angle (26.1), plano-convex. It was knapped to its lower face with extensive, flat removals that flattened the lower face and kept the edge profile straight. The retouch is derived on the upper face using a series of precise semi-flat removals which were usually longer than broader. Sometimes, after retouching the upper face, small removals correcting the edge profile were performed on the lower face. The edge has noticeable traces of several overlapping removal series, though the oldest ones are preserved solely near the base (Fig.161).

**B) Distal posterior edge.** Fragment of an edge opposite to the cutting edge, placed near the tip, positioned angularly in relation to the tool axis. It converged with the cutting edge at the tip. Its length normally covers a little less than half the entire edge length, though it is strongly dependent on the distal posterior edge profile and form. The edge is plano-convex, with flat removals derived angularly to the tool vertical axis, near the tip on the lower face. In some instances, when the distal posterior edge is strongly curved (29.3—Fig.160), the last removals closest to the cutting edge were performed parallel to the vertical axis, nearly from the tip. After a series of flat removals, the distal posterior edge was retouched on the upper

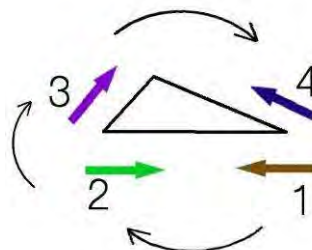
face with small semi-flat and semi-steep removals, which formed and exposed the tool's tip. Lack of removals towards the upper face caused the absence of tip exposure, which is visible in the 29.3 tool.

**C) Back.** Most frequently a separate orthogonal surface, formed by leaving the vertical natural break surface (26.1) or the cortical surface (29.3, 28.5) parallel to the tool vertical axis or set angularly to it. If the cortex extends onto the base as well, then back changes into the tool base. In two cases (28.2 and 27.3) one deals with a series of steep removals towards the upper face. At the early stages of knapping, flat removals towards the lower and the upper faces were performed from the back surface. Their aim was to form the tool surfaces. In two cases (28.2 and 27.3) a series of flat removals to the upper face, forming the back and blunting this edge can be seen. In this respect, the 27.1 tool appears to be quite interesting, the most symmetrical tool in the collection (Fig.160) which has remnants of scars that formed the back surface at the early stages of tool utilization. During its exploitation, however, the tool was redesigned and the diagonal back surface was obliterated with a series of flat removals to its lower face. Thus, a leaf-shaped tool with a small cortex fragment at the base was created. The profile of the visible scar remains that formed the back suggests that it was set at an angle towards the tool axis, which gave the tool a triangular shape. In the following rejuvenation series, the shape might have been so little ergonomic that it was decided to remove the back and form a biangular edge profile opposite to the back edge (Fig.163).

**D) Base.** A tool part usually left without knapping as a cortical base (27.1, 28.5) (Fig.160) or solely as an angle between the back surface and the cutting edge (28.2, 27.3, 26.1, 29.3). Only one tool (27.2) has a separate removal sequence derived on its lower face which formed an arched base edge.

Overlapping retouch sequences on the cutting edges, as well as the sequence arrangement chronology schemes, imply that the cutting edge was gradually rejuvenated with subsequent removal sequences. The sole tools production process is difficult to reconstruct as the tools bear numberless rejuvenation marks. Therefore, it is impossible to establish precisely which sequences come from the tool knapping itself. It is highly possible that the tool knapping was analogous with the process of rejuvenation—at least at the stage of particular functional edges formation.

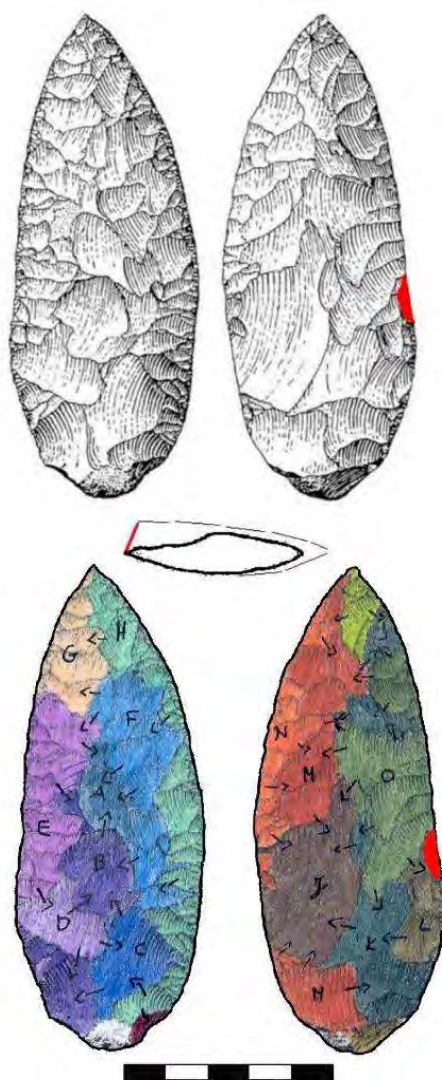
A characteristic feature of the Königsau tools is avoiding, as much as possible, any removals on the cutting edge's lower face. Cutting edge blunting caused by subsequent retouch sequences was avoided by introducing flat axis-angular removals from the distal posterior edge. These removals caused tool thinning, and left a straight cutting edge profile at the tip mainly.



*Fig.162 Surrounding scheme of Königsau tools knapping and rejuvenating depicted in cross-section.*



The cutting edge rejuvenation, then, usually required a series of removals reshaping the tool's entire tip part. The rejuvenation, in case of the described artifacts, was usually done according to a predefined scheme. First, flat removals were introduced onto the lower face (most often in the cutting edge-distal posterior edge scheme) (Fig.162) and next, semi-flat removals onto the upper face following the distal posterior edge-cutting edge scheme. The rejuvenation then took place in a surrounding scheme of knapping and the cutting edge retouch was done at the end (Fig.162). Once it was necessary, the cutting edge was additionally corrected with small single removals onto its lower face. Such rejuvenation scheme allowed for tool thinning at the tip and avoiding the process of gradual tool blunting by subsequent retouch series on the cutting edge (see the Ehringsdorf site). At the same time, the retouch onto the distal posterior edge's upper face allowed the exposed tip preservation and corrected, if possible, its edge profile so that it remained straight. It is likely that it additionally performed the function of a working edge. The cutting edge retouch was conducted so as to keep a straight edge profile which seems to be a characteristic feature of the Königsau tools. At the very tip, the cutting edge retouch caused the tip to bend towards the distal posterior edge (26.1, 27.2). Additionally, in case of the 28.2 tool, a series of flat broad removals can be seen, directed from the distal posterior edge onto the upper face, thinning the tool at its tip on the upper face (Fig.160).



*Fig.163 The 27.1 artifact with visible remains of back's vertical surface, removed during one of tool's re-shaping and rejuvenation stages.*

Lack of removals onto the distal posterior edge's upper face resulted in the absence of tip exposure. This is depicted on the 29.3 tool (Fig.160), which has a distal posterior edge transversal surface that overlaps the tool tip. At the same time, the tool's lower face from the distal posterior edge was highly and successively thinned, which enabled further cutting edge rejuvenations.

As it can be seen, the cutting edge performed a utility function solely and the subsequent removal series were aimed at keeping its most important features as a straight edge profile and its sharpness. By contrast, removals derived from other edges, from the distal posterior edge in particular, served mostly technical purposes. The distal posterior edge objective was tool rejuvenation: its thinning at the tip, possible thickness and tip corrections. Therefore, cutting edge and distal posterior edge, even though they may symmetrically converge at the tip, like in the 27.1 tool, performed totally different functions within a tool.

From the perspective of techno-functional division of certain tool edges and surfaces it can be seen that in the formation and next, rejuvenation process, **the most prominent factor was to keep a straight and sharp, long cutting edge**. The entire production and rejuvenation process was subjected to this aim. It is especially visible in those moments of the rejuvenation process, where some tool elements had been abandoned on behalf of others. For instance, in the 27.2 tool, the entire lower face is shaped with flat removals derived from the back edge and the distal posterior edge (Fig.160). A similar tendency can be observed for the 29.3 and 27.2, 28.2, 28.5 artifacts. At the same time, one can observe that removals performed onto the distal posterior edge's upper surface had a corrective function only, and if it is not necessary, deriving them is skipped in the rejuvenation process (29.3, 28.5). Based on this, a conclusion can be drawn that there were two elements crucial to the rejuvenation process. One of them were the removals performed onto the distal posterior part's lower face. In due course, those removals formed the lower faces' surface (especially at the tip), thinning it at the same time. The second important element were the retouch series shaping the cutting edge onto its upper face. These steps, during the tool rejuvenation and knapping, could not be omitted; more precisely, the former for technical reasons, the latter for the sake of functional aspect. The remaining tool elements and their form were adjusted to those two basic aspects and, if it was required, their morphology could undergo a change. Since the basic elements are reciprocally alternate removal series, their repeated character might have sometimes led to the creation of a symmetrical tool with an exposed tip positioned in its vertical axis.



### 3.2.2.3. Szeleta Cave

The analysis covered 15 artifacts from the Szeleta cave. Five of them can be found in the Otto Herman Museum in Miskolc. Their inventory numbers are 53.38.7; 53.8.2 etc. The subsequent ten artifacts can be found in the National Museum in Budapest. These artifacts have inventory numbers Pb70, Pb88, Pb93 etc. All published items (Pb72, Pb93, 53.38.8, 53.38.7, Pb84, Pb83, Pb70, Pb96, Pb88) were called “leafpoints” (Kadič, 1916). It has also been decided to analyse symmetric forms with the aim of extending the investigated specimen (Pb92, Pb73, 53.8.2, 53.6.4, Pb97, 53.4.25).

The analysed artifacts differ greatly in size, but their common feature is their little thickness, and, majorly, their regular shape. In order to compare them with those found in other sites it was decided to analyse four artifacts which resemble in their shape the leafpoints from Jankovich cave. Two other items without an exposed tip were also considered, one item with a cortical base, five symmetrical tools in the shape of a willow leaf and three with a rounded base. Based on the analyses, one can divide the tool specimen into three groups.

#### Group I

There are eight tools included in the group (Pb70, Pb72, Pb73, Pb84, Pb93, 53.8.2; 53.38.7; 53.38.8) (Fig.164). They are all called “leafpoints” in reference literature (Kadič, 1916). The artifacts are quite alike in the aspect of their shape. There are merely three instances where the base is rounded and composes a separate surface. The tools are of similar shape. In these tools one may recognize two techno-functional units, the knapping of which took place separately:

**A) Cutting edges.** The formation of these took place with flat and semi-flat removals undertaken on two sides. In the course of cuts and formation of the edges, the knapper tried to achieve a bow-shaped edge, slightly rounded at the base and at the tip. One can also recognize maximal thinning of the edges and attempts to keep their straight profile. At the same time, the knapper tried to preserve the aimed shape more than the very profile of the edge. Thus, if it appeared necessary, the final sequences of marginal removals were introduced at an angle which allowed for maximal change of the edge shape. That might have been a semi-steep angle, which would slightly blunt the edge, or a very acute one which would yield in hinges.

The two edges converge at the tip. A characteristic feature of the Szeleta tools is great care for tip symmetry and an even stronger care for symmetry rather than for clear tip exposure or its sharpness. If, therefore, in the course of knapping the ongoing exposures of the tip resulted in moving it from the axis, this procedure was abandoned. This is why some artifacts have a tip which is not entirely retouched (Pb70, Pb72, Pb93) or it is broken and corrected only to a very slight degree (Pb73) (Fig.164).

The edges do not have a retouch in a strict sense. The marginal removals were aimed at ultimately correcting the tool rather than keeping a straight edge profile. Removals were therefore introduced at the base or the tip where they were necessary in order to keep the symmetry (53.38.7–sequence U at the tip, Pb72–sequence H and I at the tip–Fig.164). There are only a few instances where the removals were introduced in such a regular scheme that they might be called “sharpening retouches” (Pb93, 53.38.8).

The edges were knapped on the entire line in the very same way. In most cases one cannot observe different treatment of the near-the-tip parts. The edges on the entire line have also a slightly S-shaped profile.

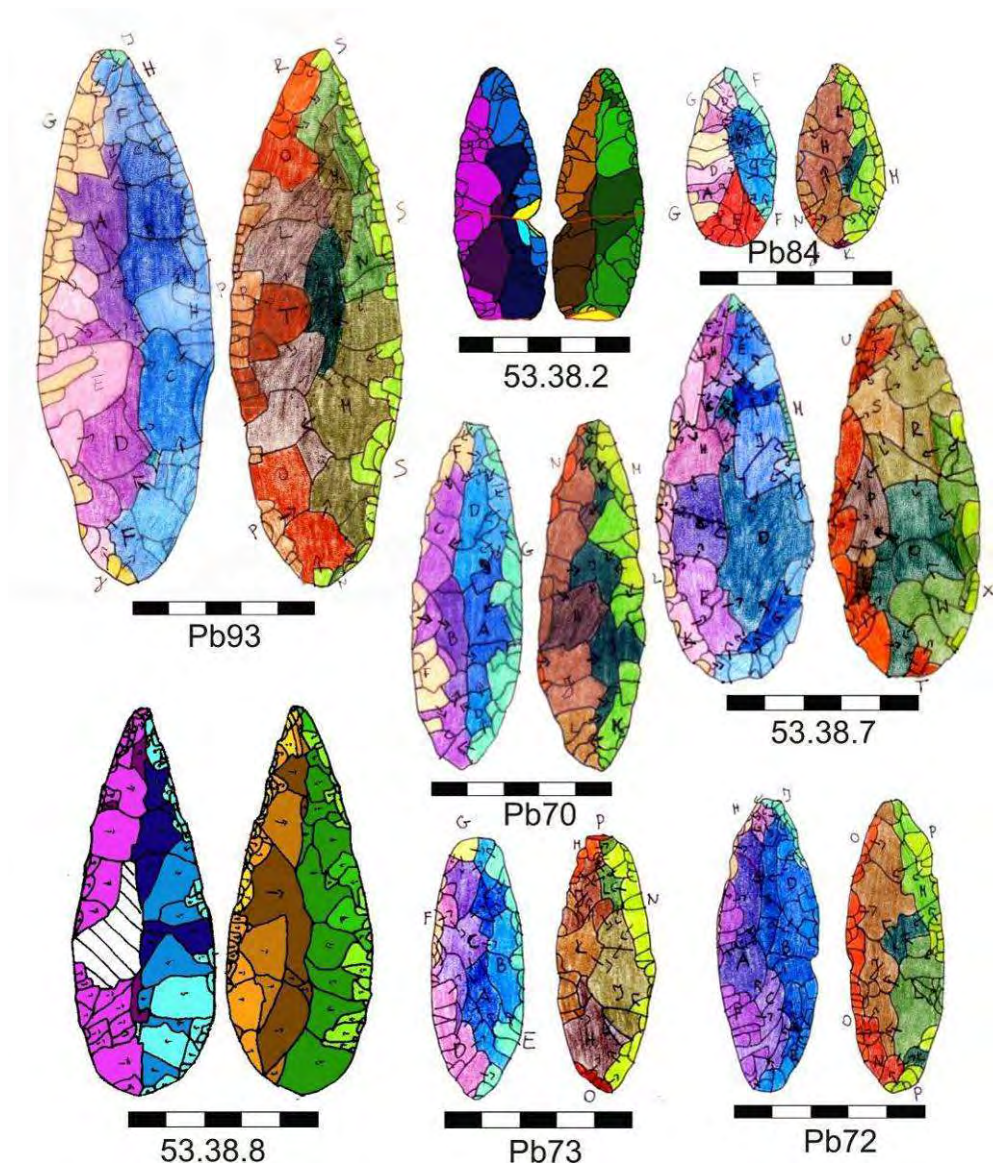


Fig.164 The analysed Szeleta group I tools comparison.

**B) Base.** Separate base edge can only be seen in three cases (53.38.7, 53.38.8 and Pb84) (Fig.164). It is rounded and formed with a series of separate angular removals. In case of Pb84 and 53.38.7, it appears to be formed with a separate series of removals from the base edge. In tools with a rounded base, the largest tool thickness can be observed at the base. These artifacts are thicker than the other ones. Additionally, the Pb84 form has certain features which may prove that it was created as a result of correcting a larger point, fractured at the base and retouched once again. One cannot exclude the option that the rounded base formation was caused by the necessity to face a tool of considerable width. Since the base was impossible to obtain using angular removals converging at base angle, a decision was made to form a separate rounded base. In other instances, the tool has an angle-shaped base formed with a series of angular removals introduced in two directions from both edges. The removals, however, are so precise that in some cases it is difficult to decide which end of the tool is meant to be its tip and which its base. In vague cases it was presumed that the tip part should be thinner than the one close to the potential base

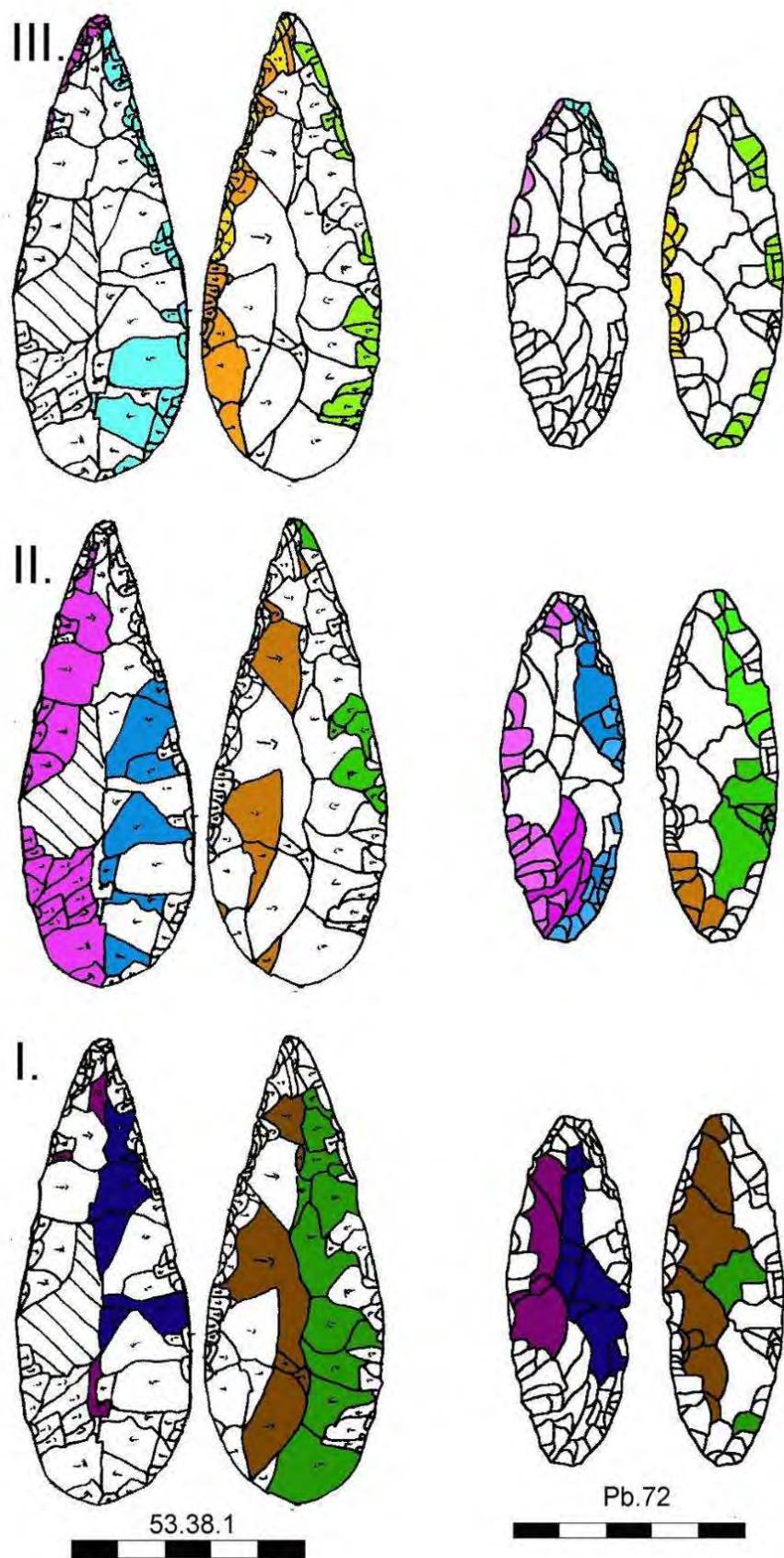


Fig.165. Manufacturing scheme of group I artifacts. Numbers from I to III correspond to tool formation stages described in the text.



The described artifacts appear coherent from the perspective of technology. Generally one may name three basic tools production phases:

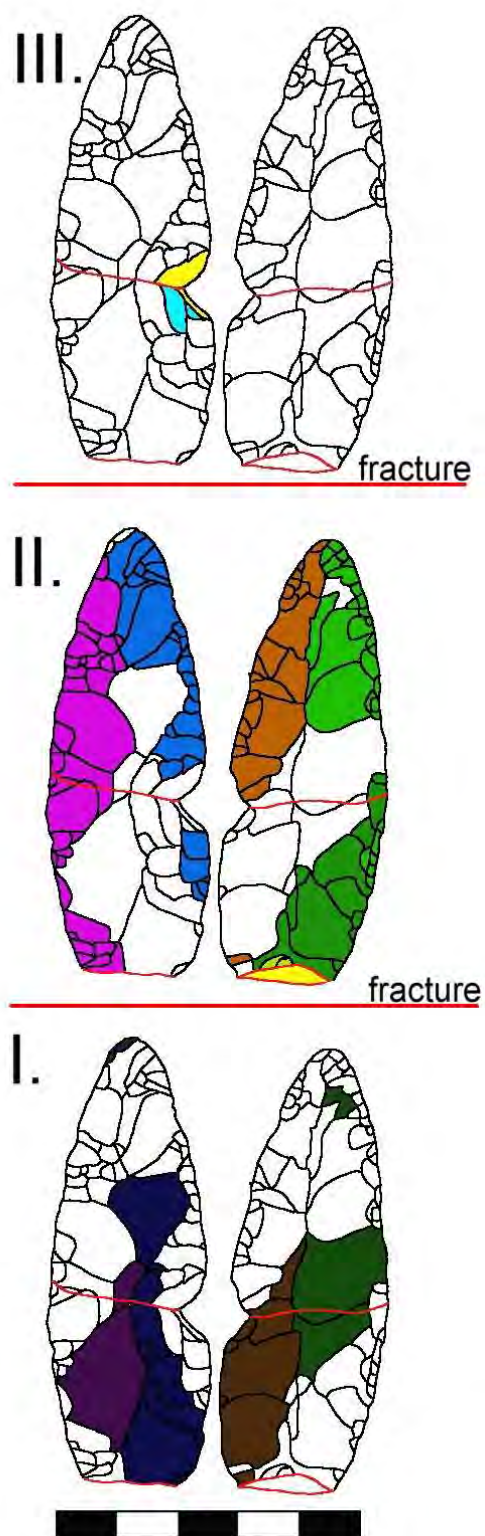
**I. Surface thinning and forming.** Flat, extensive series of removals usually introduced on two faces in a surrounding scheme (Pb72, Pb84, 53.38.8, 53.8.2, 53.38.7) or in a surface/edge analogical scheme (Pb70, Pb93). A noticeable feature here is beginning the scheme from removals on the lower surface. At this stage removals are done perpendicularly to the tool axis; it is hard to note any evident traces of tool shaping (Fig.165).

**II. Shaping.** Here the removals are performed angularly in relation to the vertical axis and independently at the base and the tip (Fig.165). The knapping is done in edge scheme, though one may observe deriving series of analogical removals on the same face, e.g. at the tip to the upper surface (Pb70). The removals often greatly overlap the tool surfaces, thinning them simultaneously. Both the tip and the base removal series show a great knapping accuracy. The Pb93 tool is an interesting example whose shape was changed considerably due to one of the removals from prior manufacturing stage. A semi-steep scar on one of the edges resulted in noticeable tool narrowing in its middle part. Subsequent series of removals to the opposite edge (series D, E, M, N–Pl.301) were aimed at such tool shaping so that it could become symmetrical. After a series of removals to the opposite edge, the tip sections of the damaged edge also required correcting. This is why the O and F removals were later introduced (Fig.164). As a result of those moves, it was possible to restore tool symmetry; nonetheless, it remained narrower in close-to-base part which creates the impression of exposing a tang on the tool. Its analysis yields the conclusion that the tang was not intended to be placed there, but resulted from having to adjust the shape of one edge to a failed removal, which had caused the creation of a deep notch on the opposite edge. The instance of Pb93 tool shows that the scheme of knapping could have been changed and adapted to the needs of blank itself. Hence, series derived several times on both faces can be often observed, each time correcting consecutive edge asymmetries (Pb72).

**III. Edge correcting.** The last manufacturing stage was the correction of edges and their profiles. At this stage, the entire length of the edge was knapped on both sides, both at the tip and closer to the base, using a series of marginal semi-flat removals (Fig.165). Their objective was correcting the tool shape and the edge profile, and, if it was possible, also their sharpening. However, a few examples show that if the edge shape required further modification, the tool underwent a series of more invasive removals, often slightly blunting the edge, but enhancing tool symmetry at the same time. The tool received edge knapping at this stage. It is difficult to notice any tendency of deriving removals in a particular scheme—e.g. from bottom to top. The scheme seems to be each time adjusted to the needs of the blank. At the same time, one may notice a tendency for deriving sequences of alternate analogical removals. The Pb73 tool and the alternate N and E sequences (Fig.164) may serve as examples.

**IV. Corrections.** A few artifacts bear transversal breakages traces at the tip (Pb73) or at the base (53.8.2). Both tools display signs of post-fracture correction. In case of the Pb73 artifact, the correction concerned edges profile at the tip and attempted to remove the transversal breakage scar (sequences G and M—Fig.164). The repair, however, did not lead to a complete fracture removal. It is hard to determine, on the basis of analysis of the repaired artifact, whether it was later in use. The 53.8.2 tool had been broken at the base in about 1/6 of its height (Fig.166). After the breakage it was decided that it should be repaired. This process, however, was not based on completely removing the breakage scar, but on reforming the angles of the base edge (sequences C and L—Fig.164), correcting the tip shape

with a probable objective to increase its symmetry towards the new tool axis (sequences D, M, N, O–Fig.164).



*Fig.166 Post-breakage group I tool repairing scheme.*

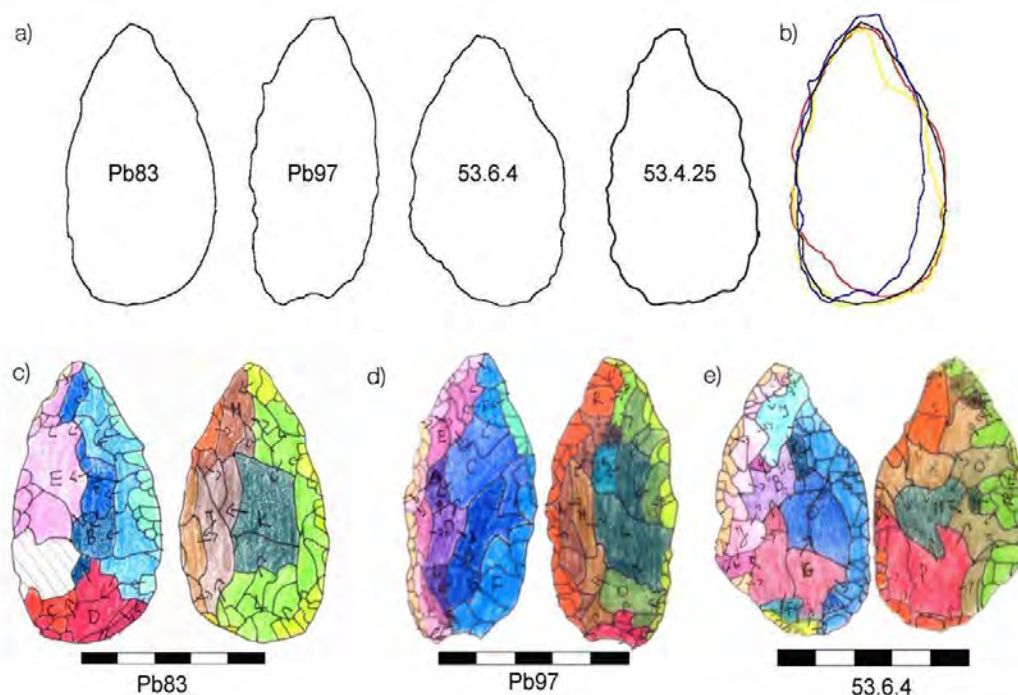


As a result, the repair included tool shaping first at the breakage, next at the tip, and finally, correcting the tool edge profile. Unfortunately, the signs of repair make it difficult to establish whether the tool was finished at the moment of fracture, or got broken at early manufacturing stages. It is possible that Pb84 tool is an example of form reshaped after breakage. This can be proved by its compact size (4.7cm of length), vertical surface at the base, likely remains of a breakage scar (K sequence–Fig.164), as well as visible, intensive tool thinning whilst forming edges shape at the base (H and L sequences and a separate E sequence derived from the base on the upper face–Fig.164). The repair of artifacts from group I concerns only the correction of post-fractures shape, while it does not constitute a sequence of repeated edge retouch/resharpening.

On the basis of conducted analyses it might be stated that group I tools are **symmetrical and were originally aimed to be so**. The described tools shape was formed at a separate manufacturing stage and all consecutive steps followed the goal of sticking to the presumed shape. The most important tool elements were the two symmetrical edges converging at the tip. The sole tip exposure was genuinely of much importance, still the tip did not have to be sharp. What was more important was to set it in the axis. The base was given two converging edges as well as the tip and, if only it was not possible due to the tool thickness at its base, a rounded edge was created at the base.

## Group II

The second group consists of four tools with shape similar to “leafpoints” from Jankovich cave (Gábori-Csánk, 1993). Here the artifacts included: Pb97, Pb83, 53.6.4, 53.4.25. They have greater width/length ratio (a greater width compared to their length) when compared to the ones of group I. They have asymmetrical edges (Fig.167) and a separate base edge which was formed in a semi-steep (Pb97) or semi-flat manner (Pb83, 53.6.4). In one case, there is a base edge blunted with a steep removal (53.4.25).



*Fig.167 Tool shapes comparison in group II of Szeleta cave. a) tool silhouettes outline, b) shapes comparison, c)–e) tool sequences distribution schemes.*

On those tools one can distinguish:

**A) Cutting edges.** Both edges are treated uniformly; however, one cannot be sure whether they were both used at the same time. This is evidenced against by the fact that both edges were knapped consecutively, from flat wide removals to marginal retouch (Pb83, Pb97). Parallel to that, some artifacts have traces of more intensive corrections of one of the edges, which results in the appearance of a notch and enhances asymmetry (53.6.4). The retouch on one of the edges is semi-steep and causes the exposure of a borer-shaped tip. The 53.4.25 artifact has two semi-steep notches on one edge near the tip causing the exposure of an edge fragment into a kind of a borer. The reconstruction of the tool formation process has proven that the artifact had not been symmetrical before the notches appeared.

**B) Base.** In case of each tool it is formed in a different way. For example, in the Pb83 artifact, base knapping was part of entire tool formation. Separate sequences thinning the tool from its base to its upper face were derived in order to remove the semi-steep scar on edge I, as well as to decorticate the upper face. These trials were not successful and the tool kept an edge-reaching fragment of cortex as well as a semi-steep scar on the opposite edge near the base.

The base, however, is formed in a very precise scheme. In contrast, the base of 53.4.27 was also formed at the early stages of knapping, though it is made of steep removals blunting the base. It is possible that the scar is a remnant of a breakage that overlapped the surface of the upper face. The Pb97 tool has a base formed with a series of semi-steep removals performed from the base onto the upper face. Together, they form a kind of a steep notch at the tool base. The 53.6.4 artifact has a curved base edge which was corrected along with the edge rejuvenation.

The artifacts from group II display incoherence in the adapted manufacturing scheme. Their common feature is lack of visible tool knapping stage (unlike those from group I). They are also characterized by little care for the proper formation of edge shape while deriving subsequent sequences. This is especially noticeable in case of artifacts such as 53.6.4 and Pb97. Special care for tool shaping is observable in the Pb83 tool (Fig.167c), where the subsequent sequences seem to be correcting the edge profile. In this case, a consequent edge scheme of knapping was adopted. It presumed shaping one edge first, from the moment of shaping until its marginal retouching. Only then, the second edge was formed, from surface formation to edge retouch. Such scheme deviates considerably from the one observed in case of group I artifacts. What is more, one of the tool edges (I) has a straight profile which is the effect of two retouch series performed on the edge's upper face. By contrast, edge II is much more S-shaped in profile. One can not exclude the probability that this artifact, as the only one from group II may be termed as a leafpoint; nonetheless, its manufacturing scheme differs considerably from the manufacturing scheme of group I tools. At the same time, the presence of one straight edge, as it can be observed in artifacts 53.6.4 and Pb75 (which depict subsequent correction stages of a tool with comparable shape) allows for the hypothesis that Pb83 should be, after all, regarded as a cutting tool. A similar edge scheme of knapping can be observed on the Pb97 tool. The latter artifact might be a remade or a failed leafpoint. For, at the early knapping stages the tool was formed with flat removals which shaped the upper surface first, and then a series of thinning removals forming the shape at the tip on the upper face (E and C sequences—Fig.167). The ongoing knapping concentrated on the edges where the retouch sequences were not performed so as to shape the edge profile, but rather to sharpen the edge's entire length. At this stage, the base edge is also formed in a semi-steep scheme. Later, the two edges were retouched again, with a semi-steep, barely regular retouch which deformed the edges profile.

Traces of several edge rejuvenation series can also be noticed in the 53.4.25 tool. The artifact, made of obsidian, has both faces formed with flat, broad removals. The edges, however, are made in a semi-flat manner, though edge I is plano-convex due to a series of flat, broad, surface-overlapping removals, derived perpendicularly to edge profile. At the tip, those removals cross its entire width and, furthermore, are derived oblong to the opposite edge (Pl.304). This series, being a strong intrusion in the tool's edge shape and profile, does not display a logical link with the remaining removal sequences that were created afterwards. Thus, it can be assumed that the sequence was a preparation for performing removals onto the upper face, which are not visible and which had been removed during subsequent edge rejuvenations. One should then assume that during one of the rejuvenations, the working edge had been changed from the initial edge II. Further on, a kind of a borer was formed on it. The tool shape reconstruction at due knapping stages allows to state that edge II was more angular than edge I, which may additionally prove that it was the working edge (it would replicate the edge formation scheme typical of the remaining group II tools).

Probably the Pb92 artifact should also be included in this group, its characteristic feature being the presence of cortex at both base faces. The tool was decorticated only in its near-the-tip half and these edge parts were retouched. The near-the-base part was shaped at the beginning of the manufacturing process, even before its decortication with steep blunting removals (C and I sequences–Pl.300). Much as at the tip part a series of flat removals introduced onto both tool faces allowed for successful decortication, at the base part further formation was abandoned and minimalised to semi-steep removals, alternately derived on the base edge. The tool was formed in a consequent edge scheme of knapping, where edge I was knapped first, starting from decortication stage, through preparing the shape at the tip. Only after that the opposite edge was decorticated. It is possible that at edge I formation stage, the tool was meant to be a leafpoint which can be supported by the D and O sequences, forming the angular shape of the near-tip edge. This attempt, however, was dropped for some unclear reasons, and already during initial edge II decortication the base was blunted, the remaining edge decortication was aborted and a series of retouches were introduced on edge I. The following knapping, which might have been a repair, was aimed at correcting the opposite edge profile and retouching the entire edge length, together with the cortical part at the base. This tool is characterized by considerable asymmetry, absence of care for edge shape and profile, as well as no care for near-the-base part. The artifact has some common features with group II tools, among them an edge-knapping and rejuvenation scheme and a visible edges arrangement asymmetry. The entire tool form is, however, largely prolonged and the base is far less knapped. These features are, nevertheless, the effect of using a particular kind of raw material slab which greatly determined the shape and subsequent steps applied towards the tool.

Based on the analyses, it can be stated that group II artifacts, both in the aspect of their morphology and knapping technology, differ considerably from group I artifacts. **The tools display either no or only slight care for shape formation**, whereas their **symmetry is a secondary phenomenon** and no attempts at improving tool symmetry during knapping can be observed, even if this is achievable. Simultaneously, **the artifacts have numerous rejuvenation sequences on them**.

### Group III

None of the previously described groups can incorporate the Pb88 and Pb96 tools. These artifacts are quite broad compared to their length and thickness (Pb88: length 11.4cm; width 4.3cm; thickness 1.1cm; Pb96: length 10.2cm; width 4.1cm; thickness 1.2cm; by comparison, average dimensions of group I artifacts: length 8.82cm; width 3.2cm; thickness 1.03cm). Their characteristic feature is a regular shape, a rounded base, and lack of exposed tip (Fig.168). The artifacts have an individually retouched edge at the tip, placed transversely or slightly angularly towards the tool main axis.

From the technological point of view, these artifacts were formed analogically to group I tools.

**I. Surface formation.** It was done with the use of broad, semi-flat removals onto both tool surfaces (Fig.168). Surface formation was performed in a surrounding scheme in one instance (Pb96), whereas in the other it was surface/edge analogical scheme (Pb88). In case of the Pb88 tool, already at this stage preliminary formation of presumed tool shape is visible.

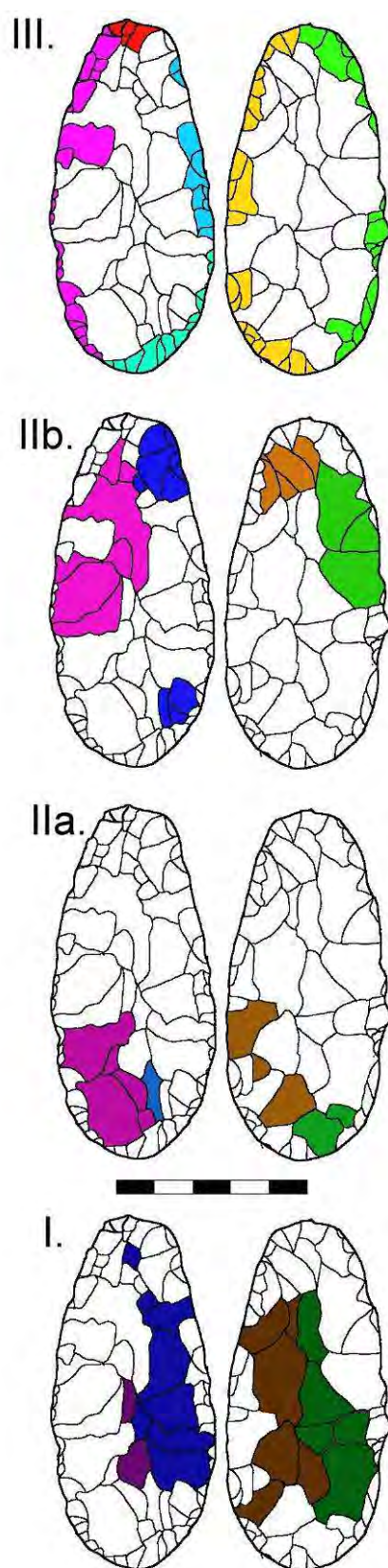
**II. Shape formation.** At this stage, similarly to group I artifacts, removals angular to tool vertical axis were derived. On the Pb96 artifact the base was formed first, then the tip edges. In case of the Pb88 tool, the situation might have been the alike; nevertheless, the degree of sequence chronology complexity makes it difficult to provide a comprehensive answer to that question.

**III. Edge profile correction.** At this point, marginal removals in an edge scheme of knapping were derived. The removals objective was to correct the edge outline and profile. Both edges were treated uniformly. Similar treatment was also applied to base parts near the tip. During edge knapping, removals from the tip are also performed, which allow for the creation and preservation of a separate edge at the tip.

In case of the Pb96 tool, the tip removals are semi-steep and form a kind of an acute working edge. When it comes to the Pb88 artifact this edge is formed angularly, owing to which the tool has a slightly exposed tip at edge II. Still, the tip is located outside the vertical axis.

The artifacts from group III make a very interesting example of tools which are formed with due diligence for tool shape and edge profile. Also the described artifacts symmetry appears to be a key issue in their formation process. However, as a result of the entire manufacturing process, artifacts with strongly parallel, not convergent at the tip edges are created. The analysis of the whole manufacturing process combined with the artifacts scarce thickness seems to suggest that these forms were initially meant to be leafpoints. Nevertheless, intensive blank thinning made it impossible to introduce further shape-correcting and tip breadth-reducing sequences. Another possibility, probably only valid for the Pb96 artifact, might be that the artifact is a remnant of a broken and retouched at the tip leafpoint. This possibility can not be excluded. If this is the case, S and I sequences should be treated as sequences rejuvenating and removing the fracture scar (Pl.302). The exposed tip, after the fracture, could not be formed again due to its comparatively slight thickness. This is why a retouch from the tip was decided upon and the tool was blunted at the tip. Much as the fracture and rejuvenation at the tip scenario is possible in case of Pb96, it is completely impossible in case of the other tool (Pb88), as the parts near its tip are incredibly thin and were formed to be so as early as at the initial knapping stages.

The artifacts from group III are characterized by a **diligently formed shape, neat edge profile, symmetry, and also lack of tip exposure**. Both edges are sharply formed, though neither of them bears traces of intensive retouch, or even more so, rejuvenations.



*Fig.168 Group III tools manufacturing scheme on the example of Pb96 artifact. Numbers from I to III correspond to manufacturing stages described in the text.*



### 3.3. Results

The aim of analysis was to reconstruct the manufacturing process, as well as the concept of form (or ideal form) of the oldest artifacts referred to in the literature as “leafpoints”. The sample also included other bifacial tools found on the same sites. This comparison of the two artifact groups was designed in order to answer two questions: whether and if yes—how, the differences in production technology and manufacturing concept between leafpoints and other bifacial tools are manifested.

Also, for comparative reasons, bifacial backed knives from two sites (Klausennische and Königsau) which do not include leafpoints, were analysed. These knives proved to be an interesting material for the reconstruction of the tools concept as they are characterized by the symmetry of form. Younger leafpoints from the Szeleta cave were also analysed in order to compare the manufacturing process of typical leafpoints from transitional assemblages (Szeletian) with that of its earlier counterparts.

Leafpoints are often treated as “index fossils” and their presence determines the fact if a given inventory is assigned to a leafpoint industry. The project was designed as a point in the ongoing debate on the legitimacy of treating leafpoints as the main culture indicator of transitional assemblages (Mester, 2008; Adams, 1998; Adams, 2007). One of its goals was also to observe whether the artifacts in the whole of Central and Southern Europe, from Greece to Germany and Ukraine, illustrate a similar tool concept, not only in terms of morphology but in terms of technology as well.

In the light of results it became evident, at the initial analysis point, that the definition of a “leafpoint” should be revised and the technological aspect should also appear as part of such revision. Majority of the analysed material fits the general definition of a leafpoint, that is: a tool in the shape of a leaf, with a sharp tip at the convergent edges, with a flat retouch covering at least  $\frac{2}{3}$  of the surface and with its width being at least three times its thickness (Ginter & Kozłowski, 1975). However, the technological analysis revealed that in many cases the material did not indicate that symmetry or edges shape were meticulously planned. Moreover, some of the artifacts became symmetrical only as a result of later repairs.

The total of analysed material includes 444 artifacts from 46 sites (Tab.1). However, taking into consideration the analysis’ initial results, the need for sample reduction became evident. The artifacts of vague chronology from surface collections (with the exception of Wahlen, Lenderscheid and Kokkinopilos) were not included. Thus, the artifacts not included in the analysis are these from Albersdorf, Zeitzlarn, Langenhardt, Flintsbach-Hardt, Rykhta, Líšeň and Mohelno. The intention behind this work was to indicate certain trends, which created the necessity of analysing the more numerous artifact groups. Thus, the results pertaining to individual artifacts from Grosse Schulerloch, Kleine Ofnet, Grosse Ofnet, Obernederhöhle, Mitoc-Izvorului, Palaiokastron, Balla, Dzerava Skala, Jezupol I, Kůlna cave, Ocelivka, Puskaporos, Reutersruh and Jezerany I sites were excluded as well.

The technological analysis of 308 artifacts from 20 sites<sup>10</sup> is presented in this work. 37 of the described artifacts originated from comparative sites i.e. Szeleta, Klausennische and Königsau, and 271 of the examined artifacts were found in assemblages with “the oldest leafpoints”. 232 artifacts from this group were previously published and described in the

---

<sup>10</sup> On the Korolevo site, two inventories from levels Korolevo II and Korolevo Va were studied. On Ripiceni Izvor, artifacts from levels MIV and MV were analysed. Artifacts from Brno Bohunice and Brno Bohunice Kejbaly were analysed jointly.

literature (Fig.169). The remaining 39 artifacts that were not previously published, were analysed owing to their interesting morphology, or their preservation state being from the early manufacturing stages. 186 of 232 published tools (Fig.169) were described in the literature as “leafpoints”. The remaining 46 specimens were described as other bifacial tools. Their analysis was included to provide comparison of their manufacturing process. The following divisions into particular groups of artifacts relate to the total of 271 artifacts described in this paper, with the exclusion of preforms, discarded at the initial stages (17 specimens), thus further division pertains to 254 artifacts.

On the basis of scar pattern analysis, the reconstruction of manufacturing process and repairs (*chaîne opératoire*) of individual artifacts was possible. The techno-functional units with specific manufacturing and particular types of flaking were defined on the artifacts (see Chapter 4). The limitations of this method are described in the chapter devoted to methodology.

The analysed sample of 254 artifacts points to notable technological diversity. In order to distinguish tool types that share the same manufacturing concept and, in particular, to distinguish leafpoint groups in the analysed sample, their key technological features need to be identified. The division takes into consideration the following features whose importance was derived from the technological analysis of individual assemblages:

- treatment of edges (identical, different),
- presence of repair series, edge resharpening,
- tool symmetry in vertical axis or traces of striving towards achieving one,
- tip exposure,
- base formation.

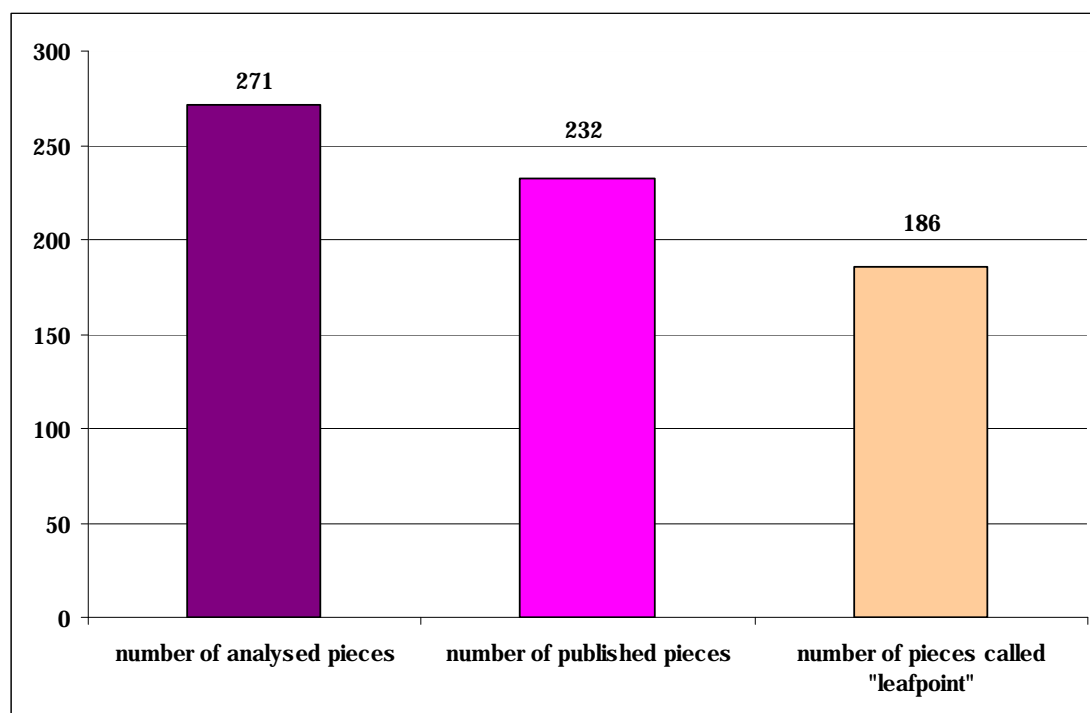


Fig.169 Number of pieces in the analysed artifact sample, recognized as belonging to early leafpoint assemblage; artifacts which were published and those which were recognized in subject's literature as “leafpoints”.

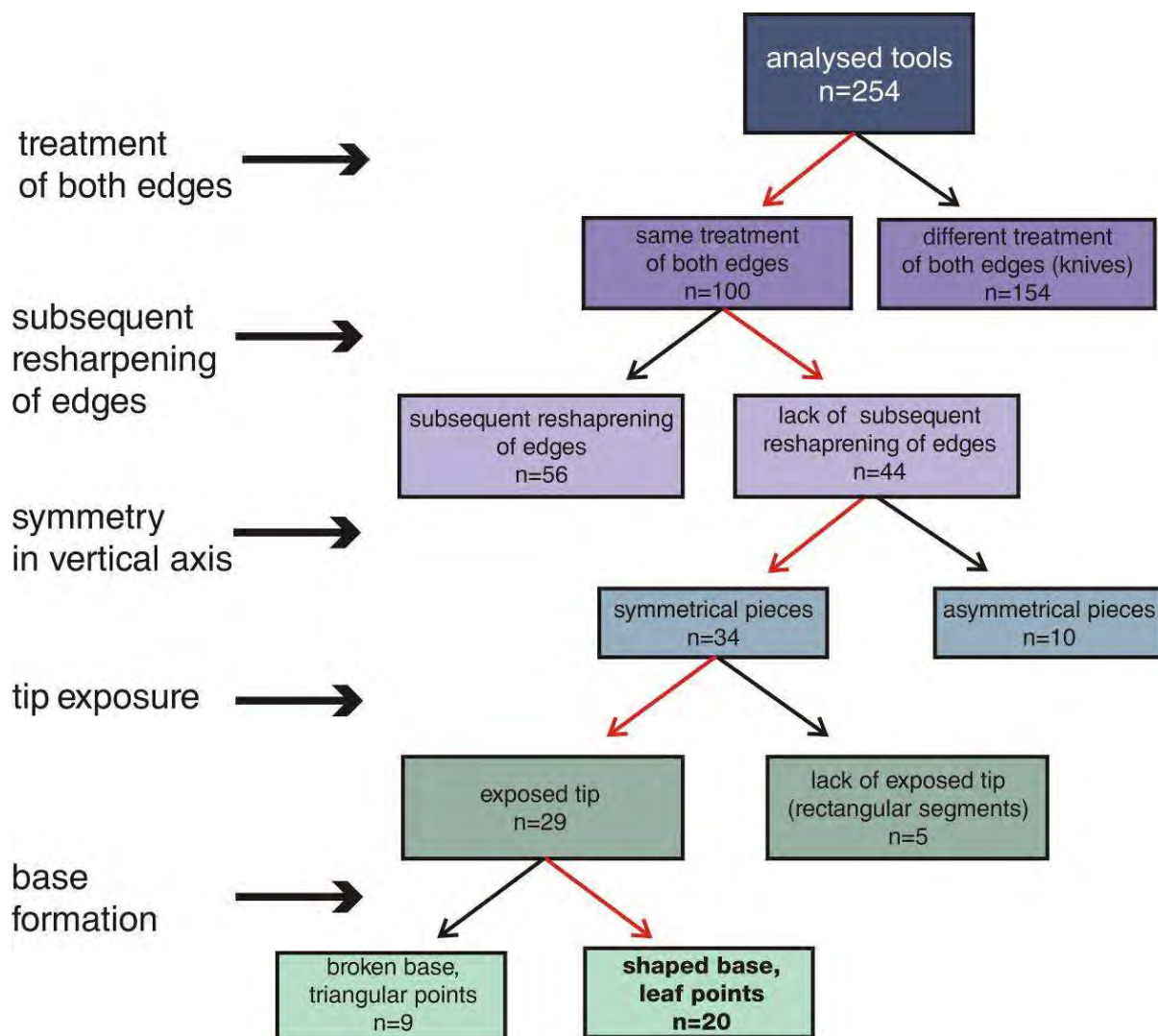


Fig.170 Diagram showing the division of analysed tools into groups of artifacts based on specific typological features of artifacts

The analysis shows that the artifacts previously described collectively as “leafpoints” in accordance with the accepted typological definition, can be divided into several individual groups when the analysis of technological aspects is included (Fig.170). This includes forms which possess a cutting edge and a back, and were manufactured, as well as repaired analogously to backed knives. The group of knives also includes forms too thin to create a separate back surface. In such tools, the edge opposite to the cutting edge is created by removals characteristic for distal posterior edge formation. The edge remains more technical than functional. These tools have been provisionally described as half-backed knives. This group also includes tools bearing marks of intentional base formation through a transversal breakage. On two sites (Lenderscheid, Sajóbáony Mész-tető), these artifacts are accompanied by rectangular bifacial tools in the form of segments, with both tips deliberately broken off. All of these tool groups have notable vertical axis symmetry and fit the definition of leafpoints or their parts. It is noteworthy that on the sites, in most cases, these forms are accompanied by similarly knapped asymmetrical forms, classified as the previously mentioned bifacial backed knives.

### 3.3.1. Edges treatment

First of all, the analysed artifacts can be classified according to edges treatment into those characterized by different treatment of both edges, and those with both edges treated similarly (Fig.171).

The majority of analysed tools (154) (Fig.171) are forms characterized by one edge of a straight profile, retouched on its whole length. The opposite edge is blunted at the base and, in most cases, was not retouched. Both edges were treated differently during manufacturing or repairs, and this determined the tools shape and their morphology.

The following artifacts were included in this group: Rörshain gr.I, II, IV, Wahlen gr.I, II, IV, Lenderscheid gr.I, III and artifacts V11.58 and V11.59, Kösten, Brno Bohunice gr.II, Vedrovice V gr.II, Sajóbáony Méhész-tető gr.II, Jankovich gr.I, Korolevo II, Korolevo V, Ripiceni Izvor gr.I, Musilievo gr.I, II, III, Samuilitsa artifacts CII.1115 and CII.1117, Kokkinopilos gr.I, III, Mauern artifact 1951\_663.

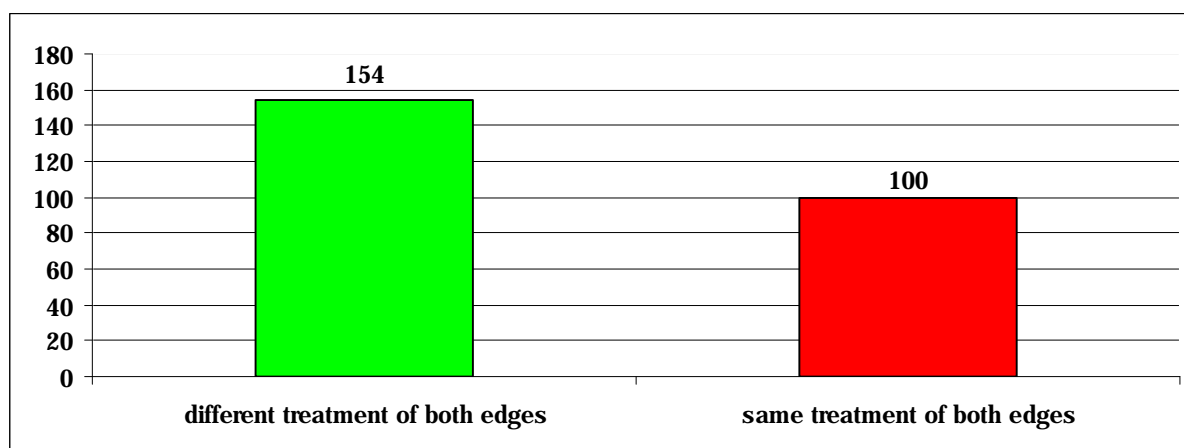


Fig.171 The number of artifacts classified with regard to both edges treatment.



Fig.172 Scheme showing the structure of a half-backed knife, based on artifacts from Brno Bohunice (top artifact) and Vedrovice V (bottom artifact.) Knife from Vedrovice exhibits reverse structure—it is a left-handed knife. Sequences introduced from cutting edge are marked in blue, sequences from distal posterior edge in yellow, and base-forming sequences in green.

These tools are characterized by differences in both edges treatment and extra care applied to the cutting edge sharpness, as well as to its straight profile. At the same time, tool shape and tip exposure are of less importance in these tools. Considering the above mentioned facts, these tools cannot be classified as leafpoints. The description of these tools structure is included below:

**Cutting edge.** A straight edge, usually retouched along the entire length, until the base angle, with a plano-convex cross-section. This edge is the most prominent tool part. Its key parameters include: preservation of acute edge angle, maximum length and straight profile. It is formed with extensive, flat removals on the lower face, while maintaining its straight profile. Retouch is derived on the upper face in the form of semi-flat, small, detailed removal series which are usually longer than wider. A series of repairs is visible on the edge in the form of retouches. Several edge resharpening retouches near the tip move the tool vertical axis closer to the opposite edge. Subsequent retouches also led to edge angle widening as well as edge blunting.

**Distal posterior edge.** Fragment of edge opposite to the cutting edge, which is situated closer to the tip, placed angularly to tool axis, convergent with the cutting edge at the tip. Its length usually comprises less than half of edge length, but it is strongly conditioned by the back's structure and its form.

The distal posterior edge is plano-convex in cross-section, sometimes it might be more plano-steep with flat removals, set angularly diagonally towards the vertical axis on the lower face. In some cases, when the distal posterior edge is heavily curved near the tip, the final removals closest to the cutting edge are introduced in parallel to vertical axis, starting almost at the tip. Flat removals that are angular to vertical axis (Fig.174) constitute an element of cutting edges formation or repair. They are aimed at tool thinning on the lower face next to the tip, without the necessity of introducing removals on the cutting edge. The distal posterior edge, after a series of flat removals was retouched to the upper face by small, semi-abrupt and semi-flat removals, which at the same time form and expose the tip. Lack of removals on the upper face results in no tip exposure.

Some tools have the entire edge opposite to the cutting edge formed by a manufacturing scheme characteristic for the distal posterior edge (Fig.172). These tools have no back and this edge changes at the bottom into a base edge or surface. In this paper, such tools shall be referred to as **half-backed knives**. This type of distal posterior edge formation is in some cases connected with the form of used raw material (e.g. thin slabs on which knives from Vedrovice V and Jankovich are made did not allow for the formation/blunting of back edge). In other cases, distal posterior edge prolongation caused the back's removal, which is connected with subsequent tool repairs and with its thinning, which becomes essential in order to retain the functional character of the cutting edge, and therefore, of the whole tool.

**Back.** Blunted tool surface or edge situated on the edge opposite the cutting edge, closer to the base. It has a practical, prehensile role. The back is the tool part that undergoes the fewest changes during repairs. In some cases, extensive repair or reorientation could have led to partial or full back removal through a series of removals which formed and widened the base, or series of removals rejuvenating/reshaping the distal posterior edge.

**Base.** A tool part formed, depending on the preform, either by using natural transversal surfaces, or by introducing separate sequences of removals, derived from the base. A noteworthy group of tools are those, which had their base formed with a transversal breakage (Lenderscheid, Wahlen, Rörshain, Sajóbáony Mész-tető). In some cases, the whole process of preparing the alternately retouched notches, that were supposed to determine the location of breakage point (Lenderscheid), can be observed. In such cases, the base is formed



during one of the final tool manufacturing stages. The result of breaking long, bifacial forms in a half is obtaining two cutting tools with bases formed by transversal breakage.

Because of the diversity of this tool part formation process, it is not easy to refer to its cohesive function. As a result of simultaneous lack of back in some artifacts with the presence of a separate base surface, they adopt the function of prehensile surface. Some tools have their base formed as a semi-flat edge. In such cases, the base bearing signs of extensive tool thinning in its lower parts, might be indicative of tool hafting.

As presented above, both longitudinal edges of the described tools differ in their morphology and their manufacturing process. The cutting edge can display a marginal retouch series which sharpens it and preserve its straightness. The opposite edge is manufactured with less precision, especially closer to the base, and shows traces of intensive thinning through flat removals derived on the lower face. Removals derived on the upper face are not regular and the edge is usually retouched only near the tip.

Analogous techno-functional units can be observed on artifacts from Königsau and Klausennische, which are described in the literature of the subject as backed knives. On this basis, the said group of 154 tools should be treated as bifacially worked cutting tools.

Key features of such knives include:

- cutting edge which is sharp, long and straight in profile.
- exposed tip (not in all artifacts),
- presence of back or base.

Knives are tools whose main aim is to maintain the cutting edge; thus, it is an essential, and supposedly also functional artifact part. The objective of tool repairs is usually the cutting edge resharpening. However, subsequent retouch series to the upper face of the cutting edge would eventually blunt it. The attempts at thinning achieved by removals to the lower face would result in forming an S-shaped profile. Therefore, on knives, the main goal of the repair process is **to resharpen/rejuvenate the edge without losing its straight profile**. The remaining elements, e.g. edge shape, its length, tip positioning in the axis or tool symmetry play a lesser role, and their parameters may be altered during their use or in the event of repair. Also the other edges, particularly the distal posterior edge, are adjusted to the needs of cutting edge repair. As far as the back and base are concerned, their change is connected with tool axis alteration, which in turn influences the artifact's handiness.

Knives do not bear traces of formation or any special treatment aimed at preserving tool symmetry. When it occurs, symmetry may be the outcome of repair series, or it may be connected with a repeated repair scheme oriented at tip exposure (Vedrovice V, Brno Bohunice, Sajóbáony Műhely-tető, Jankovich). It is also noteworthy that subsequent repair series might accidentally create a form symmetrical in its vertical axis, with an exposed tip, which will fit the typological definition of a leafpoint. The symmetry of such tools is only a side effect, and was not the aim of their manufacturing. Even though symmetrical in vertical axis, such tools exhibit differences in both edges profile, as one is more straight and the other more S-shaped.

Tools which are described as knives usually bear signs of multiple repairs. In most cases, it can be assumed that most of the visible removal sequences come from subsequent repair phases and remove previous manufacturing sequences. Thus, the analysis of the entire tool manufacturing process is impossible in most cases.

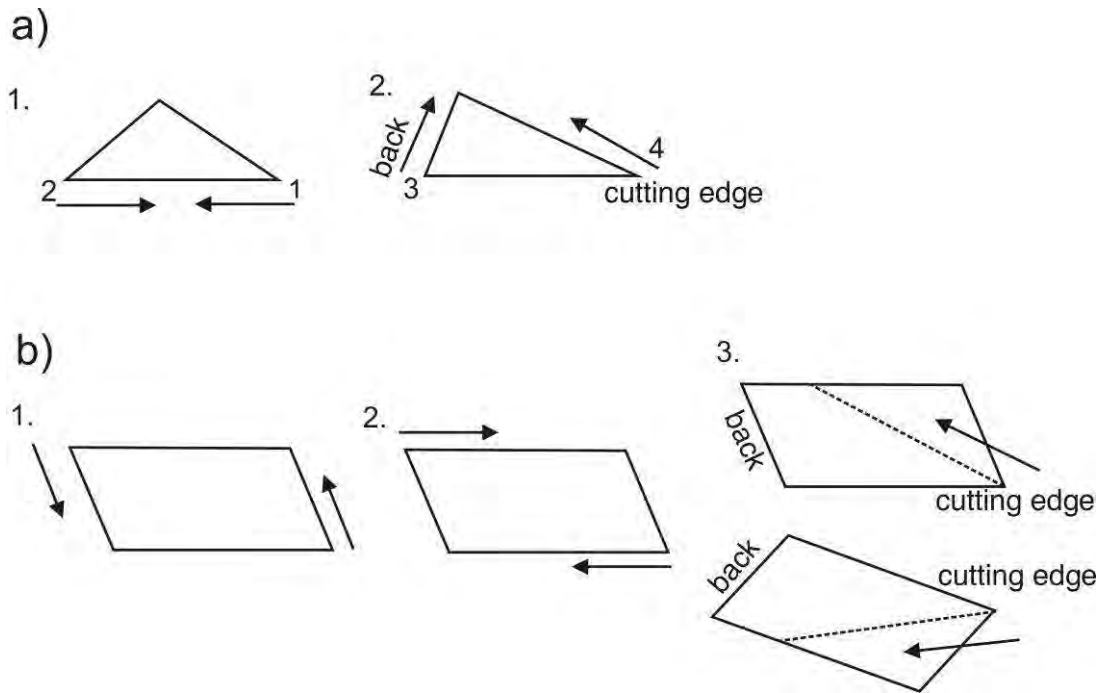


Fig.173 The formation schemes of knife surfaces; a) surface surrounding scheme of knapping, b) plano-steep alternate scheme of knapping with cutting edge thinning at the last stage.

**I. Surface formation.** This stage includes series of broad removals which are not very precise, their aim being thinning and formation of rudimentary tool surfaces.

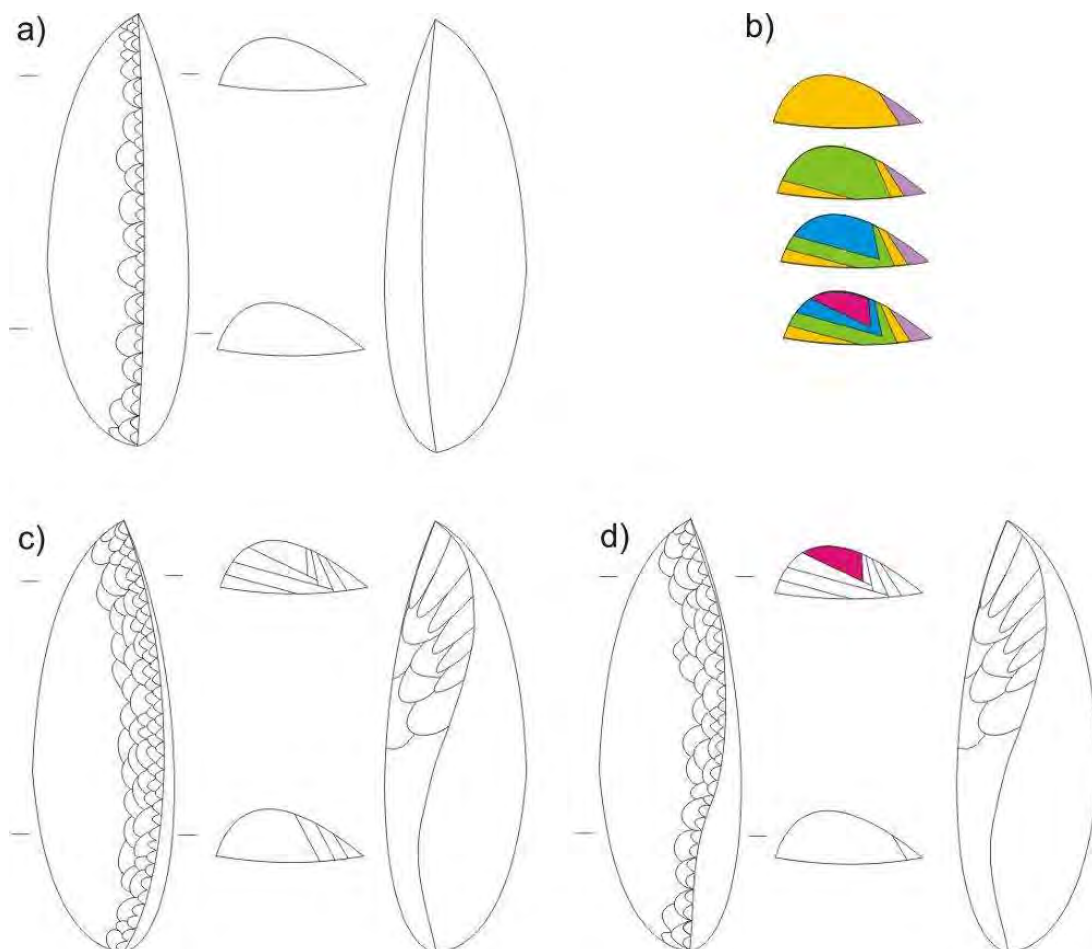
**II. Edge formation.** At this stage, manufacturing takes place in an edge/surrounding scheme of knapping. The scheme is adjusted to edge specificity. Removals derived on the lower face from the cutting edge are flat and more extensive. Removals on the opposite edge are restricted to correcting the line or retouching the distal posterior part.

The formation of knife surfaces could take two forms. The first involved a surface surrounding scheme of knapping (Fig.173a). In most such cases, the flat lower face was usually formed with flat, broad removals first (Fig.173a.1). Then, the convex upper face was formed (Fig.173a.2). This scheme either started from flat removals forming the cutting edge's lower face, continued in a surrounding scheme, and ended with semi-flat removals onto the cutting edge's upper face (Fig.173a.1,2). Or, all of this took place in the opposite order, i.e. beginning with series of semi-flat removals on the back's upper face, then flat removals to the lower face derived from both faces, and also finishing with the cutting edge's retouch on the upper face. In order to form the back, natural fracture surfaces or cortical surfaces were used. If this was not possible, the back was formed with an edge-blunting, steep removal series. These were either introduced alternately, or to the upper face. The cutting edge was formed with semi-flat, thinning removals overlapping with the surface, as well as by the introduction of marginal retouch at the end of manufacturing process. This scheme of manufacturing resulted in a plano-convex tool cross-section.

The other manner of surface formation made use of steep and flat removals derived onto both faces of the same edge, usually in a surface/edge analogical scheme of knapping (Fig.173b). In this case, a series of semi-abrupt removals onto one face (Fig.173b.1) was followed by flat removals onto the opposite face of the same edge (Fig.173b.2). This scheme was repeated alternately on the other edge, which resulted in a tool with biconvex (plano-steep) cross-section. This scheme of knapping allowed to maintain convenient edge angles for deriving removals that would thin and form the tool. The end result of the second described

scheme was a preform with two plano-steep edges formed alternately, with a rather wide angle. The next stage was the formation of specific tool edges. Both edges had already been formed in a plano-steep manner, the result of which could be the easiness of transforming one of them into a back. Nevertheless, the formation of the opposite cutting edge required thinning through removing the semi-abrupt edge angle. To achieve this, flat or semi-flat removals that thinned and formed the cutting edge were introduced to the face with an earlier series of semi-abrupt removals (Fig.173b.3). These removals were performed from the tip, angularly to vertical axis, which resulted in tip exposure. Adopting such knapping scheme after cutting edge thinning resulted in a tool which is plano-convex in cross-section.

**III. Repairs.** The objective of tool rejuvenation was to resharpen the cutting edge. In most cases, it pertains to the cutting edge only; yet, it can also involve the rejuvenation of all tool surfaces and edges (usually excluding the base). In order for the subsequent retouches not to blunt the cutting edge, and at the same time to maintain its straightness, often the scheme of tool thinning with flat, extensive removals on the lower face from the distal posterior part was used. The tools were usually corrected in a surrounding scheme, lower face-upper face, starting from removals derived from the cutting edge, and ending with the correction of distal posterior edge from the upper face.



*Fig.174 Diagram showing change in edge shape in side-view, and change in the shape of knives cross-section during their repairs; a) knife side-view and cross-section before repair; b) diagram of changes in knife cross-section near the tip during subsequent repairs; c) side-view and cross-section of knife retouched on its entire cutting edge; d) side-view and cross-section of knife with edge repair focused near the tip.*

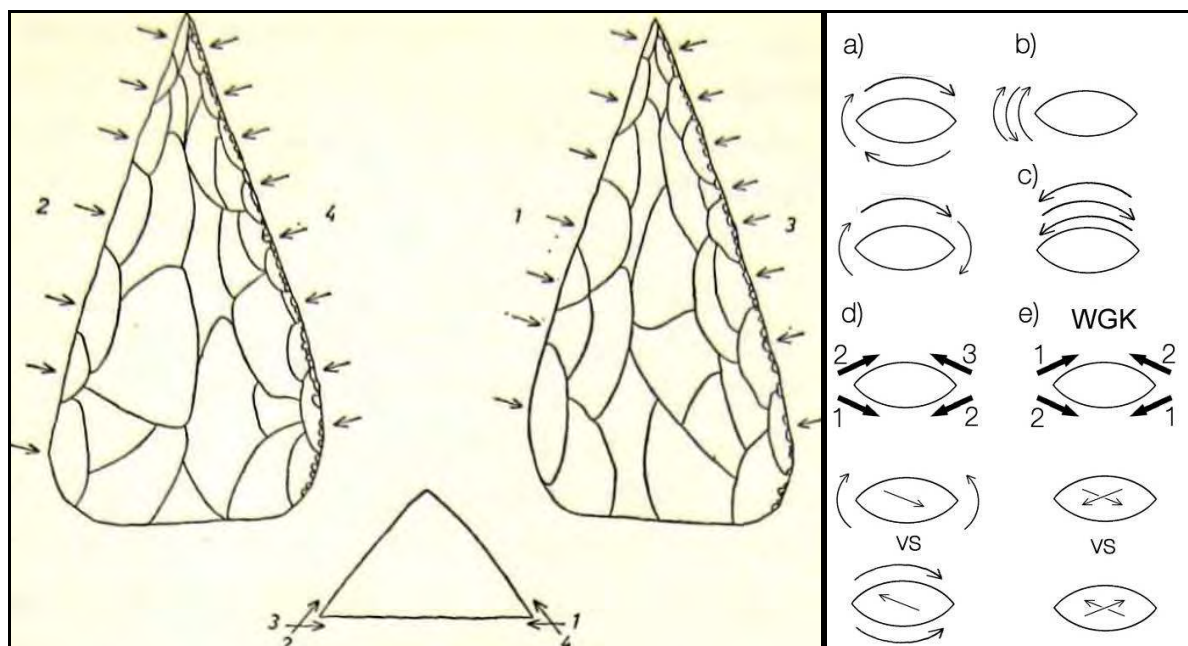


Fig.175 On the left: Wechselseitig Gleichgerichteten Kantenbearbeitung scheme presented by Bosinski (Bosinski, 1967, Abb.6); on the right: general types of artifacts manufacturing schemes shown in cross-section a) surrounding scheme of knapping, b) edge scheme of knapping, c) surface scheme of knapping, d) edge/surface analogical scheme of knapping, e) alternate scheme of knapping coherent with the WGK scheme.

Intense and repeated tool repair, incorporating the scheme of thinning near-the-tip part towards the lower face from the distal posterior edge resulted in edge line and tool cross-section modification (Fig.174). As the repair usually focused near the tip, this area was the part that underwent the most numerous changes. Consistent thinning on the lower face from the distal posterior edge caused its moving towards the upper face (Fig.174c,d). Simultaneously, subsequent cutting edge retouches on the upper face caused its bending towards the lower face in side-view (Fig.174c). As these two sequences are placed in an alternate scheme, the tool twisted closer to the tip during subsequent repairs (Fig.174b). Thus, artifacts bearing intensive repair traces have specific line of both edges. The line of the cutting edge retains its straightness in profile, but bends towards the lower face (Fig.174c), or, if the repair pertained only to the near-the-tip part, it gains a line resembling an upturned “S” letter (Fig.174d), and in terminology, this is referred to as “a twisted edge” (Butler, 2005, p.60). The distal posterior edge is also altered by the repairs and in side-view it will also gain the shape of an upturned “S” letter (reversed “S”) (Fig.174c,d).

Gerhard Bosinski described a technique specific to Central-European bifacial knives, which he had termed as Wechselseitig Gleichgerichteten Kantenbearbeitung (WGK in short, Fig.175), (Bosinski, 1967 p. 43). Bosinski noticed that removals forming the upper face’s cutting edge are usually younger than those derived from the back; and that a reversed scheme takes place on the lower face. On this basis, Bosinski reconstructed the manufacturing scheme as a four-stage process (Fig.175). Firstly, removals to the lower face from the cutting edge were introduced, and then there was a series of removals to the upper face from the back. The third stage involved the introduction of flat removals to the lower face from the back, and finally the cutting edge was formed with a series of semi-flat removals to the upper face. This scheme is analogous to the alternate scheme of knapping described above (Fig.175).

Detailed analysis of chronological order shows that the alternate scheme of knapping, which would provide the best reflection of the WGK technique, was extremely rare in the

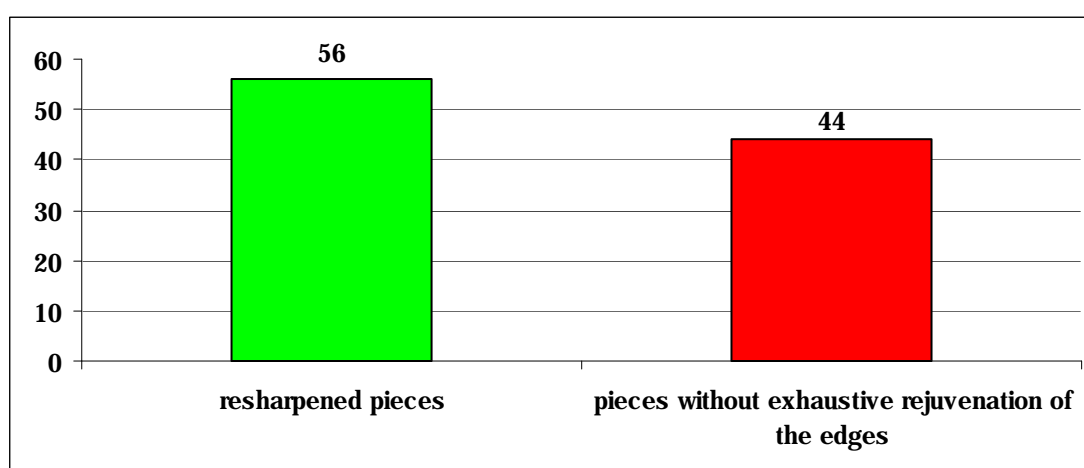
researched group of artifacts, and was usually used in edges formation, and not during repairs. This scheme was sometimes observed in tools from Korolevo V, one knife from Sajóbáony Mész-tető (61.925.2), Wahlen (WH\_C16) and Ripiceni Izvor (MV.22.59).

It is also noteworthy that, as already mentioned, two major stages in the rejuvenation process of knife edges are: the cutting edge retouch on the upper face, and flat removals on the lower face, derived from the distal posterior edge. On the tool, these sequences are alternate to each other (Fig.175b). A new repair series pertained to the cutting edge's upper face, was derived from the distal posterior edge onto the lower face, and overlapped with the removals from earlier stages of manufacturing process. With this scheme of edge repair, after several subsequent repairs, the overall chronology of removals (taking into consideration the total number of sequences derived from a given edge) became coherent with WGK.

### 3.3.2. Edge repair

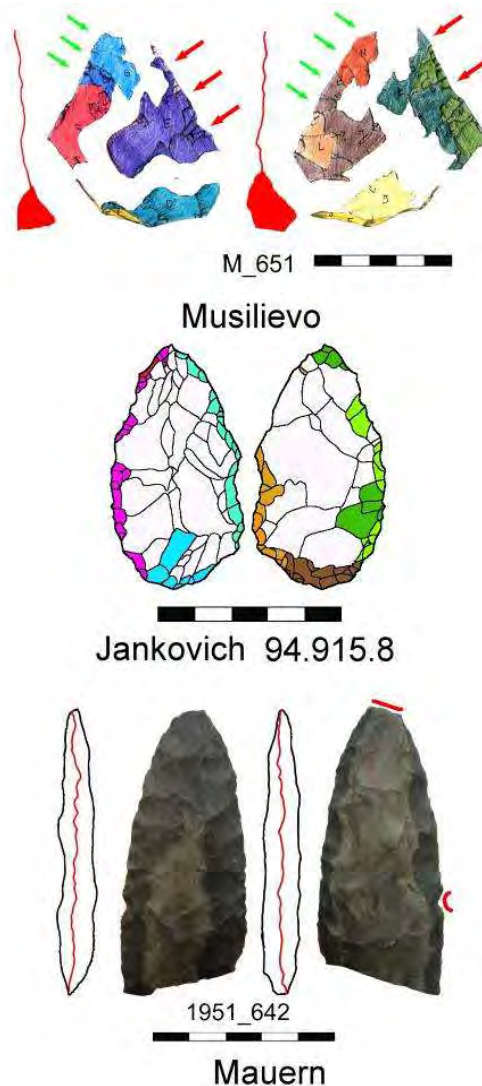
The remaining forms, characterized by the presence of two identically worked edges (n=100) (Fig.171), can be divided according to the presence of intensive edges resharpening. The first group consists of 44 forms devoid of resharpening traces (Fig.176). The second consists of 56 artifacts with two retouched and intensively rejuvenated edges. The artifacts' description can be found below.

The group with extensive edges resharpening includes: Ehringsdorf, Mauern gr.III, Sajóbáony Mész-tető gr.III, Jankovich gr.II, Ripiceni Izvor gr.II and Musilievo—artifact M.651, Samuiltsa II—artifact CII.63. These artifacts are characterized by the presence of two retouched and subsequently resharpened edges, convergent at the tip. These edges were described in this paper as cutting edges. The artifacts are also characterized by quite a large degree of symmetry in vertical axis and biconvex profile. The symmetry is connected with identical treatment of both edges, either with a retouch introduced to the upper face, or alternately onto both edges.



*Fig.176 The number of artifacts characterized by identical treatment of edges, grouped according to a distinction between forms with extensive repairs/ resharpening and forms without traces of edges repairs/resharpening.*





*Fig.177 Sample artifacts with two cutting edges.*

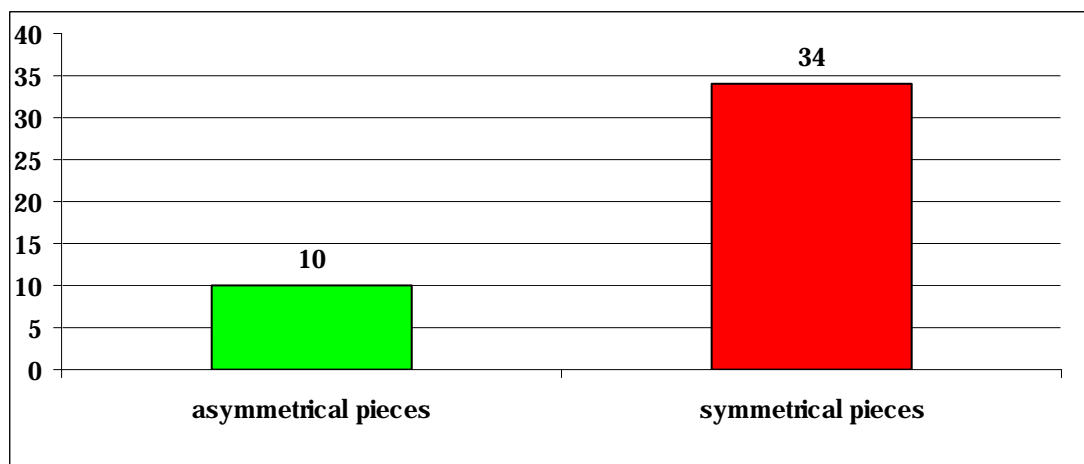
Both longitudinal edges are usually treated identically, both of them were retouched and repaired, and also they have a similar, straight profile (Fig.177). These tools do not exhibit differences in the introduced removal types. Some of them were formed as plano-convex, and in these cases the edges were retouched to the upper face.

These tools are in most cases characterized by an exposed tip, which is usually sharp and placed in tool vertical axis. They are also marked by intense edge usage and repairs. Subsequent retouch series retouches often lead to edge blunting. To avoid such consequences, in some cases, similarly to backed knives, a series of flat percussions to the lower face of edge II are introduced (see Ehringsdorf). Then, the tool is retouched on both edges.

At the same time, the discussed tools lack removal series that would indicate efforts to preserve the tool shape during manufacturing as well as during subsequent repairs. These features prove that more care was taken of maintaining the sharpness and straightness of working edge's profile, than of forming symmetrical shape and exposed tip. Also, in the described case, tool thinning does not play any role. Thus, considering the above features, this group of artifacts cannot be considered as leafpoints. It is possible that some of them were initially formed as leafpoints, but with time they were processed into tools with two working edges (see Mauern gr.III).

### 3.3.3. Tool symmetry

Among the remaining tools that can be characterized by identical treatment of both edges, as well as by lack of extensive repairs, there are tools symmetrical in vertical axis (n=34), and those which are not (n=10) (Fig.178). The asymmetrical tools do not bear any traces of attempts at achieving symmetry.



*Fig.178 Number of artifacts characterized by identical treatment of edges and lack of repairs, divided into artifacts which are symmetrical in vertical axis and those which are asymmetrical*

The group of asymmetrical tools includes artifacts from Mauern gr.I and II. These artifacts can be characterized by exposed tip and two cutting edges straight in profile. On both edges, the primacy of sharpness over shape can be seen. The artifacts are characterized by straight edge profile on its entire length, from the base to the tip. The marginal retouch does not cover the tip itself. The reason for such a feature is that more attention was devoted to the edge's profile than to the tip. Due to this, the tip is exposed, though not retouched.

Some of the tools exhibit traces of particular care for the overall tool shape. The artifacts from Mauern group I display asymmetrical edges treatment, which is manifested by the formation of one edge as straight, and the other as convex from the initial stages of manufacturing process. The removals on the straight edge are introduced perpendicularly to vertical axis, and on the convex one—angularly. Regardless of this pattern, there is no evidence of preference for any of the two edges in the manufacturing process. Angular removal series at the last production stages, applied near the tip and near the base caused the convexity of edges which converge at both tips/endings. More attention was given to edges profile, even though tool symmetry could have been achieved with very little effort. The artifacts from Mauern group I are characterized by identical edges processing near the tip and the base. Owing to tools asymmetry, though exposed, the tip is not placed in the tool axis.

In case of some tools, there is no certainty whether both edges were formed and used at the same time, as in some cases one of them was formed first, starting from extensive, flat removals, up to marginal retouch (see Mauern gr.II), and only later the second edge was processed. These tools have usewear and are retouched with most precision near the tip of one of the edges, and near the base of the opposite edge. The ends of both tools are formed in an identical way. Such formation of edges symmetrical in diagonal edge axis, the placement of usewear and the system of notches, suggest that in the case of artifacts from Mauern gr.I and

II, one of the tips was used and then the tool was rotated, and the other one was used. This is also implied by identical treatment of both tool ends.

### 3.3.4. Tip exposure

The remaining 34 artifacts are characterized by vertical axis symmetry, identical edges treatment and lack of extensive repair traces, i.e. of edges resharpening. They differ in terms of tip exposure. Most specimens in the analysed group show traces of particular care for tip exposure. However, there are 5 tools that do not have an exposed tip (Fig.179). They take the form of bifacially worked, rectangular segments with two parallel, retouched edges and two ends formed by transversal breakages. Both edges are formed with semi-flat, thinning removals derived onto both tool faces, and are characterized by identical extent of processing, although one of them is usually straighter in the profile.



Fig.179 Number of tools that are characterized by identical edges treatment, symmetry in vertical axis and lack of repairs, divided into two groups: forms without exposed tip and with exposed tip.

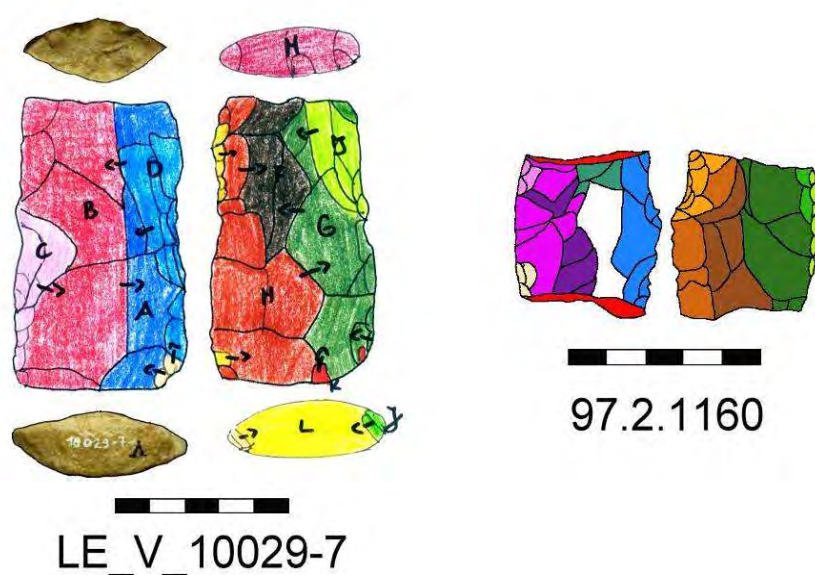


Fig.180 Rectangular segments from Lenderscheid (LE\_V\_10029-7) and Sajóbáony Mész-tető (97.2.1160).

Artifacts that can be classified as belonging to this group include those from Ehringsdorf (artifact 64/93), Lenderscheid gr.II and Sajóbáony Mész-tető gr.I (5 artifacts) (Fig.180). They are characterized by:

- biconvex cross-section with a plano-steep scheme of edges formation,
- parallel edges,
- precise retouch of both edges,
- transversal breakages on both ends,
- retouch on fracture scars or in their angles.

A characteristic feature of the described tools is their specific manufacturing process, which proves that these tools were intentionally shaped in this particular form. Both ends were broken not after, but during manufacturing process, as the breakage scars and the angles near breakages were later additionally retouched.

It is noteworthy that on both archaeological sites (Lenderscheid and Sajóbáony Mész-tető), segments were produced identically and their morphology is closely related.

**I. Surface formation.** In case of segments from the Sajóbáony Mész-tető site, formation usually involved the introduction of flat, extensive removals in an alternate scheme of knapping. On the Lenderscheid site, a plano-steep surrounding scheme of knapping that led to the creation of biconvex cross-section was used. Steep removals on one face formed better angles for sequences of flat, thinning removals on the other face. Such concept used in a surrounding knapping scheme in consequence led to obtaining biconvex tool cross-section.

**II. Edges knapping.** The range and invasiveness of subsequent removal series was adjusted to edge profile. The preservation of straight edge profile with marginal retouch was essential. In case of artifacts from Sajóbáony Mész-tető, on one of the edges a notch onto the lower face was created, probably in order to indicate the fracture line.

**III. Transversal tool breakages.** In most cases, initially one breakage was performed, and after a series of removals correcting one of the edges, another breakage was performed. In case of the artifact from Lenderscheid-V55-9—one of its ends carries two fracture scars.

**IV. Post-breakage corrections.** The last stage was post-breakage tool correction by applying small, flat removals on the fracture scar or by steep retouch of its angles. In case of artifacts from Sajóbáony Mész-tető, after both breakages marginal retouch was introduced to the one of the edges.

The artifacts which are referred to as segments can be found on sites where also knives with a base formed by transversal breakage were collected (Lenderscheid, Sajóbáony Mész-tető). Thus, it can be concluded that both tool types represent similar scheme of bifacial tool formation.

### 3.3.5. Base formation

The last criterion is the base formation. According to this decisive factor, the 29 artifacts characterized by their symmetry, exposed tip, lack of extensive repairs and identical treatment of both edges can be divided into two types: triangular bifaces and leafpoints. The first type is represented by 9 tools whose base was formed with a transversal breakage (Fig.181). The other type is represented by 20 tools, whose base is formed, thinned and shaped into a separate edge or angle at the junction of both cutting edges.

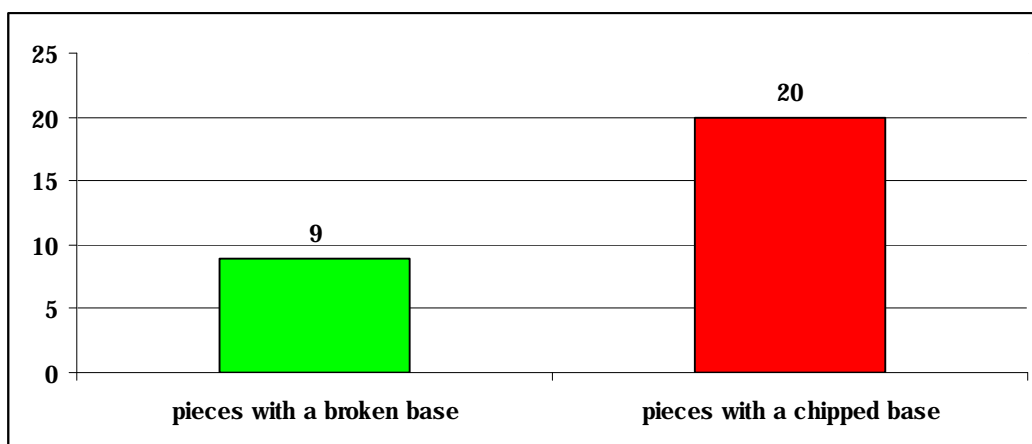


Fig.181 Number of artifacts characterized by identical edges treatment, symmetry in vertical axis, tip exposure and lack of edge repairs, based on division into forms with broken base and shaped base.

### 3.3.5.1. Triangular bifaces

This specific group includes tools of an isosceles triangle shape with two straight, symmetrical edges convergent at the tip and a base formed by transversal breakage. The artifacts are characterized by lack of repair traces. Tools belonging to this group exhibit notable symmetry. The aim of some of the processing sequences, especially at the stage of edges formation, was to increase tool symmetry. Both edges were treated identically and both are equally straight in profile. It is also noteworthy that the edges lack marginal retouches.

The tools from Rörshain gr.III a6nd Wahlen gr.III, Mauern artifact 1951\_641 (9 artifacts in total) belong to this group (Fig.182).

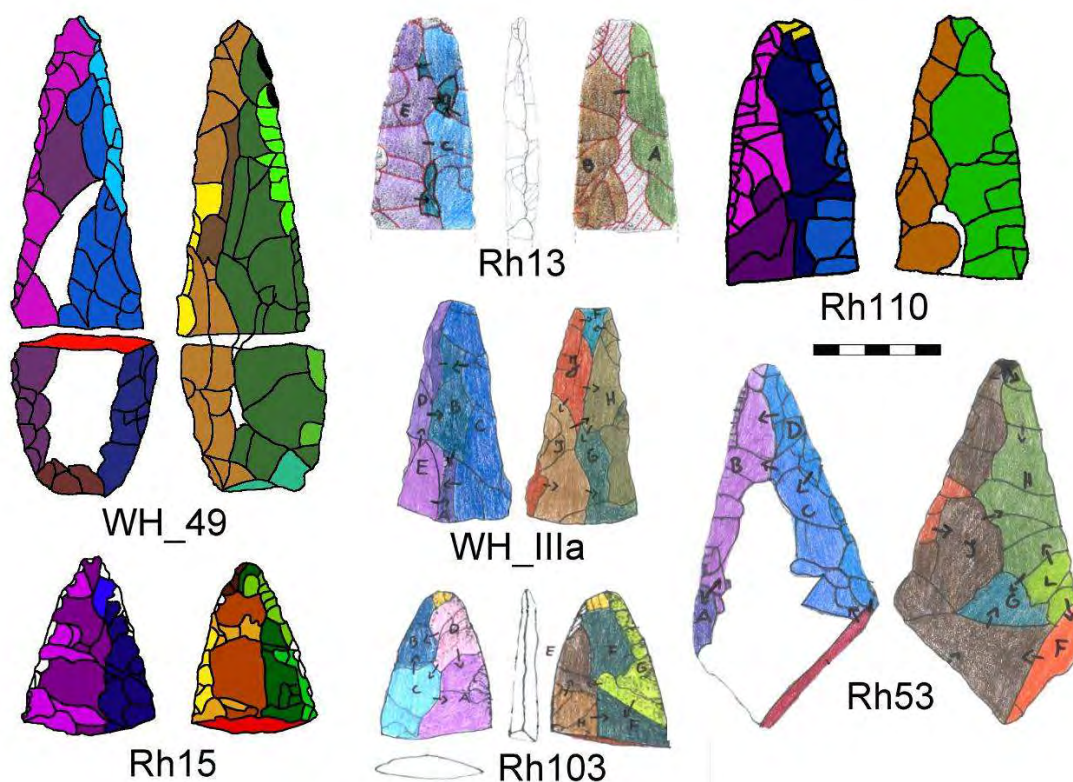


Fig.182 Compilation of all artifacts included in the triangular bifaces group.



**Cutting edges.** Both are treated identically and formed with semi-flat and flat removal series. The edges are shaped with precise removals derived onto both artifact faces, but none of them bears traces of sharpening retouch, which is often the case with knives.

The artifacts have an exposed tip, however in some cases it is not sharp. Some specimens exhibit lack of interest in the tip's sharpness and the presence of older removal sequences or transversal breakages near the tip (e.g. Rörshain Rh.53). This fact shows that not the tip itself, but convergent edges with straight profile were the main aim of the tools manufacturing process.

**Base.** This surface transversal to tool axis was usually formed with a fracture. Often, the breakage was introduced from the middle of one of the faces. In case of Wahlen WH\_49 tool, the base after breakage was additionally polished in order to increase its regularity. One of the artifacts had its base formed by two fracture scars (Rörshain, Rh,53). Additionally, most tools had their bases formed in the middle of manufacturing process, before final edges formation. These features indicate that this was an intentional process.

The artifacts which are provisionally referred to as triangular bifaces, in the literature were referred to as fragments of broken leafpoints. Scar pattern analysis shows, however, that these artifacts were shaped to form triangular tools with transversal base surface and two straight edges, convergent at the tip. These edges lack series of extensive retouches and marginal retouches, but exhibit signs of efforts to achieve a straight profile and certain shape. Tools from the said group also lack traces of repairs or signs of edges resharpening. However, they do often possess removal sequences aimed at attaining edge symmetry. Thus, they cannot represent fragments of broken leafpoints, but are completed artifacts formed as triangular bifaces with symmetrical shape and exposed tip.

### 3.3.5.2. Leafpoints

The second group consists of artifacts symmetrical in vertical axis, with two convex edges convergent at the tip. These artifacts are characterized by slender shape, biconvex cross-section, great edge line regularity and straight profile. They have a base formed as a separate edge, or they lack the base, since their longitudinal edges can be convergent both at the base and at the tip.

A characteristic and most distinctive feature is not both edges symmetry at the tip and at the base, but the presence of tool shaping sequences. The placement of shaping sequences depends on where the corrections are needed. These tools usually do not bear repair traces in the form of edges resharpening. The only traces can pertain to the correction of tool shape after transversal breakage near the tip or the base.

The second group, consisting of 20 specimens, includes artifacts from Brno Bohunice gr.I, Vedrovice V gr.I and III, Musilievo gr.IV and artifacts from M.42, Kokkinopilos gr.II, Sajóbáony Mész-tető artifact 97.2.1072, and artifact CII\_1116 from Samuilitsa II.

The tools consist of two techno-functional units, the production of which has a distinctive character:

**Cutting edges.** Slightly convex, convergent at the tip, formed by flat and semi-flat removals derived onto both faces. In cases of some artifacts, the near-the-tip part of the cutting edge is characterized by higher manufacturing precision (Kokkinopilos). During thinning and edge formation, the aim was to obtain vaulted shape, slightly rounded near the base and the tip. Efforts to thin the edge and maintain its straight profile can also be seen.

Simultaneously, more importance was placed on maintaining edge shape, rather than its profile. Thus, if it was necessary, final marginal removal sequences were introduced at an angle which enabled achieving maximum symmetry of the edges shape.

Both edges are convergent at the tip. The characteristic feature of leafpoints is great care placed on tip symmetry, which is more important than tip exposure, and its sharpness. Thus, if further tip exposure could have resulted in taking it off the axis, this process was not pursued. This is the reason why some of the artifacts have a tip which is slightly unretouched or broken and repaired only to a small extent.

Also, the edges do not have any retouch, i.e. removals aimed at tool sharpening solely. The marginal removal series are designed not to create an edge with ideally straight profile, but to perform final tool shape correction. Both edges have similar profile, which is not fully straight but slightly S-shaped, which is caused by subsequent removal series correcting the shape, derived onto both tool faces. Despite the fact that removals are introduced onto both faces, the series introduced to the lower face are usually flat. What is more, they constitute an angle correction before the main series is derived onto the upper face. As well, these removals may be a correction after the major series. At the next stage of final shaping, the removals are introduced where they are needed so as to increase tool symmetry both near the tip and the base.

The edges are worked identically on their entire length. In most cases, there are no traces of different treatment of the near-the-tip sections.

**Base.** In some artifacts, it has a slightly rounded form, created by separate series of removals angular to vertical axis, or a separate removal series derived from the base's edge. In tools with rounded base, tool width is largest near the base. These artifacts are characteristically wider compared to other artifacts. Some of them have a base angle formed by angular removals derived onto both faces from both edges. These removals are introduced meticulously, and in some cases it is difficult to differentiate between the tip and the base.

The overall manufacturing process of the said artifacts is aimed at creating forms which have edges convergent at the exposed tip, edges that are symmetrical, sharp and straight in their profile. The manufacturing process exhibits efforts towards achieving the above mentioned objectives, as well as striving for balance between maximum symmetry and edge sharpness. Simultaneously, the priority of symmetry over edge sharpness, which might take the form of not maintaining a sharp, straight in profile edge, led to striving for the entire tool's symmetry. If it was necessary, edge-blunting series which corrected the tool shape were introduced.

Leafpoints are characterized by:

- attention to overall tool shape (separate manufacturing phase aimed at its formation),
- attention to symmetry in vertical axis,
- identical treatment of both edges,
- attention to tip exposure,
- attention to maximum tool thinning.

The word "attention" has been used deliberately, as in some cases forms that do not exhibit the above mentioned features but show attempts at achieving them, can be classified as leafpoints.

Leafpoints manufacturing usually takes place in three stages, namely surface formation, shaping and edge line correction.

**I. Surface formation.** The stage of intensive thinning and introducing extensive removals to both tool faces. The stage's most important goal was to lessen the tool thickness if the tool was made on a thick, stone plaque, and also to remove cortex if tools were manufactured from thin, stone plaques. A surface surrounding or alternate scheme of knapping were favoured. At this stage, an edge scheme of knapping was not used, excluding Vedrovice V artifacts from this group. In this case, from the very start the scheme included flat removals onto both faces of one edge, followed by semi-steep removals onto both faces of the other edge, which resulted in a tool with a deltoid cross-section. In case of the remaining leafpoints, two surface formation schemes can be observed. The first introduced semi-steep removals onto one face of the edge, and flat removals onto the other face of the edge. This was repeated alternately on the other edge, which created plano-steep tools with biconvex cross-sections. At the following manufacturing stages, the face formed abruptly was thinned by flat and semi-flat removals. The other scheme of knapping formed the lower face first with flat removals, and the upper face next with semi-flat removals. The result was a tool with a slightly plano-convex cross-section.

At the surface formation stage, removals perpendicular to tool vertical axis are introduced. In most cases there are no traces of attention devoted to edge shape formation, or tip exposure.

**II. Shaping.** A stage typical of leafpoints. Flat and semi-flat removals, less extensive than those from the surface formation phase, are introduced. Their aim was tip exposure and tool shaping. The removals were introduced angularly to tool axis. In most cases, they were performed in an edge scheme of knapping, with a tendency to introduce removals onto the lower face first, and after that onto the upper face.

**III. Edge line correction.** This stage included marginal removal series which were rarely extensive, and were usually derived onto both edge faces. The aim of such removals was to correct edge line and symmetry, edge profile as well as tip placement. Removals were introduced, depending on the need, in different parts of the edge (both at the tip and the base), without a precise scheme. At this stage, attention devoted to the symmetry of form can be observed most clearly. The removals character was adjusted not to receive maximum sharpness, but maximum edge symmetry. Thus, some of the removals corrected the edges shape and the tip placement, even if this resulted in reducing sharpness. Leafpoints do not bear traces of extensive, regular edge retouches; thus, their profiles are not ideally straight but slightly S-shaped.

In conclusion, it can be stated that the formation scheme leafpoints depended on the overall concept of the tool form, and was adjusted to the situations in the stone plaque. This can be especially well observable in artifacts which bear traces of breakages or unsuccessful sequences. The manufacturing scheme after an error had occurred was fully adjusted to its correction, and in most cases it was done in an edge scheme of knapping, which enabled the successful removal of breakage, hinge or protuberance.

Among the analysed assemblages, the largest group of artifacts is that consisting of 154 backed knives. Except for them, the analysis led to distinguishing artifacts which have two cutting edges convergent at the tip (Fig.170). Both edges have series of subsequent retouches and are characterized by similar reduction sequence. These tools do not exhibit attention devoted to tool shape or the symmetry of forms themselves. In case of some tools which have two cutting edges, there is a possibility that each of them was formed separately and they were not used simultaneously. The symmetry of the described forms is connected with the

identical treatment of both edges during manufacturing process and repair; and in some cases also with the importance attached to tip exposure and its preservation.

The analysed forms also include those that exhibit attention placed not only on shape formation but also on vertical axis symmetry. Some of those tools have both ends formed with transversal breakages, which causes the finished tool to take the form of rectangular segment. Other artifacts have only their base formed with transversal breakage, and are triangular in shape. Thus, if they can be characterized by identical treatment of both edges, and exhibit attention devoted to shape symmetry, with no traces of repairs, such tools should not be treated as leafpoints and can be referred to as triangular bifaces.

The last, and quite a scarce group in the analysed assemblage, includes artifacts in the shape of a leaf that have two edges convergent at the tip. These tools can be characterized by identical treatment of both edges, and also their manufacturing scheme aimed at obtaining high symmetry in vertical axis. These artifacts bear no traces of edges resharpening. Their potential repair was connected only with the tool reshaping after transversal tip or base breakage. Only such tools will be referred to as *leafpoints*. In the analysed sample, 20 such tools were found. They come from sites such as Brno Bohunice, Vedrovice V, Sajóbáony Méhész-tető, Musilievo, Samuilitsa cave II and Kokkinopilos. The artifacts show concept analogous to that of Szeleta cave leafpoints.

The analysed leafpoints formation process can be set in the universal manufacturing scheme of bifacial tools, already described in the literature of the subject (Callahan, 2006; Migal & Urbanowski, 2008). The researchers differentiate four manufacturing stages of such tools. First, the formation of a surrounding edge, which enables further tool processing. The scars from this stage cannot usually be seen in a finished tool. The next stage was surface formation with extensive thinning of the preform. The third stage was devoted to thinning and edge formation, and can be divided into several phases. The final stage was the introduction of removals which corrected the edge shape.

The main divergence between bifacial knives and leafpoints is the visible stage of tool shaping. In case of knives, after surfaces formation, the formation of functional edges, i.e. the cutting edge, back edge and distal posterior edge takes place. In case of leafpoints, after surfaces formation, extensive work concentrated on the overall tool shaping can be observed.

## 4. Sequence Analysis

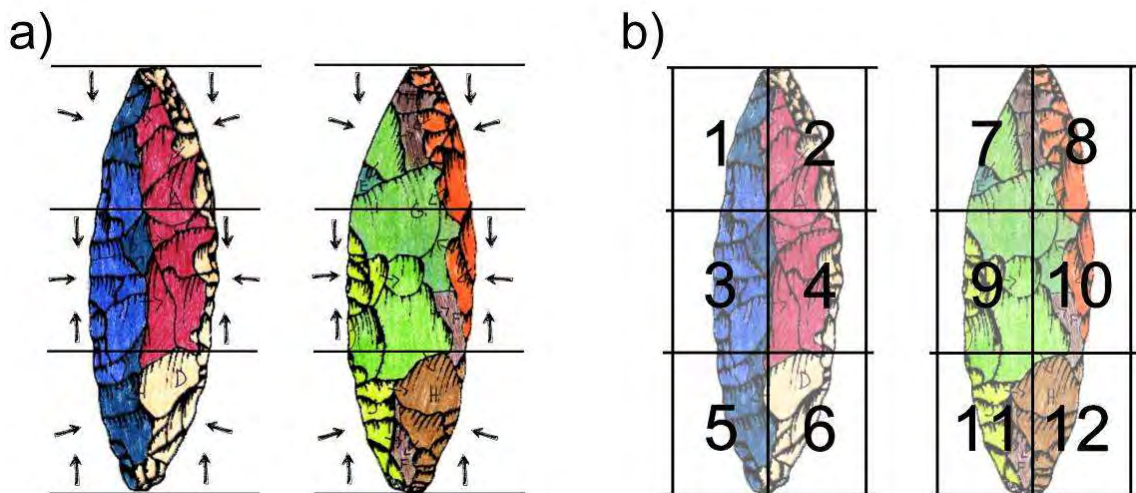
Apart from the analysis of removal sequence succession, the author decided to submit them to quantitative analysis as well. The aim was to find a good measure to establish the intensity with which the tool's particular sections were treated. This would enable to draw conclusions as to which sections of the tool were processed more, and which less intensively.

It seems that the best indicator could be the number of single removal scars derived from a given edge; however, to calculate them for all the artifacts under scrutiny would be incredibly time inefficient. At the same time, this type of work would require the use of original materials as drawings do not always incorporate all the removal scars. Regarding the time limit, instead of counting single scars, the author had decided to calculate the removal sequences distinguished as part of scar pattern analysis. Consequently, the examination will establish the number of removal sequences as a measure of the extent to which certain tool parts were treated. The treating may refer both to the process of tool formation as well as to its repairs. The examination proposed may then illustrate not only the intensity with which the formation of particular tool sections was approached, but also how often it was used and rejuvenated.

### 4.1. Assumptions

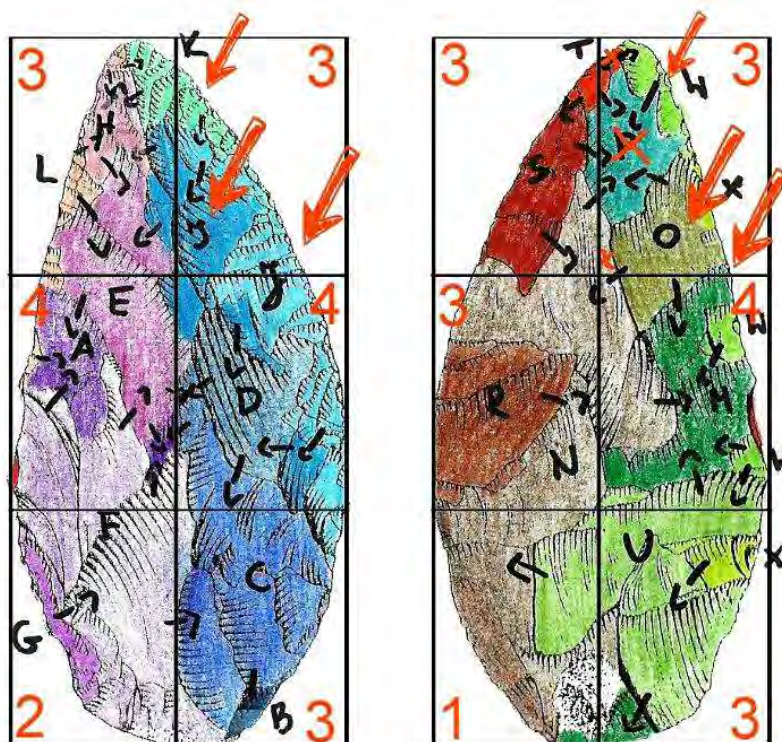
It had been agreed that the analysis shall encompass:

- entirely preserved tools or tools refitted from post-depositionally fractured elements
- finite forms (preforms were not considered)
- broken tools, provided the original tool length could be established and the artifact was preserved in at least 90% of its length.



*Fig.183 Tool sector division scheme a) sectors distinguished through tool's division into three even horizontal sections on each face and separate treatment of each edge. Black arrows mark removals direction from which the removal sequences of a given sector are derived and calculated; b) sector numbering within an artifact.*





*Fig.184 Sequence calculation method within sectors. Red arrows mark sequences which were considered during sample calculation for sectors 2 and 8. Red "X" marks sequences not included in calculations. Red figures denote number of sequences within each sector.*

The artifacts were positioned for the analysis analogously to their positioning for scar pattern analysis: the upper face on the left, the lower face on the right side of the drawing. It was agreed that the upper face was the more convex one. For the sake of analysis, each artifact was divided into 12 sectors. Each face of the tool was considered separately. The rectangle, where the tool is inscribed, gets divided into three even horizontal sections (Fig.183), and into two longitudinal sections, which in turn enables the tool's division into 6 sectors on each face. The dividing line was arbitrary as it marked the removal directions calculated for a given tool section.

The main principle of the examination is to calculate the removals number within each tool sector so as to show the extent to which each part was under interest. It was justified, then, to calculate only those sequences which had been derived from the observed edge. The sequences which overlapped with the observed edge, but which were derived from the opposite edge, were not calculated. Most frequently, they constituted the remains of far older sequences which came into existence when the tool was wider and the edge was placed differently. For that reason, they do not reflect the intensity with which the tool was treated (Fig.184). Thus, it was accepted that the sequences belonging to a given sector will be the following (Fig.183a, 184):

- sequences derived from the edge under scrutiny
- sequences derived from the tip/ base, parallel to the tool's major axis, overlapping with a given sector.

The following sequences were not considered as belonging to a given sector (Fig.184):

- flake ventral surface,

- flake scars originating from the time before the removal of flake from which the tool was made (only in case of flake tools), only if this was possible to estimate,
- remains of vast removals with an unidentified removal direction,
- postdepositional sequences,
- fracture scars not bearing traces of repair attempts after the fracture's occurrence.

Removal sequences derived from a common edge were considered and calculated separately if:

- they had different time of formation (in order to obtain this information, the results of scar pattern analysis were used)
- their morphology varied (e.g. a series of wide removals and marginal removals),
- they served a different purpose (e.g. a thinning sequence and a blunting sequence).

The examination's ultimate goal was to respond to the question if it could possibly help to determine the frequency schemes for the sequences, and subsequently, the intensity of tool knapping within the previously proposed division.

## 4.2. Analysis procedure

1. Tool sector division.
2. Calculating sequences within sectors.

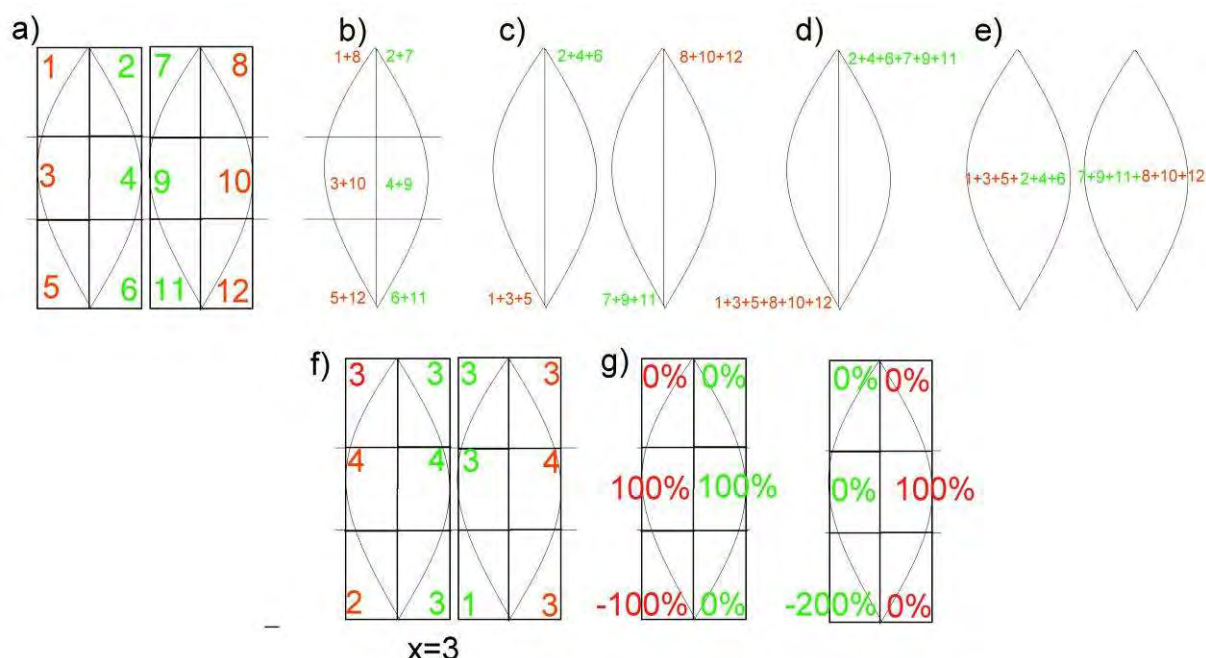


Fig.185 Sample method of collective data chart presentation. a) sequence number within each of 12 sectors; b) number of sequences in sectors located on both tool sides; c) sequence number for each edge's sectors on each tool face; d) sequence number within an edge on both faces altogether; e) sum total of sequences within all sectors on one face; f) sample sequence number values for Fig.2 tool; g) percentage deviation of each value from average ( $x=3$ ).

3. Summarizing the results for particular sites within the specified artifact types. In order to obtain this, for each sector an average value was established. Eventually, the results were standardized due to the discrepancies in the sequence number between the artifacts from various sites. Thus, the outcome was presented and analysed as a percentage variation from the average within a given sector (Fig.186–10).

To estimate this value, an average number of sequences on the tool was taken ( $x$ ). To obtain it, the sequences in all 12 sectors were counted in and then, all this was divided by 12. Next, the average value was deducted from the sequence number in each sector ( $x_1$ ), and thus the variation from the average value ( $s$ ) was received. Multiplied by 100%, it produced a percentage deviation from the average. This is what the entire formula looks like:  $s=(x_1-x)*100\%$  (Fig.185). 0% stands for absence of deviation, so the mean value for the entire tool. Positive values denote a more-than-average occurrence of sequences, whereas the negative ones imply a less-than-average sequences presence in particular sectors.

To simplify things, a scale of colours had been used, ranging from white to dark red (Fig.186). The brighter the colour, the fewer sequences in a sector there are with reference to the average and vice versa: the deeper the shade of red, the more sequences there are. Since the cases of more than a 180% deviation are but a few, the scale of colours is based on a range of values on both sides of the average, thus joining them into one group on each side of the scale  $>180\%$  and  $<-180\%$  (Fig.186). The outcome in the form of a percentage deviation from the average creates a better possibility for comparing the values of certain sites between one another, since it ignores the discrepancies in general number of sequences present on the tools (some of them are characterized by numerous sequences, others by very few).

4. Summary. The final results are given for the following values:

- a) within particular sectors (Fig.185a),
- b) within 6 parts indicated via the tool's division by vertical axis into sides, for both faces altogether (lower and upper) (Fig.185b)
- c) within tool edges on a given face (Fig.185c),
- d) within edges for both faces altogether (Fig.185d)
- e) within faces (Fig.185e).

5. Scheme drawing. A scale of colours has been used so that the results may be perceived more adequately (Fig.186–10). Negative values were marked with colours ranging from bright yellow to orange, whereas positive values got orange to red colour representation.

6. Outcome analysis—was based on comparing the obtained results with the observed schemes of tool knapping and the indicated techno-functional units, as well as with the intensity of artifacts repairs in a given group.

## 4.3. Outcomes overview

224 artifacts belonging to 13 tool groups originating from 10 sites were submitted to analysis and constituted the main subject of study: Mauern gr.I and II, Sajobabony gr.II,

Ripiceni Izvor gr.I, Musilievo gr.II and IV, Jankovich gr.I, Vedrovice V gr.I and II, Ehringsdorf, Wahlen gr.I, Rörshain gr.I and Kösten. If less than 3 artifacts met the criteria mentioned above, the groups were omitted, except for the artifacts from Vedrovice V gr.I and Musilievo gr.IV. Based on technological examination, these tools were classified as leafpoints, hence it was decided to include them in the conclusions.

To compare the results, the analysis of sample Szeleta leafpoints, as well as Königsau and Klausennische backed knives was conducted.

Particular groups of artifacts differ significantly in terms of sequences number on certain tool parts. Most artifacts are characterized by a visibly varied number of sequences within sectors. The discrepancies in some extreme cases reach the value of 400% (Mauern II–467%, Königsau–438%) (Fig.189, 9). Groups of artifacts with noticeable differences in the sequences number open the possibility for interpreting particular groups of tools according to their manufacturing process or repair methods.

Parallel to this, groups of artifacts with a uniform distribution of sequences number on the entire tool are found in the analysed sample; this means that for each sector, the values differ only slightly, never exceeding the value of 100% (e.g. Mauern I, Szeleta I, Musilievo IV, Vedrovice II, Wahlen, Rörshain) (Fig.188, 189, 190). These artifacts require special attention due to the fact that such a result may either originate from uniform tool treatment, or from a scarce number of sequences. A situation like this is encountered in Wahlen and Rörshain (Fig.189), where the average sequence number on one face is 11 only (Fig.187), whereas for Szeleta it reaches 19 (Fig.190).

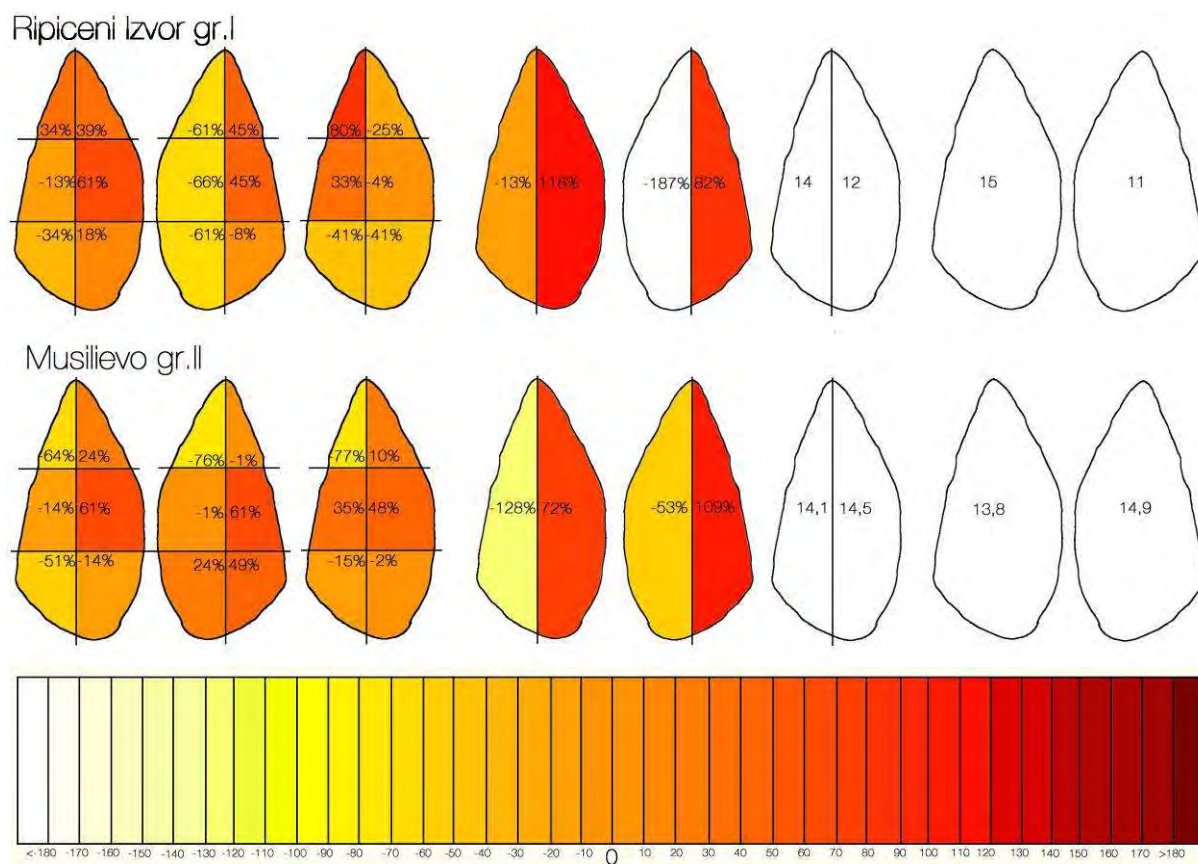


Fig.186 Collective results for sequence analysis of half-back knives from Ripiceni Izvor–gr.I and Musilievo–gr.II).

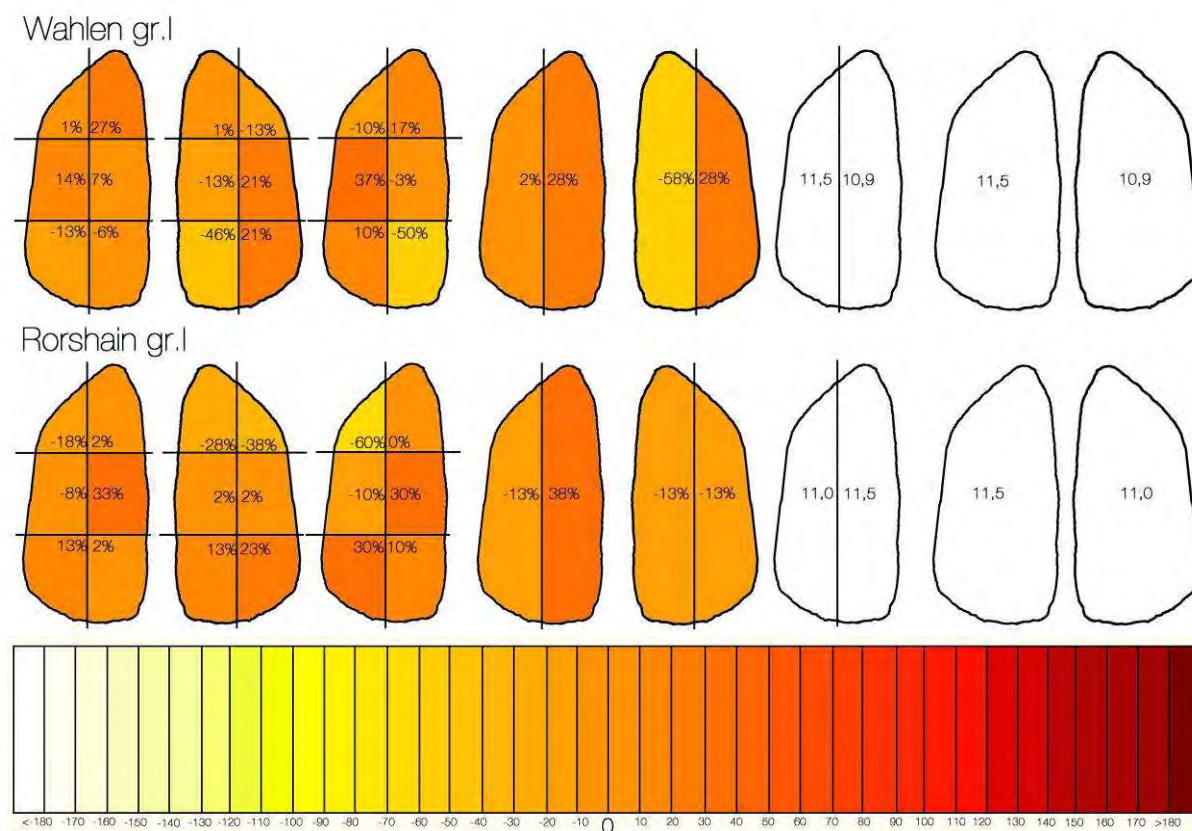


### 4.3.1. Single cutting edge tools

Tools equipped with one, successively repaired cutting edge display a dense number of sequences on the edge's upper surface as well as on the lower surface of distal posterior edge (Ripiceni Izvor gr.I-*Fig.186*). Concurrently, these artifacts are characterized by avoiding removals done on the cutting edge's lower face (*Fig.186*). This pattern fits perfectly the repair scheme for such type of tools. A similar one is found in the sequences distribution on Musilievo tools group II (*Fig.186*). These artifacts were termed as cutting tools bearing traces of tip repairs. The scheme illustrates a tendency to avoid removals on the lower face of cutting edge, especially near the tip. Few sequences on the upper face of distal posterior edge may be here attributed to the alternate scheme of knapping and repairing of both edges.

Among the remaining tools termed as backed knives or half-back knives according to the analysis, the situation is less clear. The artifacts from Wahlen (group I) and Rörshain (group I) (*Fig.187*) display little difference in the sequences number across sectors. As already mentioned in the introduction, this may be caused by a generally scarce number of sequences marked on these tools, which in turn was the consequence of raw material (quartzite) from which most of them were made. Regardless of how insignificant the differences may be, a tendency for high-intensity cutting-edge knapping on the upper face and lower-intensity cutting-edge knapping on the lower face can be clearly seen on the schemes below (*Fig.187*).

The artifacts from Sajóbábony group II (*Fig.188*) present a greater sequences number on both cutting edge faces. These tools classified as knives, were characterized by edge scheme of knapping and cutting edge rejuvenations, without any trace of distal posterior edge's thinning. Thus, the discrepancies in sequences number may reflect a more intensive exploitation of one of the edges.



*Fig.187 Collective analysis results for sequences frequency on knives (Wahlen gr.I, Rörshain gr.I).*



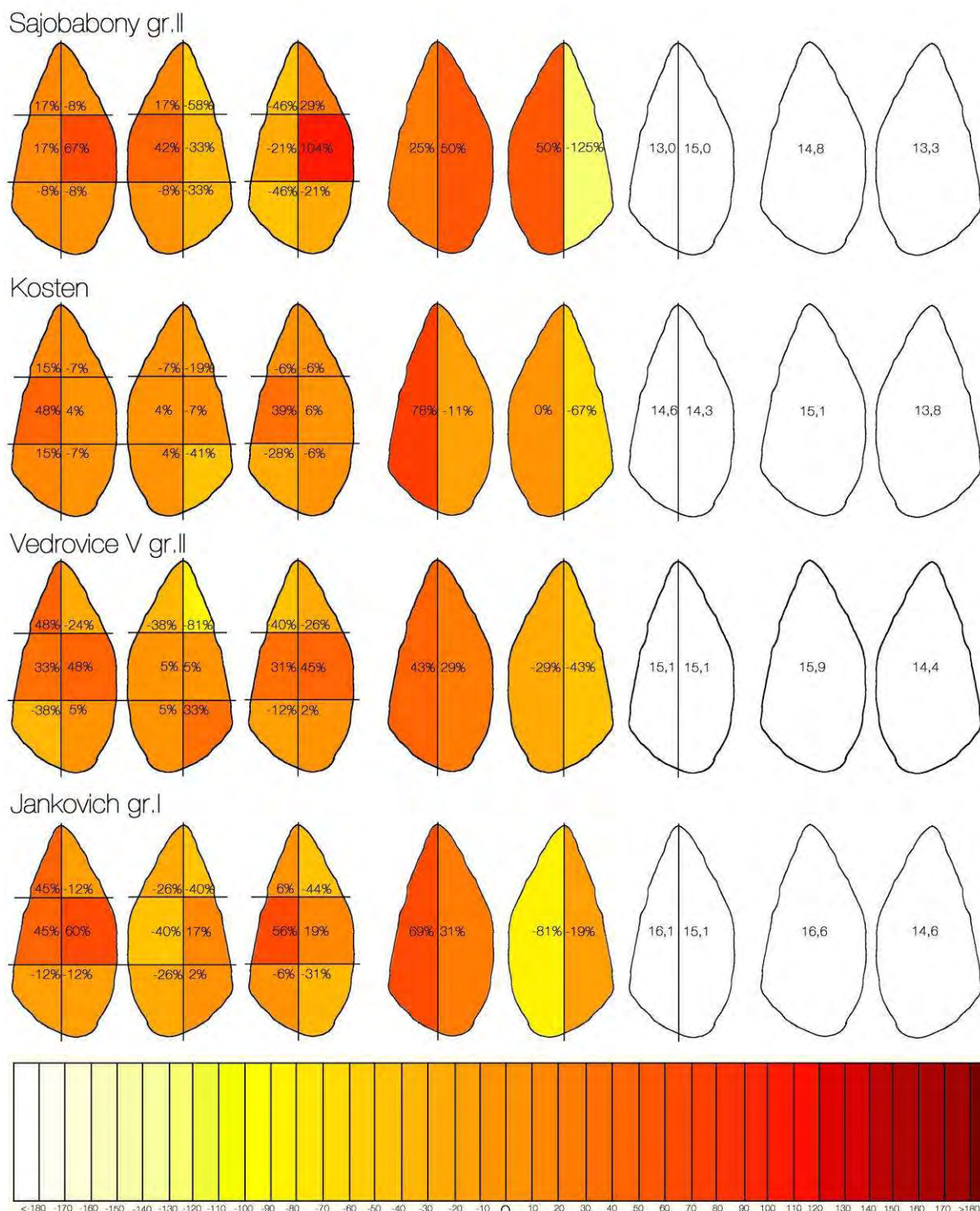


Fig.188 Collective results for sequence analysis on half-back knives (Sajóbabony gr.II, Kösten, Vedrovice V gr.II and Jankovich gr.I).

When it comes to half-back knives examination, two groups of artifacts have particularly interesting results: Vedrovice V gr.II and Jankovich gr.I (Fig.188). These tools display a similar pattern of sequences distribution. This pattern is most importantly characterized by an increased sequences number on the upper face compared to the lower face. As to the upper face, it has the most sequences on the distal posterior edge, near the tip and in its middle part, as well as on the cutting edge's middle part (Fig.188). These tools are also specified by a greater number of sequences on the lower face of the cutting edge's middle

part, and at the same time, their small number near the tip on the distal posterior edge's lower face. The tools from Kösten (Fig.188) display a similar sequences distribution scheme; however, in case of those artifacts, the group under scrutiny appeared to be highly incoherent.

Both artifact groups (Jankovich gr.I and Vedrovice gr.II) are composed of thin cutting tools termed as half-back knives. The artifacts are characterized by the presence of a base, a long distal posterior part, an exposed tip and a repeatedly repaired, often concave cutting edge. As a result of not being particularly thick, the tools were most frequently repaired through deriving new removals on their upper face, which resulted in a higher frequency of sequences appearance on the upper face. Simultaneously, successive shape changes described in the chapter devoted to technology (Chapter 3.2), caused that after each repair fewer older sequences were preserved on the artifact's lower face near the tip, whereas the old removal sequences on the distal posterior edge's upper face were not removed (Fig.188). Additional repairs of the base edges increased the number of sequences in the tool's near-the-base sectors. Thus, the sequences number distribution visible on the tools corresponds with their repairing scheme.

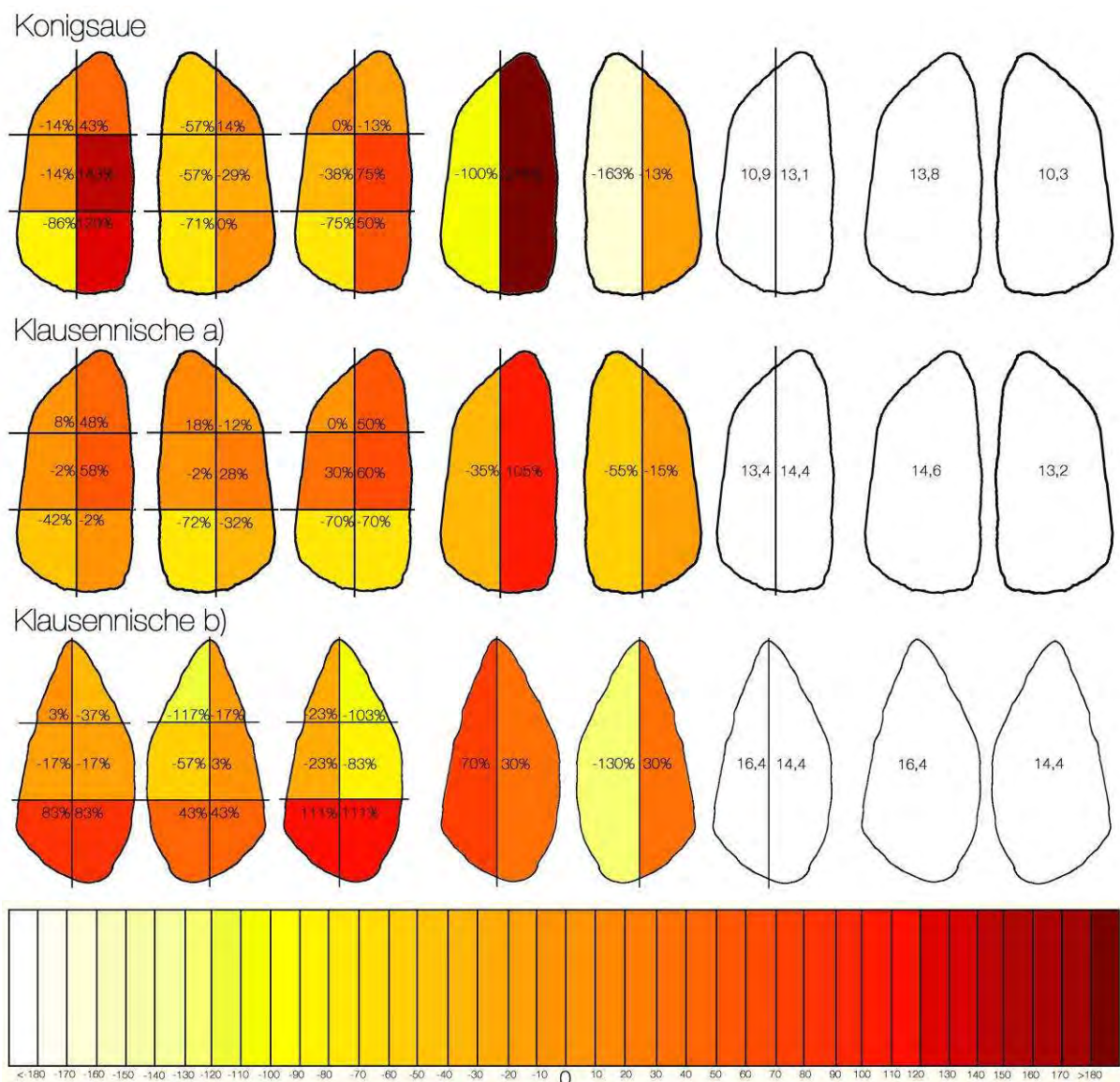


Fig.189 Collective analysis results for sequences frequency on knives (Königsauke, Klausennische).

The Königsau knives (Fig.189) are marked by an incredibly large difference in sequences number within particular sectors. The differences in sequences number within edges reach even the figure of 438%, which means that in some sectors there are up to 4 times more sequences than in the others. The most sequences are found on the upper face of the cutting edge (275%), the fewest on its lower face (-163%). Relatively more sequences are also present near the tip of the distal posterior part on the lower face (sector 8)–14% (Fig.189), whereas the fewest sequences appear at the base angles on the upper face of distal posterior part and the lower face of cutting edge.

Such distribution of sequences frequency reflects the formation process and the repairs of backed knives, with the cutting edge being thinned from the distal posterior part to the lower face. An analogical distribution can be observed on the knives from Ripiceni Izvor and it seems that it is specific of most backed knives.

Owing to the analysis of Klausennische tools (Fig.187), it was possible to differentiate two groups of artifacts. One of them are tools with a base that did not undergo knapping or repairing (Klausennische a), the other are forms with intensive base's edge formation (Klausennische b).

The tools of Klausennische b) group are highly exhausted knives, characterized by numerous repair series. The artifacts that had their base continuously repaired have an increased number of sequences near the base. Another specific element is a very small number of sequences near the tip on the cutting edge's lower face. It is directly linked to the repairs scheme aimed at keeping the cutting edge straight, especially near the tip. This trait may be highlighted as typical of cutting tools.

The Klausennische group a) artifacts, apart from their unknapped base, are characterized by a tendency to derive sequences to the cutting edge's upper face, while avoiding sequences to its lower face. The scheme reminds of that observable on Königsau tools.

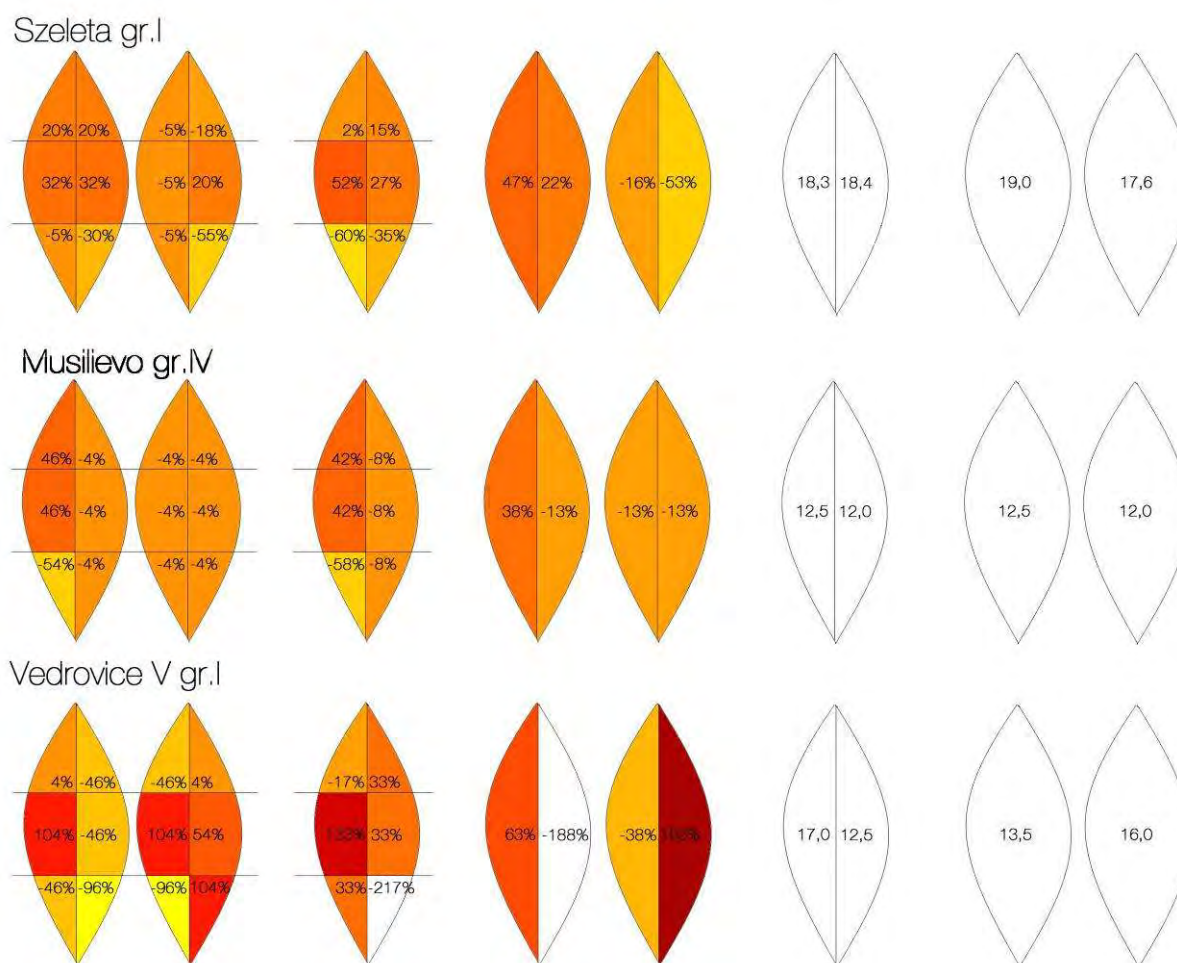
### 4.3.2. Leafpoints

The sequences number distribution for Szeleta and Musilievo gr.IV leafpoints (n=2) (Fig.190) is nearly identical with the one for half-back knives from Jankovich gr.I and Vedrovice gr.II (Fig.188). However, leafpoints do not bear any repair traces, hence in their case, the pattern of sequences distribution reflects the intensity with which given tool parts were knapped, and does not have to be interpreted according to the criterion of edge shape modifications and repairs intensity. Thus, it seems that even though the distribution pattern is identical with that of Vedrovice V and Jankovich artifacts, the latter cannot be classified as leafpoints based on sequences distribution analysis solely.

Since it was highly stressed that a desired shape should be obtained both at the tip and at the base, leafpoints treated according to edge surrounding or alternate/analogical schemes of knapping have a quite even sequences distribution. Because the artifact is widest in its middle part, this is where the sequences number may be larger due to the preservation of earlier removal sequences.

The Szeletian leafpoints are above all characterized by a very small difference in sequences number for particular sectors (up to 100% for collective edge analysis, Fig.190c), while at the same time the sequences number distinguished on the tool is very high (on average 19 sequences per face–Fig.190). The most sequences are visible in the middle sectors, the fewest at the base. Nonetheless, the discrepancies are not too significant.



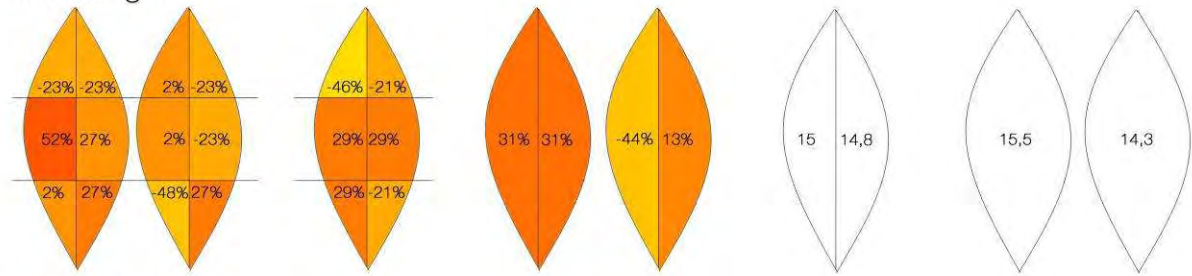


*Fig.190 Collective sequences frequency analysis results for particular leafpoints (Szeleta gr.I, Musilievo gr.IV, Vedrovice V gr.I).*

The Szeleta and Musilievo leafpoints (Fig.190) have a characteristic, slightly lower sequences number at the base, which may reflect less interest in those tool parts than in those near-the-tip. Nevertheless, it should be remembered that the Musilievo analysis was conducted on two tools only, and it can solely be regarded as a reference for the Szeleta results.

Contrary to the Szeletian and Musilievo leafpoints, the artifacts from Vedrovice (gr.I) (Fig.190), classified as leafpoints on the basis of technological examination, display a totally different pattern of sequences distribution on the tool. Most importantly, these artifacts have broad discrepancies in the sequences number in particular sectors (reaching 351% for collective edge analysis). A few times more sequences were derived on edge II (placed on the left of the upper face) than on edge I (placed on the right of the upper face) (Fig.190). Such pattern of sequences frequency is connected with a very peculiar knapping scheme of Vedrovice V leafpoints. An edge scheme of knapping was aimed at intensive thinning of one edge (edge II), and then after its appropriate thickness was obtained, edge shape correcting sequences were derived from the other edge (edge I). Therefore, sequences distribution on the artifacts under consideration constitutes the reflection of a specific knapping process.

Mauern gr.I



Mauern gr.II

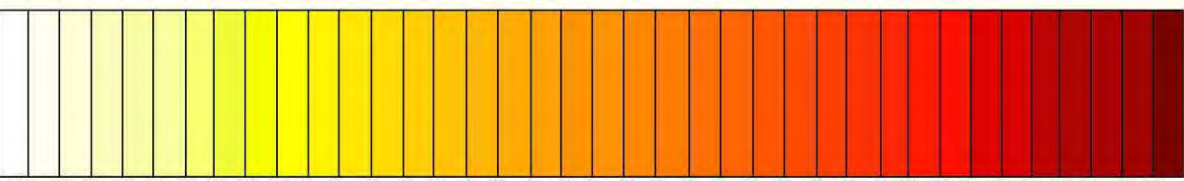
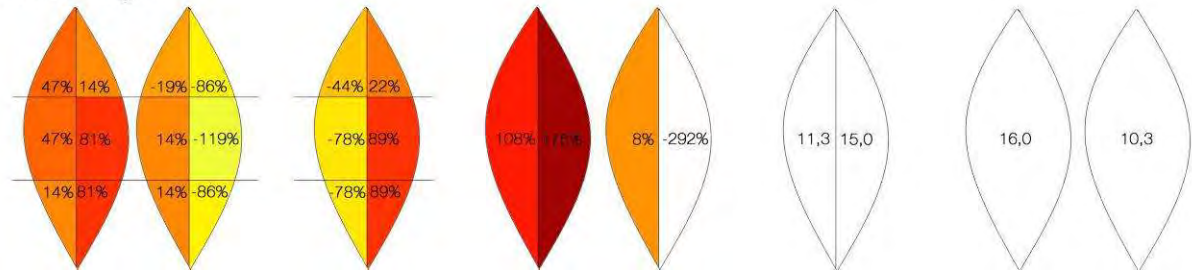


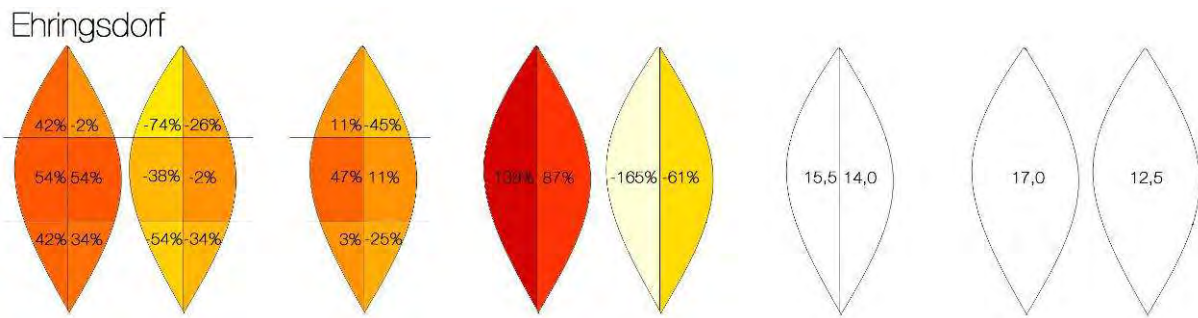
Fig.191 Collective sequences frequency analysis results for tools with two working edges (Mauern gr.I, II).

### 4.3.3. Double cutting edge tools

While describing leafpoints, it is worth to notice the sequences number distribution for Mauern group I artifacts (Fig.188). These tools are characterized by precise knapping, little thickness, double cutting edge presence: one being straighter, the other being convex. The tools asymmetry and the traces of purposeful asymmetrical artifact shape formation did not permit to include them in the leafpoint group. Nevertheless, in case of these tools, the pattern of sequences distribution resembles highly the distribution specific of the Szeletian leafpoints. These artifacts are characterized by highly uniform sequences number within sectors (the difference does not exceed 75% for collective edge analysis). As with leafpoints, this may bear witness to the formation of all tool parts, both the base and the tip, with equal intensity.

The Mauern group II artifacts are the exact opposite (Fig.191). These tools are characterized by a typical edge scheme of knapping which did not, however, condition the pattern of sequences distribution on these tools. They are marked by noticeable variety in sequences number between the upper and the lower face. In case of collective edge analysis, the differences reach 467%. The sequences number analysis for entire edges already shows that the artifacts were much more often retouched and more intensively formed through deriving removals to the upper surface (Fig.191). Parallel to that, the examination of sequences distribution within sectors constitutes a perfect picture of the repair scheme and the hypothetical uses of this type of artifacts; all this being presented in the chapter devoted to technology. On the basis of technological tests, it was concluded that the artifacts from this group bear traces of usewear on one edge, near the tip only, whereas on the second edge it is located alternately in the diagonal axis (Fig.109).





*Fig.192 Collective sequences frequency analysis results for tools with two working edges*

This scheme described for the repair process and the intensity of usewear is confirmed by sequences distribution pattern (Fig.191). Here, one can also see an increased sequence number on the upper face in sectors 1 and 3 near the tip on edge II, and in sectors 4 and 6 near the base on edge I.

The Ehringsdorf tools constitute the last group of artifacts (Fig.192). With reference to them, the sequences distribution reflects the intensity of their repairs. The Ehringsdorf tools bear numberless traces of edge repair on the upper face. The artifacts are characterized by considerable thickness, the presence of two steep retouched edges, convergent at an exposed tip. The sequences distribution pattern had showed considerable differences in their number between the upper and the lower face (Fig.192). The artifacts are densely sequenced on the upper face's entire area, whereas at the same time, the number of removals on the lower face is scarce (Fig.192). The divergence in sequences number for collective analysis amounted to 304%. The sequences on the lower face were more often derived from edge II than from edge I, which had been noticed by the author as early as during technological examination.

For Ehringsdorf artifacts, then, the pattern of sequences distribution constitutes an excellent reflection of their knapping intensity and of the repair process focused on certain artifact areas.

## 4.4. Conclusions

Based on the presented analysis, it was possible to confirm the results obtained through reconstructing the tools manufacturing processes. Simultaneously, the examination had proved that leafpoints in terms of sequences number distribution differ from cutting tools and constitute a cohesive group. It is not the case for Vedrovice V gr.I where a non-standard scheme of knapping was applied in their manufacturing process (Fig.190), which caused certain discrepancies in sequences distribution pattern.

An ideal pattern for the sequences frequency on a leafpoint will be characterized by:

1. little divergence in sequences number between particular tool sectors,
2. slightly more sequences in the middle of tool,
3. slightly fewer sequences near the base,
4. slightly fewer sequences on the lower face (characteristic not always observed).

Such pattern implies equal treatment of the entire tool as a result of the points manufacturing process, aimed at forming a specified tool shape in its full outline.

Alternatively, cutting tools in the majority of cases are marked by a considerably disproportionate intensity in the knapping of particular edges. Certain artifacts bearing numerous traces of repairs will display a tendency for gradual growth of those differences, which can be presented with the use of several characteristic elements:

1. large difference in sequences number between particular tool sectors,
2. the most sequences present on the upper face of the cutting edge (not necessarily near the tip),
3. the fewest sequences occur on the lower face of the cutting edge (most often near the tip),
4. relatively more sequences occur on the lower face of the distal posterior edge (most frequently near the tip).

The pattern reflects the concept of a knife which is equipped with one cutting edge straight in profile, rejuvenated through consecutive series of retouches on the upper face and, possibly, thinned near the tip through deriving flat, angular removals on the lower surface from the distal posterior edge.

The analysis outcomes have demonstrated that it is likely to obtain supplementary information on the knapping of tools through numerical tests. At the same time, the analysing method description provides quite a good picture of an intensive interest in certain tool parts, especially when the artifacts display multiple repair traces (Ripiceni Izvor, Königsau, Ehringsdorf,) (Fig.186, 189, 192). Yet, even then the results have to be constantly verified via comparison with the manufacturing scheme. This is due to the fact that the sequences distribution on a tool is influenced not only by the exploitation intensity of a given artifact part, but also by its thickness. It is worth noticing that the artifacts of little thickness, as a result of repair sequences, often have the earlier removals obliterated, thus reducing the sequences number for a given sector (Jankovich gr.I, Klausennische b), Vedrovice V gr.II) (Fig.188, 189). Another important factor to consider is tool shape modification during consecutive repair phases. It also provokes the removal of some of the earlier sequences.

As to the artifacts that had not been repaired, the sequences number distribution often shows particularities of their knapping scheme (Vedrovice V gr.I) (Fig.190). First this factor has to be ruled out during verification, and only then can the sequences number differences be interpreted as discrepancies related to varied knapping of certain tool parts (Mauern gr.I) (Fig.188).

To sum up, it can be stated that sequence analysis allows to distinguish traits specific of particular artifact groups. The results, however, can only undergo interpretation according to prior technological examination and the reconstruction of tool knapping scheme. With regard to the results obtained for leafpoints and knives, some clear-cut divergences between these artifact groups can be observed.



## 5. Edge Analysis

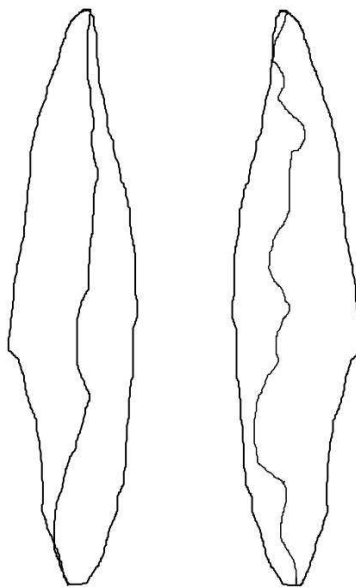
During scar pattern analysis it had been noticed that some of the examined tools had a different profile of both edges (Fig.193). The one called cutting edge by technological examination was usually of a straighter profile than the opposite one called back edge or distal posterior edge.

Whereas the divergences in both edges profile were clearly visible on most examined tools, in order to present the observations in the form of valid results, it was crucial to find a good measure for the variable treatment of both edges. It was assumed that the highly S-shaped edge was treated with the use of fewer deeper and broader removals, while the straight-profiled edge was formed with the help of more tiny removals, which removed the edge's sinuous outline resulting from its preliminary treatment, or were aimed at avoiding the creation of profile sinuosity through not deriving removals on one of the faces.

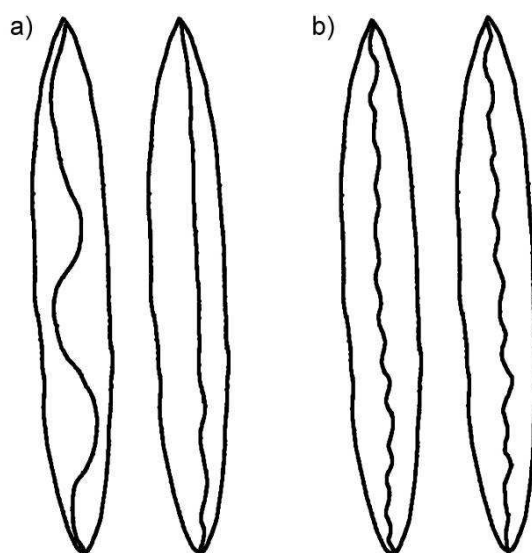
It is assumed then, that edge sinuosity may serve as a measure of its treatment precision. If so, considerable discrepancies in both edges profile sinuosity may imply the existence of a difference in their formation. An accurate profile sinuosity measure, then, would enable distinguishing tools with similar edge treatment from those with a different one.

As for leafpoints, which are equipped with two edges formed in the same way, none of them is prominent. It can be assumed then, that leafpoints and double cutting edge artifacts will display a similar profile of both edges (Fig.194b).

It can be taken for granted that the situation would be different for backed bifacial knives—defined as cutting tools equipped with one cutting edge and an opposite back edge or distal posterior edge. Differing functions assigned to both edges ought to determine their different profile outline (Fig.194a). The functional/cutting edge is formed and kept as straight as possible during subsequent rejuvenation phases. As well, its formation normally requires more effort reflected in deriving a bigger number of tiny removals correcting the profile sinuosity after the preliminary treatment phase, or, to avoid the formation of a sinuous profile, through deriving removals on one face only.



*Fig.193 Difference in edge profile sinuosity of a sample tool submitted to scar pattern analysis (Wahlen WH\_5c).*



*Fig.194 Schematic edge profile for tools marked by a) edge treatment asymmetry (e.g. knives); b) uniform treatment of both edges(e.g. leafpoints).*

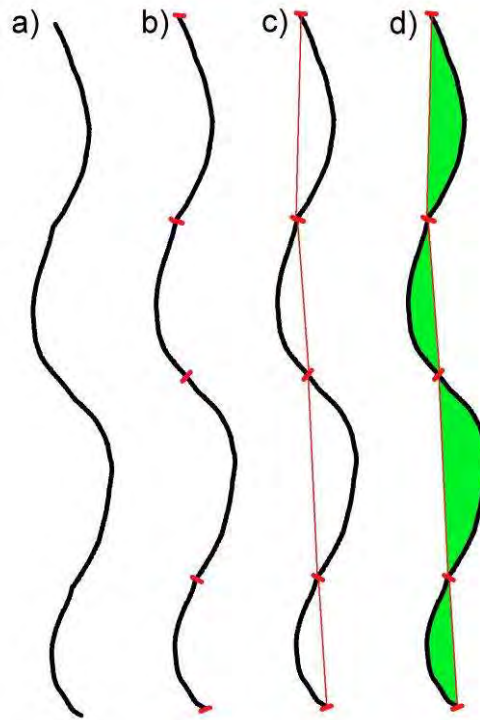
Back edge/distal posterior edge in knives serves a technical purpose mainly. It is basically either blunted with steep removals or formed so as to make it possible to derive flat, angular removals near the tip, reaching the tool's second edge and thinning the cutting edge near the tip. Removals on the upper face of distal posterior edge, as it can be concluded from technological examination, mostly serve to expose the tip and retain it in the artifact axis. Therefore, if the edge does not serve any functional purpose, but only correcting and technical, less attention should be devoted to its profile during the formation and rejuvenation process. Thus, the edge should be formed with the help of less precise removals, which is consequently visible in a more sinuous profile (Fig.194a).

It ought to be noted that the model includes finished tools and successful forms solely, functional in terms of utility. This is so because a differing edge profile on bifacial artifacts may be caused not only by divergences in their treatment, but can also stem from committed errors, defects, breaks, crumbles, hinged removals or intensive and failed rejuvenation. For this reason, the analysis presented below entailed finite forms only, and eliminated artifacts termed as preforms or unsuccessful forms. It is presumed then, that if only finished and fully functional forms are considered, in these circumstances the divergence in edges profile illustrates their different treatment process, and subsequently, different rejuvenation.

All this considered, it was decided that a method should be found to allow not only a qualitative, but also a quantitative comparison of profile sinuosity. To measure sinuosity, sinuosity value ( $p$ ) had been accepted. It was defined as the edge area divided by its length. The area is understood as the sum total of areas under each edge bend (Fig.195d). The area under edge bend is described as the figure area obtained through identifying transverse axis crossing the sinusoid centre (Fig.195b,c).

Presumably, artifacts that had both their edges treated uniformly, ought to be marked by a similar sinuosity value ( $p$ ). If this is the case, artifacts that had their edges treated in a varying manner should be characterized by a considerable discrepancy in this value. As a point of reference, the result of sinuosity value subtraction was accepted. The result of subtraction ( $p_1 - p_2$ ) depends on the size of areas solely, which in turn enables to capture large differences between edges notable for small areas.





*Fig.195 Edge sinuosity measuring method; a) edge profile; b) marking sinusoid bends (sinuosity); c) distinguishing a line joining bend points located alongside; d) area marked under edge sinuosity bends. Profile sinuosity area will equal the sum total of particular areas under consecutive bends.*

## 5.1. Measurement procedure

Measurements were made on the basis of photographic documentation. The pictures were taken at a right angle with reference to a tool positioned in a lateral projection (Fig.195). Measurements were taken on Adobe Photoshop CS3 photographs.

To estimate sinuosity value, it was necessary to calculate edge area in square centimetres first. In order to do so, edge outline was marked on the photograph so that the programme itself could designate a straight line between two bend points located alongside (Fig.195c). For each edge bend, the axis was marked individually. For figures received in such a manner, the programme calculated pixels number placed under the designated area (Fig.196c–e). The value was signified as (x). Next, it was essential to convert the pixels number into square centimetres. To achieve this, the number of pixels per photograph's square centimetre was measured (Fig.196b). This value was marked as (s). The  $x/s$  formula then provided the sinuosity area in square centimetres.

Due to the fact that the tool edges have a varying length, and edge sinuosity itself will be measured as area, it is dependent on edge length (longer edge will have larger area despite of identical sinuosity). For that reason, it was decided to divide the result by edge length estimated in the picture (Fig.196a). Length was marked as (a). Consequently, each edge had its **sinuosity value** calculated based on the  $x/(s*a)$  formula, defined as sinuosity area to edge length ratio. The sinuosity value received a letter symbol (**p**).

P1 value was determined for edge specified as the cutting edge according to positioning adopted for technological analysis. P2 value was calculated for the edge opposite to p1.

For thus estimated sinuosity values, student's t-test statistics for matched pairs were calculated, adopting a null hypothesis as to zero deviation between pairs. The analysis was conducted for a two-tailed test. According to the accepted theoretical model of artifacts with varying (knife) edge treatment, the cutting edge should be straighter in profile. Thus, it ought to be assumed that in knives, sinuosity value (p1) distinguished for the cutting edge should be considerably lower than the p2 value (for the opposite edge). As to tools characterized by uniform edge treatment (leafpoints), divergence between those values should be insignificant.

Two-tailed analysis was chosen in order to make sure that it is the described technological trend that is being measured, instead of some random area differences caused by other factors such as, for instance, rejuvenation intensity.

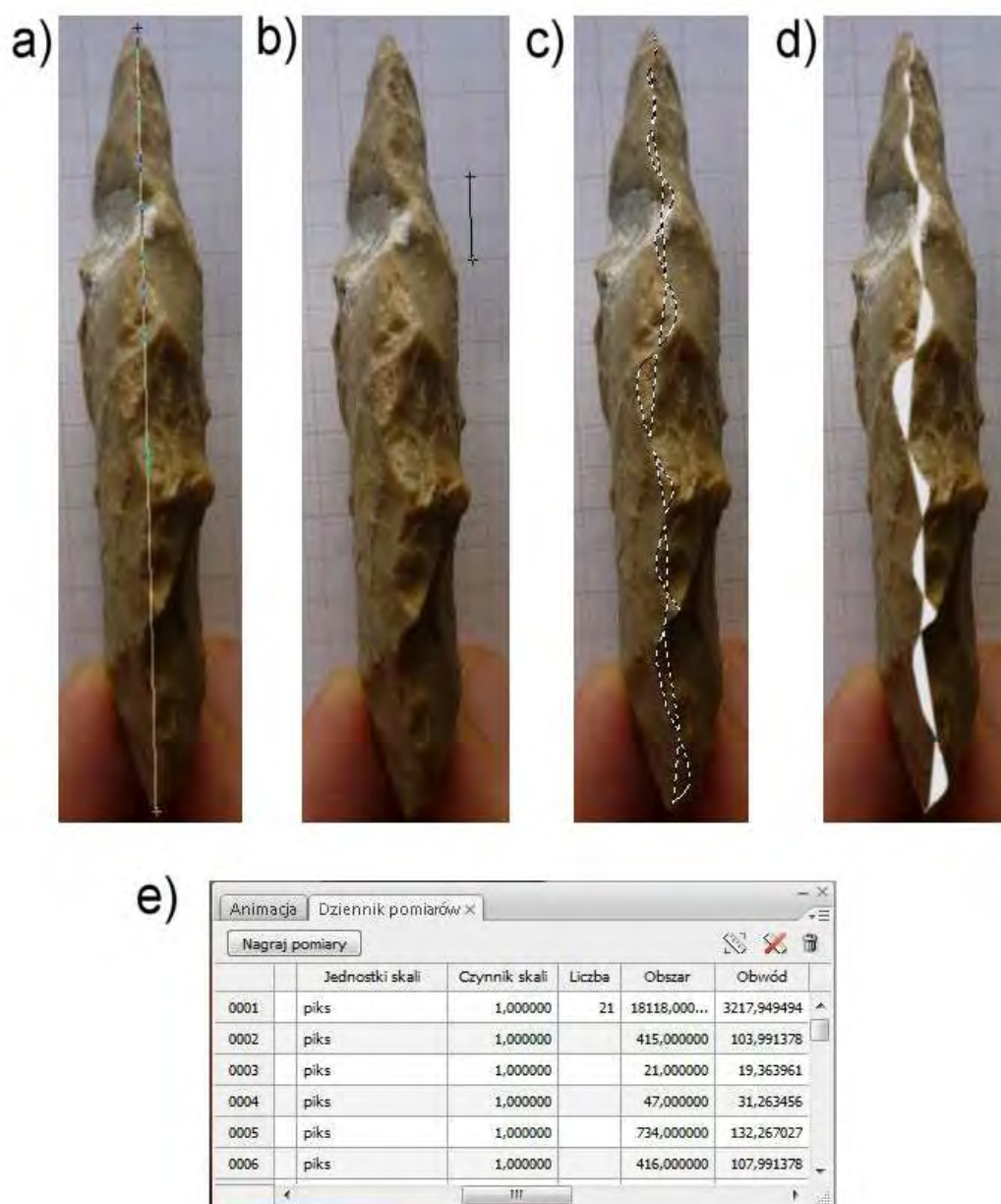


Fig.196 Adobe Photoshop CS3 edge sinuosity area measuring procedure; a) edge length measurement; b) pixel number measurement per photograph square centimetre; c) marking edge outline through drafting sinuosity bend contour between bend points located alongside, then the programme itself designates a line matching two bend points; d) marked edge sinuosity area; e) marked area of pixel number measurement.

## 5.2. Sample

The test's statistical importance required conducting analyses based on comparatively numerous samples solely.

The only artifacts that could have been submitted to examination were:

- entirely preserved tools
- large tool fragments if both edges were preserved in similar length,
- finished tools.

The analysis was not conducted on:

- preforms,
- tools with postdepositionally damaged edges,
- frost-fractured tools.

Altogether, measurements of 172 tools from 12 sites were taken: Ehringsdorf, Rörshain, Wahlen, Lenderscheid, Kösten, Mauern, Klausennische, Vedrovice V, Szeleta, Jankovich, Musilievo, Ripiceni Izvor. The exact catalogue of analysed artifacts is presented in Tab.2. Artifacts were examined within groups distinguished during the technological analysis. Only for the Rörshain site, it was decided to combine two knife groups, gr.I and II (n=8). On the Wahlen site, artifacts from knife groups II and IV (n=7) were also analysed together. The Lenderscheid artifacts were examined as one group due to a scarce sample size (n=10). The analysis entailed only those artifacts which had earlier undergone technological examination that allowed their classification into relevant groups. In case of Mauern, Rörshain and Wahlen, the collective statistic of all forms submitted to edge analysis was done separately, also of those not examined technologically. In total, 17 artifact groups underwent analysis.

## 5.3. Observational error

Before commencing measuring, it was concluded that the method's precision ought to be verified. Above all, it was necessary to consider the occurrence of observational error related to distinguishing the edge profile and determining the sinusoid bend point responsible for profile sinuosity by hand. For that reason, it was decided that an experiment based on the analysis of 5 sample artifacts should be conducted (Musilievo M\_1207, Ripiceni Izvor 3856, 2259, 2277 and Szeleta 53.38.8). The sample included both forms with highly sinusoid edges, as well as those with slight sinuosity. The experiment's main principle was to measure the 5 chosen tools' edges 10 consecutive times. Each measuring was based on re-establishing edge profile (x), its length (a) and the square centimetre area (s) in the photograph. Once the measuring was done, sinuosity value (p) was calculated in accordance with the formula  $p=x/(s*a)$ . Since the three parameters (x, a, s) are independent of one another, a decision was made to calculate combinations of all three parameters for all the values, which would altogether give 1000 results for each edge ( $10x*10s*10a$ ). From a thus received sample, a relative error was calculated, otherwise called measurement uncertainty. Observational error values spanned the range 0.19% to 0.9%, with the average being 0.44% for 10 samples.

Tab.2 Edge area subtraction values (bolded type marks high subtraction value  $>10E-05$ , very low subtraction values  $<2E-05$  given in red) and the two-tailed student's *t*-test results as well as the outcome validity levels (bolded type used for statistically significant results)

Tool type	Site/group	Sample quantity (n)	Edge area absolute subtraction value p1–p2	Test value (t)	Validity level (p)
<b>Leafpoints</b>	Szeleta	7	<b>0.1574E-05</b>	0.1467	
Double cutting edge tools	Mauern (ensemble)	16	<b>1.0503E-05</b>	0.8152	
	Mauern gr.III	7	<b>1.7508E-05</b>	1.0117	
Single cutting edge tools	Musilievo gr.II	5	<b>0.0916E-05</b>	0.6218	
	<b>Jankovich gr.I</b>	9	4.2828E-05	<b>2.8614</b>	<b>0.05</b>
	<b>Vedrovice V gr.II</b>	5	8.1673E-05	<b>2.9124</b>	<b>0.05</b>
	Lenderscheid	10	6.2084E-05	1.9911	
	Wahlen gr.II+IV	7	9.5767E-05	1.6658	
	Wahlen gr.I	11	<b>12.0163E-05</b>	2.0361	
	<b>Klausennische</b>	13	<b>10.7294E-05</b>	<b>2.7682</b>	<b>0.02</b>
	Musilievo gr.I	7	<b>28.5887E-05</b>	1.7413	
	Wahlen (ensemble)	28	<b>33.3089E-05</b>	1.5147	
	Kösten	8	<b>63.2687E-05</b>	1.5218	
	<b>Ripiceni-Izvor</b>	19	<b>81.7554E-05</b>	<b>2.5214</b>	<b>0.05</b>
	<b>Rörshain (ensemble)</b>	22	<b>238.1305E-05</b>	<b>4.2146</b>	<b>0.001</b>
	<b>Rörshain gr.I+II</b>	8	<b>333.7548E-05</b>	<b>3.2800</b>	<b>0.02</b>

## 5.4. Results

In the two-tailed *t*-student's test, statistically valid divergences between edge area values appeared in 6 from among 17 analysed artifact groups. They encompass:

- Klausennische–*n*=13, *t*=2,77 (validity level–0.02),
- Ripiceni Izvor gr.I–*n*=19, *t*=2,42 (validity level–0.05),
- Rörshain (all together)–*n*=22, *t*=4,21 (validity level–0.001),
- Rörshain gr.I +II–*n*=8, *t*=3,28 (validity level–0.02),
- Vedrovice V gr.II–*n*=5, *t*=2,91 (validity level–0.05),
- Jankovich gr.I–*n*=9, *t*=2,86 (validity level–0.05).

In case of the artifacts from Ehringsdorf, Kösten, Lenderscheid, Musilievo, Mauern, Szeleta and Wahlen, lack of statistically valid differences was observed.

Parallel to this, it is worth noticing that the test had been conducted on samples scarce from the perspective of statistic tests, which may influence lack of possibility to reject the null hypothesis in some of the groups.

The average (p) subtraction values analysis for both edges already shows that the artifacts differ considerably in terms of those numbers (Tab.2). The table presents absolute subtraction values which do not include information as to which edge differed from which one.

The subtraction value for Szeleta artifacts, classified as leafpoints, equals **0.15741E-05**. Low values (though 10 times higher) are taken by average subtractions for the Mauern site

(**-1.0503E-05**), or Musilievo gr.II (**9.1604E-06**). By comparison, for gr. I Musilievo artifacts termed as backed knives, the value is 15 times higher and amounts to **28.5888E-05**. Apart from the groups where the subtractions are statistically valid, high numbers are also found in Kösten **63.2687E-05** and Wahlen **33.3089E-05**. For those groups, however, standard deviation was too high to prove the presence of statistically valid differences.

Conversely, average subtraction values for Jankovich gr.I and Vedrovice gr.II were quite insignificant (**4.28284E-05** and **8.16738E-05** for absolute values respectively); nevertheless, in this case, such minor result ought to be primarily ascribed to small area value for both edges (both artifact groups are very thin, biplan half-backed knives).

The outcomes presented above illustrate the fact that the examined artifacts differ among one another in terms of both edges treatment. Based on the obtained results, groups of artifacts which display statistically valid differences in both edges treatment can be distinguished. These groups include the artifacts of Ripiceni Izvor, Rörshain, Klausennische, Vedrovice V gr.II and Jankovich gr.I. As a result of technological examination, all the artifacts were classified as single cutting edge tools (knives). For those forms, large edge treatment asymmetry can be discussed, manifesting itself through the differing profiles of both edges.

Except the tool groups mentioned, there are also tools which do not display statistically valid differences; nonetheless, their average sinuosity subtraction value is quite high. These groups entail the artifacts of Kösten, Wahlen, Musilievo gr.I, Lenderscheid. Such forms were classified as single cutting edge tools as well. Lack of statistically valid differences may in this case originate from large variance within measurements, as well as from samples of small size.

It is possible to distinguish an artifact group which is characterized by small area subtraction value, and consequently, as it can be assumed, uniform (symmetrical) treatment of both edges from the point of view of their treatment precision. These artifacts include Szeleta leafpoints, Mauern double cutting edge tools, as well group II Musilievo half-backed knives.

Curiously, the Ehringsdorf artifacts do not display statistically valid divergences; nonetheless, the area subtraction value for those artifacts equals **10.47E-05** for  $n=20$ . They are characterized by intense edge rejuvenation, with the edge placed on the right side of upper face (edge I) usually having a straighter profile. This is triggered by the fact that the opposite edge (edge II) normally, apart from performing functional role, performs technical role as well. Flat, thinning removals near the tip on the lower face are derived from this edge. This kind of edge rejuvenation process will result in the formation of certain, but slight differences in both edges profiles.

## 5.5. Edge analysis utility review

The analysis presented above, based on the displayed results, seems to make a good tool for the evaluation of edge treatment divergences, even more precisely, of the tool edges precision treatment. Nevertheless, it should not be applied without prior tool technological examination, since it is crucial not only to preliminarily recognize the techno-functional tool units, but also to eliminate unsuccessful forms and preforms. It appears to be justified to analyse the tools according to a division into functional or technical groups, since a collective examination of all bifacial artifacts from a particular inventory, given its internal incoherence, may result in a confusing outcome. To enhance outcome reliability, the sample's size is of critical importance.

Concurrently, it should be stressed that for future purposes, measurement precision ought to be increased through introducing artifacts measuring with the use of a 3D edge scan.



It is taken into consideration that photographs taken at a right angle in the tool's middle section deform the picture near the tips, thus causing distortions in the shape and area of measured sinuosity. This dissertation assumes that deformations have uniform distribution across all artifacts and can thus be omitted; however, introducing a more precise measurement method is highly recommended.

## 6. Conclusions

### 6.1. Definition of the term “leafpoint”

For many years leafpoints were treated as a kind of “index fossil” (Mester, 2010; Adams, 2009; Allsworth-Jones, 1986; Adams, 1998; Chmielewski, 1961; Freund, 1952). Thus, it is essential that the attribution of these artifacts is conducted according to a definition that presents a coherent tool concept. Until now, “leafpoint” was defined as: a slim tool in the shape of a leaf which *“has a sharp tip formed in the place of convergence of the two edges, placed symmetrically to the outline of side edges, on the axis of a tool (...) characterized by a flat retouch covering more than  $\frac{2}{3}$  of its surface”*<sup>11</sup> (Ginter & Kozłowski, 1975 p. 86), and which is also at least three times wider than it is thick. This last feature is supposed to be a differentiating parameter between tools under discussion and hand axes.

The analysis’ results show that the definition used until now is too broad. Therefore, the term “leafpoint” pertained so far to artifacts with different tool concepts, and probably also, different functions.

The conducted analyses give ground to the creation of new, techno-functional definition of leafpoints. Thus, a leafpoint shall be defined as a bifacial tool in the shape of a leaf<sup>12</sup>, which is characterized by identical treatment of both edges which are convergent at the exposed tip. The manufacturing process is aimed at maximising symmetry in the tool’s vertical/longitudinal axis. Both leafpoint edges are characterized by identical precision and the way in which they are knapped. This is manifested in the edges’ identical profiles, as well as in types of removals introduced to both sides. The characteristic features are removals aimed at tool shaping, and its symmetry, which can be seen in the manufacturing process. In the case of a leafpoint, tool symmetry, understood as tip positioning on the vertical axis and identical shape/outline of the edges, is a predominant feature, which is of more importance than the tool’s sharpness. Also, there are noticeable efforts in the manufacturing process, which aim at reducing the tool’s S-shape in its profile. However, symmetry remains a predominant goal, and the edge formation precision is of less importance. Therefore, the edges’ profiles are never entirely straight, as opposed to the cutting edges of knives, which have straight profiles. What is more, leafpoints do not bear signs of repairing in the form of edge resharpening by series of additional retouches. The cutting edge repairs, which did not affect negatively its functionality, could be aimed at reshaping after either the base or the tip breakage.

One important problem is the recognition of leafpoints in assemblages, as these forms do not have to fulfil all morphological criteria, in order to fulfil the criteria of definition (e.g. failed, unfinished artifacts). The observation of sequences which lessen the tool’s symmetry is especially valuable. What it shows is which features were of more importance than the tool symmetry for the user and knapper during the introduction of these sequences. Owing to these observations, a list of features that would be necessary to fulfil in order for the tool to retain its functionality can be identified. Also, a hierarchy of features desired for a particular tool, in this case a leafpoint, could be created on this basis.

---

<sup>11</sup> originally in Polish: „posiadające ostry wierzchołek utworzony na przecięciu dwu zbieżnych krawędzi, położonych na osi pośrodkowej symetrycznie w stosunku do zarysu krawędzi bocznych (...) charakteryzujące się płaskim retuszem pokrywającym ponad  $\frac{2}{3}$  powierzchni”

<sup>12</sup> Usually, the shapes of willow or bay leaves.

The features of leafpoints which are necessary and defined as required in order for the form to retain its functionality in accordance with the initial concept of the tool's creator include:

- symmetry in vertical axis,
- similar shape of both edges,
- straight profile of side view (tool is not bent)
- tip exposure,
- small thickness (defined individually)<sup>13</sup>,
- acute angle of the edges.

Important but not necessary features include:

- edges sharpness,
- straight profile of both edges,
- tip sharpness,
- slenderness (defined individually)<sup>14</sup>,
- length (defined individually)<sup>15</sup>.

It should be noted that a given artifact can be referred to as a leafpoint when it was formed with the intention of creating a symmetrical tool with an exposed tip, and is characterized by identical, but not necessarily simultaneous (see Vedrovice V gr.I) knapping of both edges. In case the tool lost its crucial features as a result of, e.g. a breakage, it was possible to repair it either through re-exposing the tip, reorienting the tool, or enhancing its symmetry. When the repair was not feasible, the leafpoint could have been made into another tool, e.g. through using one of the edges as a cutting edge and sharpening it. Nonetheless, the recognition of such forms is truly difficult and achievable only when the *chaîne opératoire* shows that earlier knapping stages lead to the formation of a tool different from that obtained at final knapping stages.

## 6.2. Assemblages characteristics

Out of the 272 analysed bifacial artifacts, which were previously numbered to the earliest leafpoint industries, only 20 fulfil the criteria of the above introduced technological leafpoint definition. These include artifacts from Brno Bohunice gr.I, Vedrovice V gr.I and III, Musilievo gr.IV, Kokkinopilos gr.II, Sajóbáony Mész-tető artifact 97.2.1072, and artifact CII\_1116 from Samuilitsa II.

The analysis did not include all the bifacial tools from each individual assemblage. It only pertained to artifacts described in the literature of the subject as leafpoints, forms morphologically close to points, and in some cases, artifacts that could be a reference for the manufacturing process analysis. Thus, on the base of conducted analyses, one cannot conclude about the bifacial tools production technology in each of the analysed assemblages. Only further technological analysis of mentioned assemblages could result in such a description.

---

<sup>13</sup> Feature whose expression varies in different assemblages. No set values shall be adopted in this paper.

<sup>14</sup> See footnote 2.

<sup>15</sup> See footnote 2.

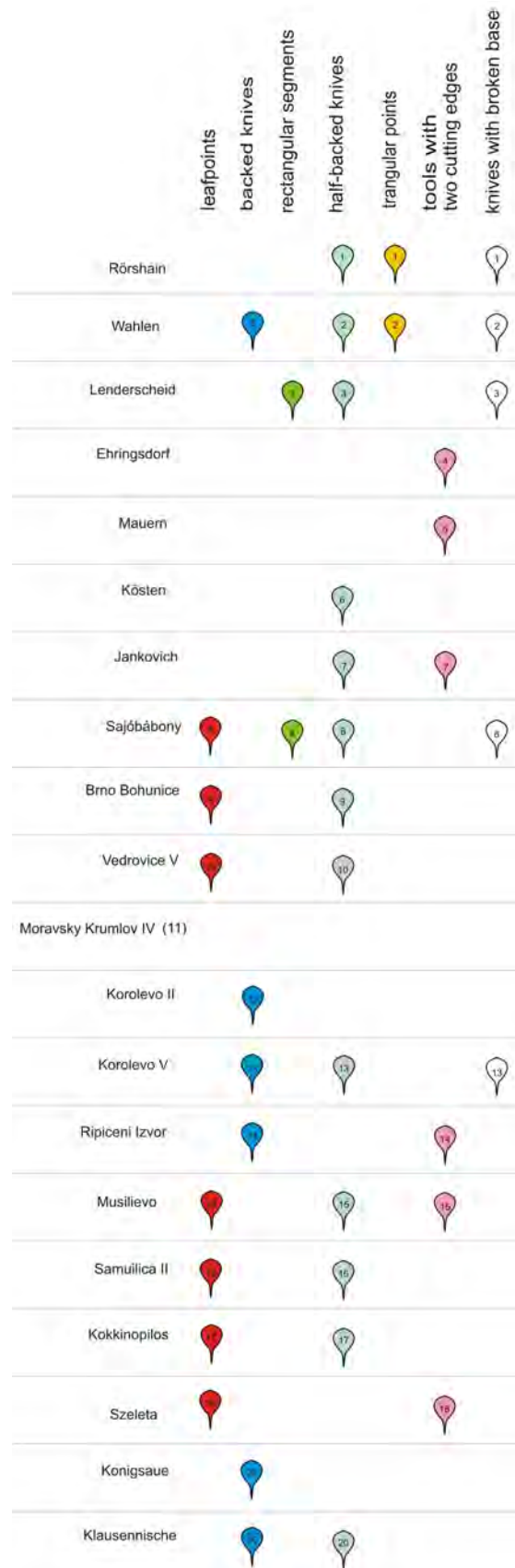


Fig.197 The occurrence of artifact groups on analysed sites. Numbers of sites correspond to numbers on maps.

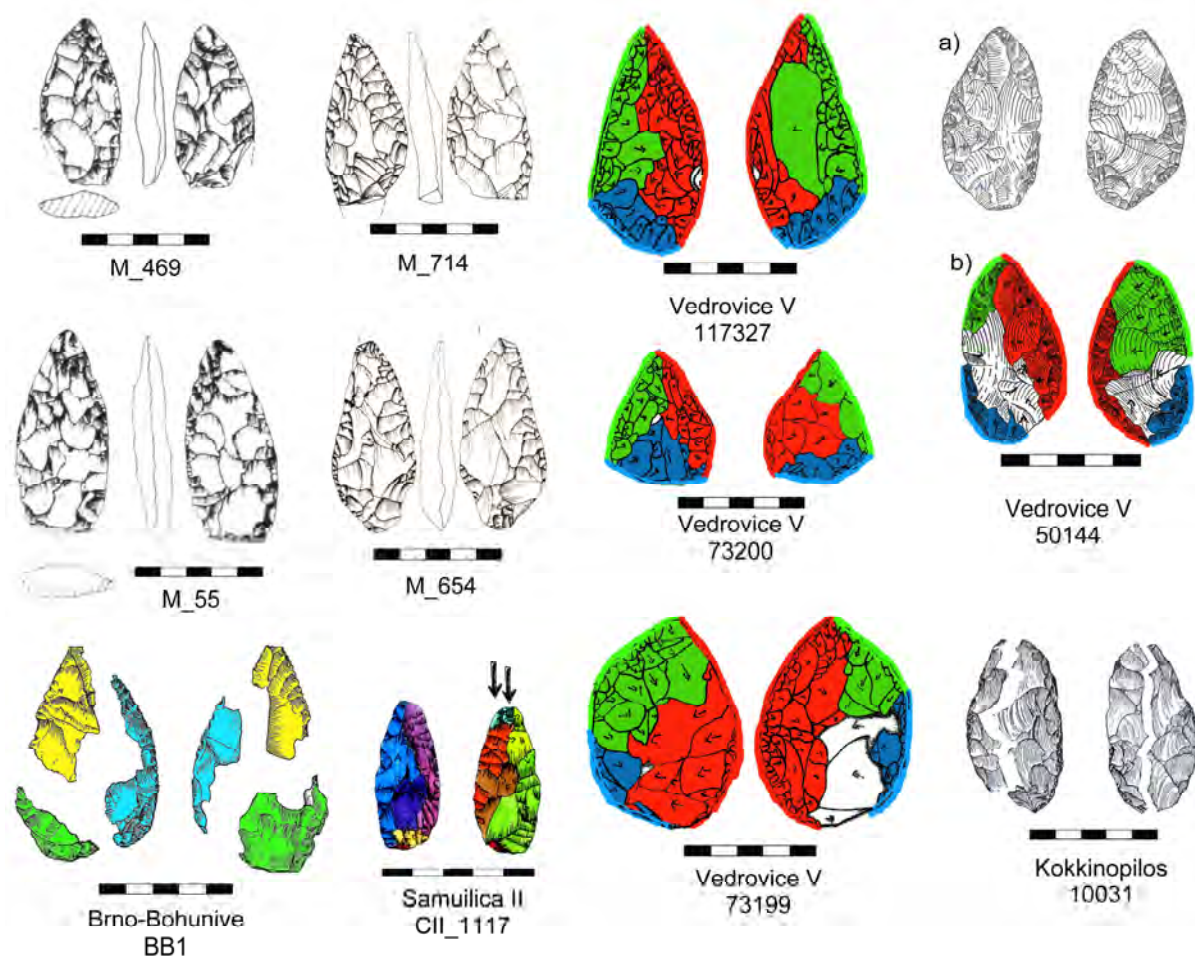


Fig.198 Half-backed knives in assemblages with leafpoints. Artifact 50144 was shown in b) in mirror image in order to show analogies in its body. Proper artifact image is shown in a).

On the basis of analysed artifacts, it can be concluded that leafpoints are accompanied by other bifacial forms (Fig.197). They include such artifacts as thin cutting tools of half-backed knife type (Fig.198) (group I). These artifacts are characterized by specific shape and the occurrence of usually one convex edge and, in most cases, the other being vertical (in some cases even concave), as well as tip exposure. Notches on the edges and near the base, in addition to a small thickness of these artifacts, suggest that such artifacts were hafted (Fig.74, 91, 132, 134). From the perspective of the mentioned assemblages' technological cohesion, it is noteworthy that all the inventories referred to (with the exception of Vedrovice V and Sajóbáony Mész-tető) show significant occurrence of the Levallois technique.

It might be the case that the above mentioned elements, i.e. the production of leafpoints, the occurrence of thin bifacial tools, and the usage of the Levallois technique, should be treated as these inventories distinctive features. If these features are adopted as distinctive, then it might be the case that the artifacts from Jankovich should be included. This is because of the presence of thin bifacial knives of similar morphology in the inventory, as well as the types of repairs in the near-the-tip parts, and also the presence of Levallois technique. Unfortunately, access to the entire Jankovich tools' collection was limited, as the most symmetrical of these forms are on permanent exhibition in the Hungarian National Museum in Budapest. Hence, it might be assumed that absence of leafpoints in the analysed sample results from the fact that only forms of lesser symmetry were analysed; yet, the presence of leafpoints in the Jankovich inventory cannot be ruled out.



There are also several differences between the analysed inventories. One of the most prominent is the presence of Upper Palaeolithic elements in the form of single Upper Palaeolithic tools i.e. endscrapers and burins in the inventories from Vedrovice V. These elements are not present on other analysed sites with leafpoints. Also, the usage of Levallois technique in the inventory from Vedrovice V is very limited. There is, nonetheless, the dominance of specific single platform flake cores' exploitation (Nerudová, 2000). The Vedrovice V assemblage resembles, then, to an extent greater than the other analysed ones, the later Szeletian assemblages.



*Fig.199. Map showing the location of sites with leafpoints. 8. Sajóbábony Mész-tető, 9. Brno Bohunice, 10. Vedrovice V, 15. Musilievo, 16. Samuilitsa cave II, 17. Kokkinopilos.*

### 6.3. Leafpoints sites' location

By examining the geographical location (Fig.199) of six sites where the analysed leafpoints were found, it becomes apparent that they are located in two concentrations. One of these concentrations is located in the Moravia area and Bükk Mountains in the present-day Czech Republic and Hungary, and includes the sites: Brno-Bohunice, Vedrovice V and Sajóbábony Mész-tető. This region also includes such caves as Jankovich and Szeleta. The other concentration is in the area of Balkans, i.e. the Musilievo, Samuilitsa II and Kokkinopilos sites.

## 6.4. Leafpoints sites' chronology

The chronology of the discussed sites is, to a certain extent, problematic. The most difficult is the dating of inventories from Kokkinopilos. Artifacts from Zone B of this site, which includes all the analysed samples of bifacial tools, are dated to OIS 7. In the whole collection of Kokkinopilos, eight bifacially worked tools were found and analysed. Additionally, this collection includes three massive hand axes, which it was not possible to access. The analysed forms include only four leafpoints, one of which is a broken tool. Only this broken fragment comes directly from an in situ layer of Higgs excavation (3638). The other tools were found on the surface in the 60s by Higgs during his research (Runnels & Van Andel, 1993; Tourloukis, 2009; Dakaris, Higgs & Hey, 1964; Higgs & Vita-Finzi, 1966). Hence, their dating and stratum attribution dated to 250 kya BP, and especially the co-occurrence with massive hand axe forms, should be treated with caution.

Two Bulgarian sites (Musilievo and Samuilitsa II) were dated by Madeyska and Chmielewski to Brørup Interstadial (OIS 5c) (Chmielewski, 1977 p. 109). Haesaerts was, however, more inclined to date the layer with limestone rubble, in which artifacts from the Musilievo site occurred, to a cold period of the end of Lower Pleniglacial (OIS 4) (Haesaerts & Sirakova, 1979). This was additionally supported by a C14 date  $40,075 \pm 911$  cal BP<sup>16</sup> for the overlying layer F.D. and a C14 date  $46,504 \pm 1659$  cal BP<sup>17</sup> from Samuilitsa II stratum, containing leafpoints (Sirakov, 1979).

The Moravian inventories (Brno Bohunice, Vedrovice V), on the basis of C14 dating, are dated to Moershoofd–Oerel/Glinde Interstadials. Dates for Brno Bohunice can be estimated within 36,380–48,749 cal BP<sup>18</sup> (Valoch, 1976; Nejman et al., 2011), and for Vedrovice V within 38,791–45,174 cal BP (Valoch, 1993). Moreover, this dating of Brno Bohunice was supported by OSL and TL results stratum 4 was dated by TL as  $47.3 \pm 7.3$  and  $48.2 \pm 1.9$  kya BP (D. Richter, Tostevin & Škrdla, 2008; Valoch, Nerudová & Neruda, 2000) and by OSL within  $38.30 \pm 3.0$ – $52.89 \pm 3.81$  kya BP (Nejman et al., 2011; D. Richter et al., 2009; D. Richter, Tostevin & Škrdla, 2008).

Recent OSL dating results for Vedrovice V are slightly older than the dates from C14 dating. From the layer which contained stone artifacts, the following dates have been received: from the top of archaeological layer the date of  $60.28 \pm 3.42$  kya BP, and the date of  $102.10 \pm 6.79$  kya BP from the bottom (Nejman et al., 2011). Also, Moravský Krumlov IV has OSL dating, which is slightly older than the previous C14 dating. The OSL dating resulted in the dates:  $43.6 \pm 3.3$  and  $64.6 \pm 7.0$  kya BP and C14 dating resulted in  $41,818 \pm 299$  cal BP and  $42,585 \pm 377$  cal BP. The OSL dating suggests that there is the possibility of widening the dating of assemblages to the Lower Pleniglacial (OIS 4) and maybe Early Vistulian OIS 5d–a. Especially noteworthy is the discrepancy in Vedrovice V dates, as there is a 40,000 years difference between the OSL dating of top and bottom within an archaeological layer of 30cm in thickness. Thus, especially the date received from the bottom, i.e.  $102.1 \pm 6.79$  kya BP, should be approached with caution.

So far, the assemblage from Sajóbáony Mész-tető has only been dated indirectly. The layer below the archaeological horizon was TL dated to:  $173.0 \pm 14.2$  kya BP and  $157.9 \pm 7.0$  kya BP. The paleosol located in the geological profile near the site received the dates of  $85.3 \pm 7.0$  kya BP and  $101.4 \pm 9.0$  kya BP. Based on these dates, Ringer (Ringer &

---

<sup>16</sup>  $35,100 \pm 500$  uncal BP—all the dates were calibrated with the help of CalPal\_2007\_HULU curve.

<sup>17</sup>  $42,780 \pm 1270$  uncal BP

<sup>18</sup> Single standard deviation.

Adams, 2000; Ringer, 2001; Ringer, 2000), who examined the site, is inclined to date this inventory to the Eemian Interglacial, or Early Vistulian.

A characteristic feature of the inventory from Sajóbáony is the occurrence of artifacts with a broken base, and also the occurrence of rectangular segments, which bear traces of deliberate shaping. Therefore, this inventory resembles the collection from Lenderscheid. A characteristic feature of this collection is also the presence of small cutting tools with a base formed by transversal breakage, as well as rectangular segments. Since the Lenderscheid site is a surface site, its chronology cannot be discerned.

In conclusion, two alternative hypotheses for dating the earliest inventories with leafpoints can be formulated.

The first one, which takes into account all available and recognized sources and datings, would suggest that the concept of leafpoints was a long lasting one, and its origins were quite early (Kokkinopilos–OIS 7), that it was present during the Eemian Interglacial and the early stages of Vistulian (Sajóbáony, Vedrovice V–OSL dates), and was also present until the early stages of Middle Pleniglacial (OIS 3).

However, critical dating analysis enables to narrow down the dating of inventories containing leafpoints. It can be assumed that the dating of surface inventories from Kokkinopilos is not certain, especially in view of the fact that, although the collection from this site is impressive, it contains a relatively small number of bifacial forms. Also, the dating of assemblages from Sajóbáony Mész-tető is based only on indirect data. The layer containing flint inventories is yet to be dated. The OSL dates from Vedrovice V, which suggest the prolongation of leafpoints' tradition until the Early Vistulian, do not correlate with the C14 dates. Especially the oldest of these is questionable, in the light of other OSL dates for sites in the same region (Nejman et al., 2011). If these tree reservations are adopted, the development of inventories with leafpoints should be located in the late stages of OIS 4 and the early stages of OIS 3–Oerel/Glinde and Moershoofd Interstadials. With this assumption taken into consideration, it can be concluded that the Bulgarian inventories would be slightly older than the Moravian inventories. This is probably the result of considerable climate cooling during the Lower Pleniglacial (OIS 4) in Moravia and the Carpathian Basin.

The second of the presented dating hypotheses for early assemblages with leafpoints seems to be more convincing.

The problem of bifacial leafpoints is, of course, much broader than the scope of this analysis. This paper presents only the analysis of the earliest assemblages containing this group of tools. The leafpoints themselves are the most characteristic for so-called transitional Middle to Upper Palaeolithic leafpoints' industries, such as the Szeletian (Allsworth-Jones, 1986), or Ranis–Jerzmanowician (Flas, 2011; Chmielewski, 1961). In recent years, however, the consistency and also the dating of assemblages, especially the Szeleta assemblages, has been brought under questioning. The reason for this are the verification studies conducted in the eponymous Szeleta cave (Ringer & Mester, 2000). Some researchers are inclined to broaden the dating of these assemblages to even 22 kya BP (Lengyel & Mester, 2008). Only further comparative analysis would yield the answer to the question of continuity between the earliest (studied in this paper) and “classical”–transitional leafpoint assemblages. Czech researchers (Neruda & Nerudová, 2009; Neruda, 2008; Valoch, 1990; Valoch, 1968; Valoch, 1969; Oliva, 1995; Oliva, 1991), among others, point to this possibility, and include the inventories from Vedrovice V and Moravský Krumlov IV in the early Szeletian (Neruda & Nerudová, 2009).



*Fig.200 Map showing the location of sites, where the technique of intentional transversal artifacts breakage was used. The presence of half-backed knives is marked in red, of knives with broken base in green, of rectangular segments in blue and of triangular bifaces in yellow. 1. Rörshain, 2. Wahlen, 3. Lenderscheid, 8 Sajóbáony, 13. Korolevo V.*

## 6.5. Assemblages with intentionally broken tools

Owing to the research-underlying concept, the analyses were limited to leafpoints only. Thus, the gained results cannot serve as a basis for full description of assemblages with leafpoints, and especially for those that, as the analysis proved, do not contain leafpoints.

Forms that were until now referred to as leafpoints are in their majority bifacial backed knives. At further research stages, these inventories should be analysed in the context of all assemblages with bifacial knives. However, such analysis is beyond the scope of this work.

In the text below, some attention will be devoted to one group of inventories under particular interest. More precisely, it is the group of inventories where the technique of artifacts' intentional transversal breaking, in order to create the base or back, was used. The analysis proved that a number of artifacts that had previously been described in the literature of the subject as fragments of leafpoints, were actually final, finished tools, which were broken intentionally during their manufacturing process. These tools are, firstly, knives with their base formed by transversal breakage (Sajóbáony, Wahlen, Lenderscheid, Rörshain,



Korolevo V), secondly, rectangular segments with transversal breakage at both ends (Sajóbábony, Lenderscheid), thirdly, triangular, symmetrical bifaces with transverse base surface formed by breakage (Rörshain, Wahlen) (Fig.115, 125).

As this subject is of marginal importance to the elaboration, the analysis of other assemblages containing tools that were manufactured using the intentional breakage technique, was not conducted. However, the presence of such elements in the Middle Palaeolithic is noteworthy. It is also significant that these artifacts usually occur in several types in a given inventory (Fig.200). This suggests a wide usage of the intentional breakage technique in a particular inventory. It should also be underlined that in Germany these inventories form a very dense group (Fig.200) located in Hesse (Rörshain, Lenderscheid, Wahlen). As far as the technological aspect is concerned, the artifacts from Sajóbábony Mész-tető are very similar to the forms from Lenderscheid. Both sites include knives with bases formed by transversal breakage and rectangular segments. Although, as it was proven, the Hessian artifacts do not have leafpoints among them.

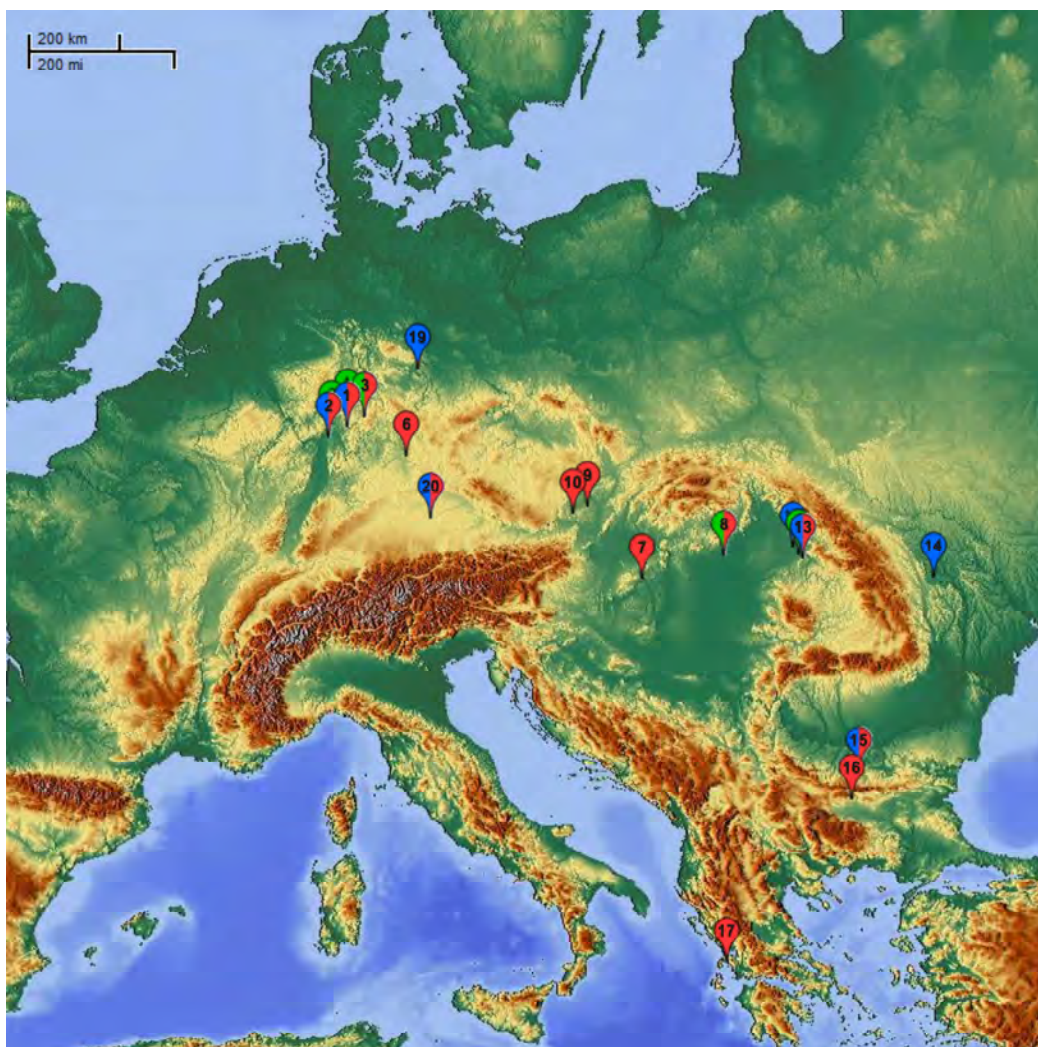


Fig.201 Map showing the location of sites with knives. The presence of backed knives is marked in blue, of half-backed knives in red, of knives with broken base in green. 1. Rörshain, 2. Wahlen, 3. Lenderscheid, 6. Kösten, 7. Jankovich, 8. Sajóbábony Mész-tető, 9. Brno Bohunice, 10. Vedrovice V, 12. Korolevo II, 13. Korolevo V, 14. Ripiceni Izvor, 15. Musilievo, 16. Samuilitsa cave II, 17. Kokkinopilos, 19. Königsau, 20. Klausennische.



## 6.6. Leafpoints versus backed knives

The results of these analyses only enable to state that a leafpoint exhibits a different mental tool template than a knife. The whole manufacturing process of these tools differed because of its different aims.

A thorough analysis of assemblages with both types of tools was not subject to this paper and should be treated as a further step in the said inventories' study. The results of conducted analyses, however, show that leafpoints are absent from the assemblages with backed knives (Fig.197). A characteristic feature of assemblages with backed knives is the usual lack of Levallois technique (Boëda, 1995; J. Richter, 1997; Kozłowski, 2003 Fig.156; Foltyn, Kozłowski & Waga, 2010 Fig.16).

It is also noteworthy that such results weaken the hypothesis which suggested that leafpoints stem from assemblages with backed knives, and from those mentioned, e.g. the assemblages from Rörshain, as inventories of a transitional character between knife and leafpoint production (Bosinski, 1967). The conducted analysis does not provide bases for determining the connections between assemblages with leafpoints and backed knives. On the basis of particular inventories' dating, it can only be concluded that both types of assemblages existed simultaneously in OIS 3. Only further comparative analyses will enable a more detailed determination of possible relationships, and will maybe even yield an answer to the question of whether it is justified to refer to assemblages with leafpoints as quite separate unit.

It might be the case that the difference between assemblages with leafpoints and those with backed knives should be defined from a different perspective. It is noteworthy that tools occurring in assemblages with backed knives are massive forms, and it can be assumed that they were used in bare hand, and were not hafted (Jöris, 2006; Urbanowski, 2004). These tools are accompanied by artifacts which were intentionally broken (Fig.201). Those broken tools, although extremely rarely, do sometimes include symmetrical tools in the form of triangular bifaces with a base formed by transversal breakage (Wahlen, Rörshain). Such tools could be used in bare hand, as well as in hafts.

On the other hand, in the inventories which include leafpoints, the said points are accompanied by knives, which usually have a system of notches, that might suggest hafting (Fig.197). Also, the thinning of these forms near the base might suggest that they were hafted. Bifacial artifacts accompany other tool forms. This includes Levallois points, which, as it can be presumed, were also hafted.

Thus, it might be the case that the differences between these two types of inventories could be differentiated by the following functional feature: whether the tool was manufactured in order to be used in bare hand or in haft. This hypothesis, however, calls for a thorough and coherent technological analysis of inventories with leafpoints, as well as inventories with backed knives. This question exceeds the scope of this paper.

One of the postulates formulated in this study is the narrowing of leafpoint definition. Until now, this term was used in a sense which was too broad. This led to obtaining a wide range of inventories "with leafpoints". The technological analysis of forms that were referred to as leafpoints proved that most of the analysed artifacts have edges manufactured differently and exhibit differences in the way they were used and repaired during the whole reduction sequence. The symmetry of such forms is often a side-effect, and not the aim of

manufacturing process. These tools, however, do meet all the criteria of cutting tools in the form of bifacial backed knives with one subsequently retouched and repaired/resharpened cutting edge, and with a set scheme of repairs aimed at preventing the tool's blunting.

As far as the technological aspect is concerned, only a small number of the analysed artifacts exhibit a coherent manufacturing concept of symmetrical tool, with two identically formed edges, which are convergent at the exposed tip. Both edges are treated identically, while the most important elements of manufacturing process included: symmetry in vertical axis, maximum tool thinning, and tip exposure. These tools do not bear signs of repairing by edges' resharpening. As far as the technological aspect is concerned, only such tools should be referred to as 'leafpoints'.

The earliest assemblages which include leafpoints can be dated to the end of the Lower Pleniglacial (OIS 4) and the beginning of Middle Pleniglacial (OIS 3). The earliest inventories in Central Europe include the Musilievo and Samuilitsa II sites. Leafpoints occur on these sites in the context of Levallois technique. Also, in assemblages from Brno Bohunice, which are dated later, to the beginning of OIS 3, leafpoints are accompanied by Levallois technique, which provides an intriguing basis for further research of this subject.

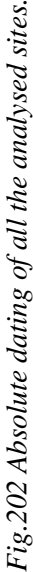
The presented results are only a starting point for further analyses. As the dating of surface sites with leafpoints, such as the Bavarian (Albersdorf, Zeitlarn, Langenchardt), or Ukrainian (Rykhta) collections, is not certain, they were not included in this paper.

Looking at this project from the perspective of four years, it is noteworthy that its first aim was to analyse the technological diversification of the oldest leafpoints in Central and Southern Europe. It was only during further analysis that it became apparent that most of the analysed specimens do not have the essential features which would classify them, from a technological point of view, as leafpoints. Thus, partial study reformulation was necessary. This led to the idea of creating a new leafpoint definition, which would in turn correspond to a coherent concept of forming a particular artifacts' group. Already after the analysis of leafpoints from Szeleta, knives from Klausennische and Königsau, as well as their comparison to key analysed artifact samples, technological indicators and the frame for the analysed artifacts group were created. As at that point the project was already quite advanced, the second analysis of materials was not possible. Therefore, the concept of full analysis of all bifacial forms in assemblages with leafpoints was abandoned. Such research should be treated as a natural continuation of this study.

The most important results of the study are presented below:

- definition of leafpoints used so far is too broad and should include the technological aspect,
- suggestion to specify the definition of the term "leafpoint", which would include the technological aspect that was introduced in the results (Chapter 4.3),
- leafpoints defined in such a way only occur in 6 out of 16 analysed inventories,
- leafpoints do not occur on the sites with backed knives,
- leafpoints are accompanied by half-backed knives,
- leafpoints are usually accompanied by the use of Levallois technique,
- earliest assemblages with leafpoints can be dated to the Lower Pleniglacial (OIS 4) and the beginning of Middle Pleniglacial (OIS 3).





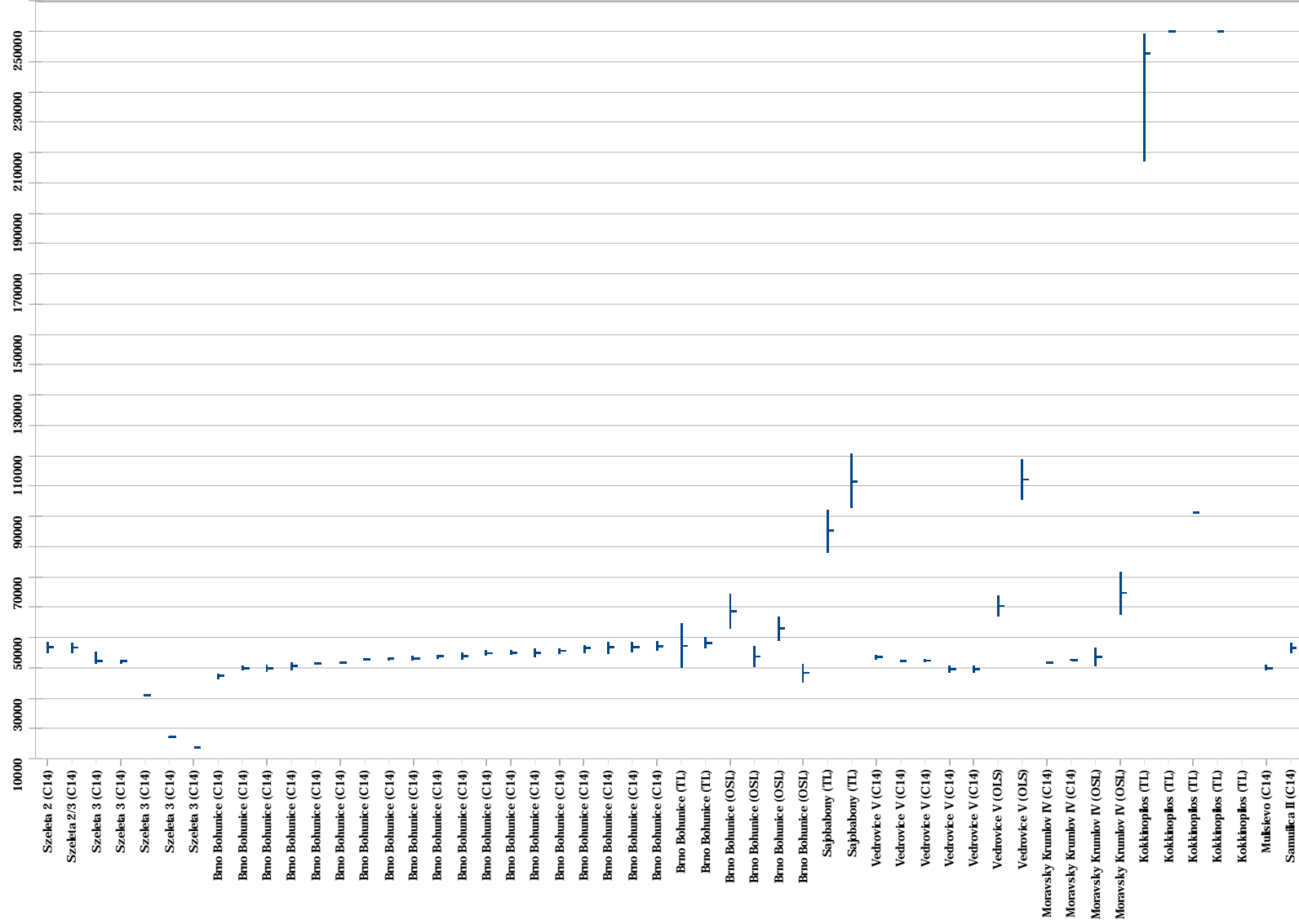


Fig.203 Absolute dating of sites with leadpoints.



# BIBLIOGRAPHY

- ABEL, W. 1936. Ein menschlicher Milchschnidezahn aus der Klausenhöhle (Niederbayern). *Zeitschrift für Ethnologie*. **68**, pp. 256–259.
- ADAMS, B. 1998. *The Middle to Upper Paleolithic Transition in Central Europe. The record from the Bükk Mountain region* BAR IS 693. Oxford: Archaeopress.
- ADAMS, B. 2007. Gulyas Archaeology: The Szeletian and the Middle to Upper Palaeolithic Transition in Hungary and Central Europe. *BAR IS*. **1620**, pp. 91–110.
- ADAMS, B. 2009. The Bükk Mountain Szeletian: Old and New Views on “Transitional” Material from the Eponymous Site of the Szeletian. In: M. CAMPS and P. CHAUHAN, eds. *Sourcebook of Paleolithic Transitions*. New York: Springer New York, pp. 427–440.
- ADAMS, B. and Á. RINGER 2004. New C14 Dates for the Hungarian Early Upper Palaeolithic. *Current Anthropology*. **45** (4), pp. 542–551.
- ALLSWORTH-JONES, P. 1986. *The Szeletian and the transition from Middle to Upper Palaeolithic in central Europe*. Oxford: Clarendon Press.
- ALLSWORTH-JONES, P. 1990. The Szeletian and the Stratigraphic Succession in Central Europe and Adjacent Areas : Main Trends , Recent Results , and Problems for Resolution. In: P. MELLARS, ed. *The Emergence of Modern Humans: an Archaeological perspective*. Edinburgh: Edinburgh University Press, pp. 160–242.
- ANDREE, J. 1939. *Der Eiszeitliche Mensch in Deutschland und seine Kulturen*. Stuttgart: Verlag von Ferdinand Enke.
- ARCHER, W. and D.R. BRAUN 2010. Variability in bifacial technology at Elandsfontein, Western cape, South Africa: a geometric morphometric approach. *Journal of Archaeological Science*. **37** (1), pp. 201–209.
- BAILEY, G., V. PAPACONSTANTINO and D. STURDY 1992. Asprochaliko and Kokkinopilos: TL Dating and Reinterpretation of Middle Palaeolithic Sites in Epirus, North-West Greece. *Cambridge Archaeological Journal*. **2** (01), pp. 136–144.
- BAR-YOSEF, O. 2006. Defining the Aurignacian. In: O. BAR-YOSEF and J. ZILHÃO, eds. *Towards a Definition of the Aurignacian.*, pp. 11–18.
- BAR-YOSEF, O. and P. VAN PEER 2009. The Chaîne Opératoire Approach in Middle Paleolithic Archaeology. *Current Anthropology*. **50** (1), pp. 103–131.
- BEHM-BLANCKE, G. 1960. *Altsteinzeitliche Rastplätze im Travertingebiet von Taubach, Weimar, Ehringsdorf*. Weimar: H. Böhlau.

- BEHM-BLANCKE, G. 1967. Zur Datierung der altsteinzeitlichen Artefakte von Ehringsdorf bei Weimar. *Ausgrabungen und Funde*. **12**, pp. 247–251.
- BIRKNER, F. 1914. Der Eiszeitmensch in Bayern. *Beiträge zur Anthropologie und Urgeschichte Bayerns*. **19** (3-4), pp. 105–134.
- BIRKNER, F. 1916. Die eiszeitliche Besiedlung des Schulerloches und des unteren Altmühltals. In: *Abhandlungen der Bayerischen Akademie der Wissenschaften, Mathematisch-Physikalische Klasse* 28 (5). München: Franz in Komm.
- BIRKNER, F. 1929. Die paläolithische Siedlung von Kösten bei Lichtenfels a. M. und das Solutréen im schwäbisch-fränkischen Jura. *Zeitschrift für Ethnologie*. **69** (1/3), pp. 223–226.
- BLACKWELL, B. a B. and H.P. SCHWARCZ 1986. U-series analyses of the Lower Travertine at Ehringsdorf, DDR. *Quaternary Research*. **25** (2), pp. 215–222.
- BOËDA, É. 1995. Caractéristiques techniques des chaînes opératoires lithiques des niveaux micoquiens de Külna (Tchécoslovaquie). In: *Les industries à pointes foliacées d'Europe centrale, Actes du Colloque de Miskolc, 10-15 septembre 1991. Paléo, supplément.1*. Liège: Université de Liège, pp. 57–72.
- BOËDA, É. 2001. Détermination des unités techno-fonctionnelles de pièces bifaciales provenant de la couche acheuléenne C'3 base du site de Barbas I. In: D. CLIQUET, ed. *Les industries à outils bifaciaux du Paléolithique moyen d'Europe occidentale. Actes de la table-ronde internationale organisée à Caen (Basse-Normandie - France) - 14 et 15 octobre 1999. Liège, ERAUL*. 98. Liège: Université de Liège, pp. 51–75.
- BOHMERS, A. 1939. Die Ausgrabungen in den Höhlen von Mauern. *Germanien*. **4**, pp. 151–156.
- BOHMERS, A. 1951. Die Höhlen von Mauern. *Palaeohistoria*. **1**, pp. 1–107.
- BOLUS, M. 2004. Settlement analysis of sites of the Blattspitzen complex in central Europe. In: N. J. CONARD, ed. *Settlement Dynamics of the Middle Paleolithic and Middle Stone Age II*. Tübingen: Kerns Verlag, pp. 201–226.
- BOSINSKI, G. 1967. *Die mittelpaläolithischen Funde im westlichen Mitteleuropa*. Cologne-Graz: Böhlau-Verlag.
- BOSINSKI, G. 1973. Der Mittelpaläolithische Fundplatz Rörshain, Stadtkreis Schwalmstadt (Hessen). *Archäologische Informationen*. **2-3**, pp. 27–28.
- BRIDGLAND, D.R. et al. 2004. Biostratigraphical correlation between the late Quaternary sequence of the Thames and key fluvial localities in Central Germany. *Proceedings of the Geologists' Association*. **115**, pp. 125–140.
- BRONGER, A. 2003. Correlation of loess–paleosol sequences in East and Central Asia with SE Central Europe: towards a continental Quaternary pedostratigraphy and paleoclimatic history. *Quaternary International*. **106-107**, pp. 11–31.

- BRUNNACKER, K. et al. 1983. Radiometrische Untersuchungen zur Datierung mitteleuropäischer Travertinvorkommen. *Ethnographisch-Archäologische Zeitschrift Berlin*. **24** (2), pp. 217–266.
- CALLAHAN, E. 2006. Neolithic Danish Daggers: an experimental peek. In: J. APEL and K. KNUTSSON, eds. *Skilled Production and Social Reproduction. Aspects on Traditional Stone-Tool Technologies. Proceedings from an International Symposium held in Uppsala August 20 – 24, 2003*. Uppsala: Societas Archaeologica Upsaliensis. SAU Stone Studies 2, pp. 115–137.
- CAMPEN, I. and J. HAHN 1973. Eine Grabung auf dem mittelpaläolithischen Fundplatz Rörshain, Kreis Ziegenhain. *Fundberichte aus Hessen Wiesbaden*. **13**, pp. 75–85.
- CAMPEN, I. and J. HAHN 1975. Die vierte Untersuchung des mittelpaläolithischen Fundplatzes Rörshain, Gemeinde Schwalmstadt, Schwalm-Eder-Kreis. *Fundberichte aus Hessen Wiesbaden*. **15**, pp. 9–20.
- CHMIELEWSKI, W. 1961. *Civilisation de Jerzmanowice*. Wrocław, Warszawa, Kraków: Zakład Narodowy im. Ossolińskich.
- CHMIELEWSKI, W. 1977. Chronologia lessów w Muselijewie na podstawie analizy źródeł archeologicznych. *Studia Geologica Polonica*. **52**, pp. 97–113.
- CONARD, N.J. (ed.). 2006. *When Neanderthals and modern humans met*. Tübingen: Tübingen Publications in Prehistory, Kern Verlag.
- COOK, J. et al. 1982. A review of the chronology of the European Middle Pleistocene hominid record. *American Journal of Physical Anthropology*. **25** (S3), pp. 19–65.
- CZIESLA, E. 1989. *Siedlungsdynamik auf steinzeitlichen Fundplätzen methodische Aspekte zur Analyse latenter Strukturen*. Bonn: Holos.
- DAKARIS, S.I., E.S. HIGGS and R.W. HEY 1964. The climate, environment and industries of Stone Age Greece: Part I. *Proceedings of the Prehistoric Society*. **30**, pp. 199–244.
- DARMARK, K. 2010. Measuring skill in the production of bifacial pressure flaked points: a multivariate approach using the flip-test. *Journal of Archaeological Science*. **37** (9), pp. 2308–2315.
- DAVIES, W. and Z. NERUDOVÁ 2009. Moravský Krumlov IV— Its chronological place in a wider arena. In: P. NERUDA and Z. NERUDOVÁ, eds. *Moravský Krumlov IV: vícevrstevná lokalita ze středního a počátku mladého paleolitu na Moravě*, Anthropos. 29. Brno: Moravské Zemské Muzeum, pp. 84–88.
- DEBÉNATH, A. and H.L. DIBBLE 1994. *Handbook of Paleolithic Typology: Lower and middle paleolithic of Europe*. University Museum, University of Pennsylvania.
- DEMIDENKO, Y.E. and V.I. USIK 1995. Sur les critères de reconnaissance de la fabrication in situ des pointes foliacées : l'exemple de Korolevo II. In: *Les industries à pointes*

- foliacées d'Europe centrale, Actes du Colloque de Miskolc, 10-15 septembre 1991. Paléo, supplément.1. Liège: Université de Liège, pp. 213–216.*
- DJINDJIAN, F., J.K. KOZŁOWSKI and F. BAZILE 2003. Europe during the early Upper Paleolithic (40 000–30 000 BP): A synthesis. In: J. ZILHÃO and F. D'ERRICO, eds. *The chronology of the Aurignacian and of the transitional technocomplexes: Dating, stratigraphies, cultural implications*. Lisbon: Instituto Português de Arqueologia, pp. 29–47.
- DOBOSI, V.T. 1988. Ásatás Sajóbáony–Méhéztetőn / Excavations at Sajóbáony–Méhéztető. *Archaeologiai Értesítő*. **112-113**, pp. 226–235.
- DOLAKOVA, N. 2009. Palynologická analýza vzorků z Moravského Krumlova IV. In: P. NERUDA and Z. NERUDOVÁ, eds. *Moravský Krumlov IV: vícevrstevná lokalita ze středního a počátku mladého paleolitu na Moravě, Anthropos. 29*. Brno: Moravske Zemske Muzeum, pp. 49–53.
- DZAMBAZOV, N. 1959. Разкопки в Пещерата Самуилица II (Razkopki w Peshcherata Samuilica II). *АРХЕОЛОГИЯ (Archeologia)*. **1** (1-2), pp. 47–53.
- DZAMBAZOV, N. 1964. Оучвания на палеолитната и мезолитната култура в България (Ouchwanja na Paleolitnata i Mesolitnata Kultura w Bulgarja). *АРХЕОЛОГИЯ (Archeologia)*. **6** (3), pp. 67–73.
- DZAMBAZOV, N. 1967a. Палеолитно находище при с. Муселиево, Плевенски окръг (Paleolitno nahodishte pri s. Muselievo, Plevenski okrug). *АРХЕОЛОГИЯ (Archeologia)*. **10** (2), pp. 54–64.
- DZAMBAZOV, N. 1967b. Les pointes bifaciales dans les grottes Samouilitza I et II et les autres stations du Paléolithique récent en Bulgarie. *Quartär*. **18**, pp. 195–200.
- DZAMBAZOV, N. 1971. Начало на късния палеолит в България (Nachalo na kijnja Paleolit w Bulgarja). *АРХЕОЛОГИЯ (Archeologia)*. **13** (4), pp. 1–16.
- DZAMBAZOV, N. 1981. La grotte de Samuilica II. *Izvestija na Arheologiceskija Institut Sofija*. **36**, pp. 5–62.
- EISENMANN, V. 1991. Les chevaux quaternaires européens (mammalia, perissodactyla) : taille, typologie, biostratigraphie et taxonomie. *Geobios*. **24** (6), pp. 747–759.
- FEUSTEL, R. 1983. Zur zeitlichen und kulturellen Stellung des Paläolithikums von Weimar-Ehringsdorf. *Alt-Thüringen. Jahresschrift des Museums für Ur-und Frühgeschichte Thüringens Weimar*. **19**, pp. 16–42.
- FIEDLER, L. 1994. *Alt- und mittelsteinzeitliche Funde in Hessen*. Stuttgart: Theiss.
- FIEDLER, L. 2006. Spätmittelpaläolithische und frühjungpaläolithische Fundkomplexe mit Blattspitzen in Hessen. *Fundberichte aus Hessen Wiesbaden*. **46/47**, pp. 1–58.

- FIEDLER, L., H. QUEHL and H. SCHLEMMER 1979. Steinzeitliche Funde vom Paläolithikum bis zum Neolithikum aus Wahlen, Gemeinde Kirtorf, Vogelsbergkreis. *Fundberichte aus Hessen Wiesbaden*. **19/20**, pp. 11–43.
- FLAS, D. 2008. *La transition du Paléolithique moyen au supérieur dans la plaine septentrionale de l'Europe*. *Anthropologica et Praehistorica* 119, Bruxelles.
- FLAS, D. 2011. The Middle to Upper Paleolithic transition in Northern Europe: the Lincombian-Ranisian-Jerzmanowician and the issue of acculturation of the last Neanderthals. *World Archaeology*. **43** (4), pp. 605–627.
- FOLTYN, E., J.K. KOZŁOWSKI and J.M. WAGA 2010. Geochronology and environment of the pre-Eemian Middle Palaeolithic in Southern Poland. *Studia Archeologiczne*. **41**, pp. 1–25.
- FRANK, N. 1997. *TIMS Th/U Datierung von Pleistozänen Travertinen*. Ph.D. Thesis. University of Heidelberg.
- FREUND, G. 1952. *Die Blattspitzen des Paläolithikums in Europa*. Bonn: Ludwig Röhrscheid Verlag.
- FREUND, G. 1954. Les industries à pointes foliacées du Paléolithique en Europe centrale (A propos du “Présolutréen”). *Bulletin de la Société préhistorique de France*. **51** (3/4), pp. 183–192.
- FREUND, G. 1987. *Das Paläolithikum der Oberneder-Höhle (Landkreis Kelheim/Donau)*. Bonn: Ludwig Röhrscheid Verlag.
- FREUND, G. 1963. Die ältere und mittlere Steinzeit in Bayern. *Jahresbericht der Bayerischen Bodendenkmalpflege*. **4**, pp. 9–167.
- GINTER, B. and J.K. KOZŁOWSKI 1975. *Techniki obróbki i typologia wyrobów kamiennych paleolitu i mezolitu*. Warszawa: Państwowe Wydawnictwo Naukowe.
- GLADILIN, N.V. 1989. The Korolevo Palaeolithic Site: Research Methods, Stratigraphy. *Anthropologie*. **27** (2-3).
- GLADILIN, N.V. and Y.E. DEMIDENKO 1989. Upper Palaeolithic stone tool complexes from Korolevo. *Anthropologie*. **27** (2-3).
- GLADILIN, N.V. and Y.E. DEMIDENKO 1990. On the origins of Early Upper Paleolithic industries with leaf points in the Carpatho-Balkan region. In: *Feuilles de pierre: les industries à pointes foliacées de Paléolithique supérieur européen: actes du colloque de Cracovie, 1989, ERAUL*. 42. Liège: Université de Liège, pp. 115–124.
- GLADILIN, N.V., V.I. SLITLVYJ and V.I. TKACHENKO 1995. Les premières industries à pointes foliacées en Europe centrale. In: *Les industries à pointes foliacées d'Europe centrale, Actes du Colloque de Miskolc, 10-15 septembre 1991. Paléo, supplément.1*. Liège: Université de Liège, pp. 111–116.



- GRASSKAM, S. 2001. *Roershain*. Master Thesis. Cologne University.
- GROSMAN, L., O. SMIKT and U. SMILANSKY 2008. On the application of 3-D scanning technology for the documentation and typology of lithic artifacts. *Journal of Archaeological Science*. **35** (12), pp. 3101–3110.
- GRÜNBERG, J.M. et al. 1999. Untersuchung der mittelpaläolithischen „Harzreste“ von Königsau, Ldkr. Aschersleben-Staßfurt. *Jahresschrift für Mitteldeutsche Vorgeschichte*. **81**, pp. 7–38.
- GÁBORI, M. 1976. *Les civilisations du paléolithique moyen entre les Alpes et l'Oural*. Budapest: Akadémiai Kiadó.
- GÁBORI-CSÁNK, V. 1993. *Le Jankovichien: Une civilisation paleolithique en Hongrie*. Etudes et Recherches Archéologiques de l'Université de Liège.
- GÁBORI-CSÁNK, V. 1990. Le Jankovichien en Hongrie de l'Ouest. *Paléolithique moyen récent et Paléolithique supérieur ancien en Europe*. Nemours: Musée de Préhistoire d'Ile-de-France. *Mémoires*. **3**, pp. 97–102.
- HAESAERTS, P. et al. 2010. Charcoal and wood remains for radiocarbon dating Upper Pleistocene loess sequences in Eastern Europe and Central Siberia. *Palaeogeography, Palaeoclimatology, Palaeoecology*. **291** (1-2), pp. 106–127.
- HAESAERTS, P. and L. KOULAKOVSKAYA 2006. La sequence pedosedimentaire de Korolevo (Ukraine transcarpatique): contexte chronostratigraphique et chronologique. In: L. KOULAKOVSKAYA, ed. *The European Middle Palaeolithic*. Ukraine, Kyiv: Institute of Archaeology. National Academy of Sciences, pp. 21–37.
- HAESAERTS, P. and S. SIRAKOVA 1979. Le paléolithique moyen à pointes foliacées de Moussellievo (Bulgarie). *Prace Archaeologiczne*. **28**, pp. 36–63.
- HAHN, J. 1977. *Aurignacien, das ältere Jungpaläolithikum in Mittel- und Osteuropa*. Köln; Wien: Böhlaus Verlag.
- HAHN, J. 1990. La technologie des pointes bifaciales de Rörshain et leurs relations avec l'Allemagne du Sud. In: *Feuilles de pierre: les industries à pointes foliacées de Paléolithique supérieur européen: actes du colloque de Cracovie, 1989*, ERAUL. **42**., pp. 79–93.
- HARDAKER, T. and S. DUNN 2005. The Flip Test - a new statistical measure for quantifying symmetry in stone tools. *Antiquity* [online]. **79** (306). Available from: <http://antiquity.ac.uk/projgall/hardaker/> [Accessed September 18, 2012].
- HEINRICH, W.-D. 1981. Zur stratigraphischen Stellung der Wirbeltierfaunen aus den Travertinfundstellen von Weimar-Ehringsdorf und Taubach in Thüringen. *Zeitschrift für geologische Wissenschaften*. **9**, pp. 1031–1055.
- HIGGS, E.S. and C. VITA-FINZI 1966. The climate, environment and industries of Stone Age Greece: Part II. *Proceedings of the Prehistoric Society*. **32**, pp. 1–29.

- HILLEBRAND, J. 1935. *Die ältere Steinzeit Ungarns*. Budapest: Magyar Történeti Múzeum.
- HOPKINSON, T. 2007. *The Middle Palaeolithic leaf points of Europe: ecology, knowledge and scale* BAR IS1663. Oxford: John and Erica Hedges Ltd.
- HORVÁTH, E. 2001. Marker horizons in the loesses of the Carpathian Basin. *Quaternary International*. **76-77** (1), pp. 157–163.
- HÜLLE, W. 1977. *Die Ilsenhöhle unter Burg Ranis in Thüringen*. Stuttgart: G. Fischer.
- HÜLLE, W. 1939. Vorläufige Mitteilung über die altsteinzeitliche Fundstelle Ilsenhöhle unter Burg Ranis, Kreis Ziegenrück. In: J. ANDREE, ed. *Der Eiszeitliche Mensch in Deutschland und seine Kulturen.*, p. 105.
- INIZAN, M. et al. 1999. *Technology and terminology of knapped stone*. Nanterre, CREP.
- IVANOVA, S. and S. SIRAKOVA 1995. Chronology and Cultures of the Bulgarian Palaeolithic. In: D. W. BAILEY, I. PANAIOTOV and S. ALEXANDROV, eds. *Prehistoric Bulgaria*. Prehistory Press, pp. 9–54.
- JÁNOSSY, D. et al. 1957. Forschungen in der Bivakhöhle, Ungarn. *Eiszeitalter und Gegenwart*. **8**, pp. 18–36.
- JÖRIS, O. 2001. *Der spätmittelpaläolithische Fundplatz Buhlen (Grabungen 1966-69) : Stratigraphie, Steinartefakte und Fauna des oberen Fundplatzes*. Bonn: Habelt.
- JÖRIS, O. 2006. Bifacially backed knives (Keilmesser) in the Central European Middle Palaeolithic. In: N. GOREN-INBAR and S. GONEN, eds. *Axe Age: Acheulian Tool-making from Quarry to Discard*. London: Equinox Publishing Limited, pp. 287–310.
- JÖRIS, O. and M. STREET 2008. At the end of the 14C time scale--the Middle to Upper Paleolithic record of western Eurasia. *Journal of human evolution*. **55** (5), pp. 782–802.
- JUNGA, B. 2009. *Blattspitzen, Faustkeile, Keilmesser... Der Hessische Fundplatz Wahlen - Eine Wichtige Quarzlitstatton Mitteleuropas*. Ph.D. Thesis. Marburg University.
- KADIČ, O. 1916. Ergebnisse der Erforschung der Szeletahöhle. *Mitteilungen aus dem Jahrbuch der kgl. Ungarischen Geologischen Reichsanstalt*. **23**, pp. 161–301.
- KAHLKE, H. 1974. *Das Pleistozän von Weimar-Ehringsdorf. Teil II. - Abhandlungen des Zentralen Geologischen Instituts, Paläontologische Abhandlungen*. Berlin: Akademie-Verlag.
- KAMINSKÁ, L., J.K. KOZŁOWSKI and P. ŠKRDLA 1995. New Approach to the Szeletian-Chronology and Cultural Variability. *Eurasian Prehistory*. **8** (1-2), pp. 29–49.
- KOENIGSWALD, W. von. and H.J. MÜLLER-BECK 1975. Das Pleistozän der Weinberghöhlen bei Mauern (Bayern). *Quartär*. **26**, pp. 107–119.

- KOENIGSWALD, W. von., H.J. MÜLLER-BECK and E. PRESSMAR 1974. *Die Archäologie und Paläontologie in den Weinberghöhlen bei Mauern (Bayern) : Grabungen 1937-1967*. Tübingen: Selbstverlag Institut für Urgeschichte.
- KOLFSCHOTEN VAN, T. 1990. *The evolution of the mammal fauna in the Netherlands and the middle Rhine area (Western Germany) during the late middle Pleistocene*. Haarlem, the Netherlands: Rijks Geologische Dienst.
- KOLLER, J., Ursula BAUMER and Dietrich MANIA 2001. Pitch in the Palaeolithic- Investigations of the Middle Palaeolithic “resin remains” from Königsau. In: G. WAGNER and Dietrich MANIA, eds. *Frühe Menschen in Mitteleuropa - Chronologie, Kultur, Umwelt Kolloquium vom 9. bis 11. März 2000 in Heidelberg.*, pp. 99–112.
- KORDOS, L. and Á. RINGER 1991. A magyarországi felső-pleisztocén Arvicolidae-stratigráfiájának klímato- és archeostratigráfiai korrelációja (Climatostratigraphic and archeostratigraphic correlation of Arvicolidae stratigraphy of the Late Pleistocene in Hungary). In: *A Magyar Állami Földtani Intézet évi jelentése az 1989. évről*. Budapest, pp. 524–531.
- KOULAKOVSKAYA, L. 1995. Aspects typologiques des industries micoquiennes : le site de Korolevo en Ukraine. In: *Les industries à pointes foliacées d'Europe centrale, Actes du Colloque de Miskolc, 10-15 septembre 1991. Paléo, supplément.1*. Liège: Université de Liège, pp. 207–211.
- KOULAKOVSKAYA, L. 2001. Le Complexe bifacial à Korolevo (couche II-A). In: *Les industries à outils bifaciaux du Paléolithique moyen d'Europe occidentale. Actes de la table-ronde internationale organisée à Caen (Basse-Normandie - France) - 14 et 15 octobre 1999. Liège, ERAUL. 98*. Liège: Université de Liège, pp. 209–211.
- KOULAKOVSKAYA, L., V.I. USIK and P. HAESAERTS 2010. Early Paleolithic of Korolevo site (Transcarpathia, Ukraine). *Quaternary International*. **223-224**, pp. 116–130.
- KOZŁOWSKI, J.K. 1975. Badania nad przejściem od Środkowego do Górnego Paleolitu na Bałkanach. *Przegląd Archeologiczny*. **23**, pp. 5–48.
- KOZŁOWSKI, J.K. 1988. Problems of continuity and discontinuity between the Middle and Upper Paleolithic of Central Europe. In: H. L. DIBBLE and A. MONTET-WHITE, eds. *Upper Pleistocene prehistory of Western Eurasia. The University Museum*. Philadelphia: University of Pennsylvania, pp. 349–360.
- KOZŁOWSKI, J.K. 1990. Certains aspects techno-morphologiques des pointes foliacées : De la fin du Paléolithique moyen et du début du Paléolithique supérieur en Europe Centrale. In: *Paléolithique moyen récent et Paléolithique supérieur ancien en Europe : Ruptures et transitions : Examen critique des documents archéologiques /Actes du Colloque International de Nemours, 9-10-11 mai 1998.*, pp. 125 – 133.
- KOZŁOWSKI, J.K. 1995. La signification des “outils foliacés”. In: *Les industries à pointes foliacées d'Europe centrale, Actes du Colloque de Miskolc, 10-15 septembre 1991. Paléo, supplément.1*. Liège: Université de Liège, pp. 91–99.

- KOZŁOWSKI, J.K. 2002. La Grande Plaine de l'Europe avant le Tardiglaciaire. In: *Préhistoire de la Grande Plaine du Nord de l'Europe, Actes du Colloque Chaire Francqui interuniversitaire au titre étranger (Université de Liège, 26 juin 2001)*. Liège, ERAUL. 99., pp. 53–65.
- KOZŁOWSKI, J.K. 2003. From Bifaces to Leaf Points. In: M. SORESSI and H. L. DIBBLE, eds. *Multiple Approaches to the Study of Bifacial Technologies*. Philadelphia: University of Pennsylvania Museum of Archaeology and Anthropology, pp. 149–164.
- KOZŁOWSKI, J.K. 2008. Europe, Eastern, Peopling of. *Encyclopedia of Archaeology*, pp. 1211–1215.
- KRETZOI, D. 1977. Die Castor-Reste aus den Travertinen von Taubach bei Weimar. *Quartärpaläontologie*. 2, pp. 389–400.
- LENGYEL, G. and Z. MESTER 2008. A new look at the radiocarbon chronology of the Szeletian in Hungary. *Eurasian Prehistory*. 5 (2), pp. 67–76.
- LENGYEL, G., P. SZOLYÁK and M. PACHER 2009. Szeleta Cave Earliest Occupation Reconsidered. *Praehistoria*. 9-10, pp. 9–20.
- LUTTROP, A. 1955. Altsteinzeitliche Funde im Kreis Ziegenhain. *Germania*. 33 (4), pp. 311–315.
- LUTTROP, A. 1970. Mittelpaläolithische Funde von Rörshain, Kreis Ziegenhain (Hessen). In: K. GRIPP, R. SCHÜTRUMPF and H. SCHWABEDISSEN, eds. *Frühe Menschheit und Umwelt. Teil I, Archäologische Beiträge*. Köln, Wien, pp. 131–133.
- LUTTROP, A. and G. BOSINSKI 1967. Rörshain, Kr. Ziegenhain. *Fundberichte aus Hessen Wiesbaden*. 7, pp. 13–18.
- ŁANCZONT, M. and A. BOGUCKYJ 2007. High-resolution terrestrial archive of the climatic oscillation during Oxygen Isotope Stages 5-2 from the unique loess-paleosol sequence at Kolodiiv (East Carpathian Foreland, Ukraine). *Geological Quarterly*. 51 (2), pp. 105–126.
- MADE VAN DER, J. 2000. A preliminary note on the rhinos from Bilzingsleben. *Praehistoria Thuringica*. 4, pp. 41–64.
- MADE VAN DER, J. 2003. *Megaloceros giganteus* from the Middle Pleistocene of Neumarkt-Nord. *Veröffentlichungen des Landesamtes für Archäologie Sachsen-Anhalt*. 57, pp. 373–378.
- MADEYSKA, T. 1977. Wiek młodszych lessów Bułgarii Północnej w świetle badań geologicznych stanowiska paleolitycznego w Muselijewie. *Studia Geologica Polonica*. 52, pp. 297–314.
- MALLICK, R. and N. FRANK 2002. A new technique for precise uranium-series dating of travertine micro-samples. *Geochimica et cosmochimica Acta*. 66 (24), pp. 4261–4272.

- MANIA, D. 1988. Le Paléolithique ancien et moyen de la région de la Saale et de l'Elbe, Allemagne de l'Est. *L' Anthropologie*. **92** (4), pp. 1051–1091.
- MANIA, Dietrich and M. ALTERMANN 2003. *Die Travertine in Thüringen und im Harzvorland*. Halle (Saale): Institut für Geologische Wissenschaften und Geiseltalmuseum der Martin-Luther-Universität Halle-Wittenberg.
- MANIA, Dietrich and V. TOEPFER 1973. *Königsau : Gliederung, Ökologie und mittelpaläolithische Funde der letzten Eiszeit*. Berlin: Deutscher Verlag der Wissenschaften.
- MCNABB, J., F. BINYON and L. HAZELWOOD 2004. The Large Cutting Tools from the South African Acheulean and the Question of Social Traditions. *Current Anthropology*. **45** (5), pp. 653–677.
- MERTENS, S. 1996. The middle paleolithic in Romania. *Current Anthropology*. **37** (3), pp. 515–521.
- MESTER, Z. 2002. Excavations at Szeleta Cave before 1999: methodology and overview. *Praehistoria*. **3**, pp. 57–78.
- MESTER, Z. 2008. Les outils foliacés de la grotte Jankovich: la renaissance d'un problème ancien. *Praehistoria*. **8-9**, pp. 67–84.
- MESTER, Z. 2010. Technological analysis of Szeletian bifacial points from Szeleta Cave (Hungary). In: L. LONGO, ed. *Integrated methodological approaches to the study of lithic tools. Human Evolution (Firenze)*, pp. 107–123.
- MEYRICK, R.A. and D.C. SCHREVE 2002. *The Quaternary of Central Germany (Thuringia & Surroundings). Field Guide*. London: Quaternary Research Association.
- MIGAL, W. and M. URBANOWSKI 2008. Narzędzia bifacjalne jako wskaźniki chronologiczne? Technologie środkowego paleolitu i wczesnej epoki brązu na przykładzie materiałów ze stanowiska Polany Kolonie II. In: W. BORKOWSKI et al., eds. *Materiały z konferencji w Orońsku "Krzemień Czekoladowy w Pradziejach", 08-10-12.2003, Studia nad gospodarką surowcami krzemiennymi w pradziejach.*, pp. 215–244.
- MONCEL, M.-H. and J. VOISIN 2006. Les « industries de transition » et le mode de spéciation des groupes néandertaliens en Europe entre 40 et 30 ka. *Comptes Rendus Palevol*. **5** (1-2), pp. 183–192.
- NEJMAN, L. et al. 2011. New chronological evidence for the Middle to Upper Palaeolithic transition in the Czech Republic and Slovakia: New optically stimulated luminescence dating results. *Archaeometry*. **53** (5), pp. 1044–1066.
- NERUDA, P. 2000. The cultural significance of the bifacial retouch. The transition from the Middle to Upper Palaeolithic age in Moravia. In: J. ORSCHIEDT; and G.-C. WENIGER, eds. *Neandertahls and Modern Humans - Discussing the Transition: Central and Eastern Europe from 50.000 - 30.000 B.P.* Mettmann: Neanderthal-Museum, pp. 151–158.



- NERUDA, P. 2008. Moravia during OIS 3: Cultural relations. *Praehistoria*. **9-10**, pp. 125–147.
- NERUDA, P. 2009. Stratigrafie sedimentů v Moravském Krumlově IV. In: P. NERUDA and Z. NERUDOVÁ, eds. *Moravský Krumlov IV: vícevrstevná lokalita ze středního a počátku mladého paleolitu na Moravě*, *Anthropos*. 29. Brno: Moravské Zemské Muzeum, pp. 59–83.
- NERUDA, P. and Z. NERUDOVÁ 2009. Postavení lokality Moravský Krumlov IV v kontextu střední Evropy. In: *Moravský Krumlov IV: vícevrstevná lokalita ze středního a počátku mladého paleolitu na Moravě*, *Anthropos*. 29. Brno, pp. 178–213.
- NERUDA, P. and Z. NERUDOVÁ 2005. The development of the production of lithic industry in the Early Upper Palaeolithic of Moravia. *Archeologické rozhledy*. **57** (2), pp. 263–292.
- NERUDA, P. and Z. NERUDOVÁ 2010. Moravský Krumlov IV - A new multilayer Palaeolithic site in Moravia. *Archäologisches Korrespondenzblatt*. **40** (2), pp. 155–174.
- NERUDOVÁ, Z. 2000. Vedrovice V. Szeletská technologie štípané industrie. *Acta Musei Moraviae, Scientiae Sociales*. **85**, pp. 13–28.
- NERUDOVÁ, Z. et al. 2003. Analysis of a burnt clay fragment from the paleolithic site Brno-Bohunice I. *Anthropologie*. **41** (3), pp. 295–301.
- NERUDOVÁ, Z. 2008. Moravský Krumlov IV. : rekonstrukce sídelního areálu. *Acta Musei Moraviae, Scientiae Sociales*. **93**, pp. 39–50.
- NERUDOVÁ, Z. 2010. Způsob výroby listovitých hrotů v szeletieniu. In: Š. UNGERMAN et al., eds. *Zaměřeno na středověk. Zdeňkovi Měřínskému k 60. narozeninám*. Praha: Nakladatelství Lidové noviny, pp. 41–54.
- NERUDOVÁ, Z. and P. NERUDA 2004. Les remontages des gisements szélétiens en Moravie, République Tchèque. *Anthropologie*. **42** (3), pp. 297–309.
- NOVOTHNY, Á. 2002. The loess profile at Albertirsa, Hungary—improvements in loess stratigraphy by luminescence dating. *Quaternary International*. **95-96**, pp. 155–163.
- NOVOTHNY, Á. et al. 2009. Luminescence and amino acid racemization chronology of the loess–paleosol sequence at Süttő, Hungary. *Quaternary International*. **198** (1-2), pp. 62–76.
- NOVÁK, J. 2009. Antrakologická analýza vzorků z Moravského Krumlova IV. In: P. NERUDA and Z. NERUDOVÁ, eds. *Moravský Krumlov IV: vícevrstevná lokalita ze středního a počátku mladého paleolitu na Moravě*, *Anthropos*. 29. Brno: Moravské Zemské Muzeum, pp. 43–48.
- OBERMAIER, H. 1927. *Der skulptierte Rengeweihestab aus der mittleren Klausenhöhle bei Essing (Niederbayern)* Ipek. Klinkhardt & Biermann.

- OBERMAIER, H. and P. WERNERT 1914. Die Klausennische bei Neu-Essing (Niederbayern). *Paläolithbeiträge aus Nordbayern*. **44**, pp. 53–55.
- OBERMAIER, H. and P. WERNERT 1929. Alt-Paläolithikum mit Blatt-Typen. *Mitteilungen der Anthropologischen Gesellschaft in Wien*. **59**, pp. 293–310.
- OCHES, E.A. and W.D. MCCOY 1995. Aminostratigraphic Evaluation of Conflicting Age Estimate for the “Young Loess” of Hungary. *Quaternary Research*. **44**, pp. 160–170.
- OLIVA, M. 1984. Le Bohunicien, un nouveau groupe culturel en Moravie: quelques aspects psycho-technologiques du développement des industries paléolithiques. *L'Anthropologie*. **88** (2), pp. 209–220.
- OLIVA, M. 1991. The Szeletian in Czechoslovakia. *Antiquity*. **65** (247), pp. 318–325.
- OLIVA, M. 1995. Le Szélétien de Tchécoslovaquie : industrie lithique et répartition géographique. In: *Les industries à pointes foliacées d'Europe centrale, Actes du Colloque de Miskolc, 10-15 septembre 1991. Paléo, supplément.1*. Liège: Université de Liège, pp. 83–90.
- ORSCHIEDT, J. and G.C. WENIGER (eds.). 2000. *Neanderthals and Modern Humans – Discussing the Transition: Central and Eastern Europe from 50.000–30.000 B.P.* Mettmann: Neanderthal Museum.
- OTTE, M. 2000. Le passage du Paléolithique moyen au Paléolithique supérieur en Europe centrale et orientale. In: Z. MESTER and Á. RINGER, eds. *À la recherche de l'Homme Préhistorique. Volume commémoratif de Miklos Gábori et Veronika Gábori-Csánk. ERAUL*. 95. Liège: Université de Liège, pp. 41–49.
- PAPAGIANNI, D. 2000. *Middle Palaeolithic occupation and technology in Northwest Greece: the evidence from open-air site BAR IS 882*. Oxford: Archaeopress.
- PAUNESCU, A. 1965. Sur la succession des habitats paléolithiques et postpaléolithiques de Ripiceni-Izvor. *Dacia*. **9**, pp. 5–32.
- PAUNESCU, A. et al. 1976. Considerații arheologice, geocronologice și paleoclimatice privind așezarea Ripiceni-Izvor. *SCIVA*. **27** (1), pp. 5–21.
- PAUNESCU, A. 1993. *Ripiceni-Izvor: paleolitic si mezolitic: studiu monografic*. Bucuresti: Editura Academiei Romane.
- PROŠEK, F. 1953. Szeletien na Slovensku. *Slovenská Archeologia*. **1**, pp. 133–194.
- RICHTER, J. 2008. The Role of Leaf Points in the Late Middle Palaeolithic of Germany. *Praehistoria*. **9-10**, pp. 99–115.
- RICHTER, D. et al. 2000. Thermoluminescence, Electron Spin Resonance and <sup>14</sup>C-dating of the Late Middle and Early Upper Palaeolithic Site of Geißenklosterle Cave in Southern Germany. *Journal of Archaeological Science*. **27**, pp. 71–89.

- RICHTER, D. et al. 2009. New radiometric ages for the Early Upper Palaeolithic type locality of Brno-Bohunice (Czech Republic): comparison of OSL, IRSL, TL and 14C dating results. *Journal of Archaeological Science*. **36** (3), pp. 708–720.
- RICHTER, D., G.B. TOSTEVIN and P. ŠKRDLA 2008. Bohunician technology and thermoluminescence dating of the type locality of Brno-Bohunice (Czech Republic). *Journal of human evolution*. **55** (5), pp. 871–85.
- RICHTER, J. 1997. *Sesselfelsgrotte III : der G-Schichten-Komplex der Sesselfelsgrotte : zum Verständnis des Micoquien*. Saarbrücken: Saarbrücker Druckerei und Verlag.
- RICHTER, J. 2001. Une analyse standardisée des chaînes opératoires sur les pièces foliacées du Paléolithique moyen tardif. In: L. BOURGIGNON, I. ORTEGA and M.-C. FRÈRE-SAUTOT, eds. *Préhistoire et approche expérimentale*., pp. 77–78.
- RINGER, Árpád 1983. *Bábonyien e. mittelpaläolit. Blattwerkzeugindustrie in Nordostungarn*. Budapest: Eötvös Loránd Tudományegyetem Régészeti Intézetéből.
- RINGER, Árpád 1989. L'origine du Szélétien de Bükk en Hongrie et son évolution vers le Paléolithique supérieur. L'état de la recherche actuelle. *Anthropologie*. **27** (2-3), pp. 223–229.
- RINGER, Árpád 1995. Les industries à pièces foliacées en Europe centrale : proposition de synthèse. In: *Les industries à pointes foliacées d'Europe centrale, Actes du Colloque de Miskolc, 10-15 septembre 1991. Paléo, supplément.1*. Liège: Université de Liège, pp. 15–18.
- RINGER, Árpád 2000. Le Complexe techno typologique du Bábonyien-Szélétien de la Hongrie de Nord-Est et le Yabroudien. In: A. RONEN and M. WEINSTEIN-EVRON, eds. *Toward modern humans : the Yabrudian and Micoquian, 400-50 k-years ago : proceedings of a congress held at the University of Haifa, November 3-9, 1996, BAR IS 850*. Oxford, pp. 181–183.
- RINGER, Árpád 2001. Complexe techno-typologique, Bábonyien-Szélétien. In: *Les industries à outils bifaciaux du Paléolithique moyen d'Europe occidentale. Actes de la table-ronde internationale organisée à Caen (Basse-Normandie - France) - 14 et 15 octobre 1999. Liège, ERAUL. 98*. Liège: Université de Liège, pp. 213–220.
- RINGER, Árpád 2002. The Chronostratigraphy and Palaeo-human-ecology of the Middle and Upper Palaeolithic in Northeast Hungary, Between 130,000 and 10,000 BP. *Praehistoria*. **3**, pp. 39–46.
- RINGER, Árpád and B. ADAMS 2000. Sajóbábony-Méhészető, eponymous site of the Middle Palaeolithic Bábonyian industry: microwear studies made on tools found at the site during the 1997 excavation. *Praehistoria*. **1**, pp. 117–128.
- RINGER, Árpád and L. KORDOS 1995. Le complexe babonyien-szeletien en Hongrie du nord-est dans son cadre chronologique et environnemental. In: *Les industries à pointes foliacées d'Europe centrale, Actes du Colloque de Miskolc, 10-15 septembre 1991. Paléo, supplément.1*. Liège: Université de Liège, pp. 27–30.

- RINGER, Árpád and Zsolt MESTER 2000. Résultats de la révision de la grotte Szeleta entreprise en 1999 et 2000. *Anthropologie*. **38** (3), pp. 261–270.
- RINGER, Árpád and P. SZOLYÁK 2004. A Szeleta- barlang tűzhelyeinek és paleolit leleteinek topográfiai és sztratigráfiai eloszlása. Adalékok a leletgyűttes újraértékeléséhez. *Herman Ottó Múzeum Évkönyve*. **43**, pp. 13–32.
- ROCHE, H. and J. TIXIER 1982. Les Accidents de Taillee. *Studia Praehistorica Belgica*. **2**, pp. 65–76.
- ROSSBACH, G. 1913. *Steinzeitliche Siedelungen bei Lichtenfels a. M.* Nürnberg: Nister.
- RUNNELS, C.N. and T.H. VAN ANDEL 1993. A Handaxe from Kokkinopilos, Epirus, and Its Implications for the Paleolithic of Greece. *Journal of Field Archaeology*. **20** (2), pp. 191–203.
- RUNNELS, C.N. and T.H. VAN ANDEL 2003. The Early Stone Age of the Nomos of Preveza: Landscape and Settlement. In: J. WISEMAN and K. ZACHOS, eds. *Landscape archaeology in Southern Epirus, Greece I (Hesperia supplement 32)*. Athens: American School of Classical Studies at Athens, pp. 47–133.
- SCHREVE, D.C. et al. 2002. Sedimentology, palaeontology and archaeology of late Middle Pleistocene River Thames terrace deposits at Purfleet, Essex, UK. *Quaternary Science Reviews*. **21**, pp. 1423–1464.
- SCHWARCZ, H.P. et al. 1988. The Bilzingsleben Archaeological Site: New Dating Evidence. *Archaeometry*. **30** (1), pp. 5–17.
- SCHÄFER, D. 1991. Weimar-Ehringsdorf: Diskussionsstand zur geochronologischen und archäologischen Einordnung sowie aktuelle Aufschlußsituation. *Quartär*. **41-42**, pp. 19–43.
- SCHÄFER, D. et al. 2007. Aspects of the geology, palaeontology and archaeology of the travertine site of Weimar-Ehringsdorf (Thuringia, Central Germany). *Courier Forschungsinstitut Senckenberg*. **259**, pp. 141–148.
- SCHÄFER, D. 2007. Paläotechnik, das Pleistozän von Weimar-Ehringsdorf und der wissenschaftliche Erkenntnisprozess. In: *Archäologische Gesellschaft Thüringen: TERRA PRAEHISTORICA. Festschrift für Klaus-Dieter Jäger zum 70. Geburtstag*. Langenweißbach: Kommissionsverlag Beier u. Beran, pp. 175–201.
- SCHÜLER, T. 2003. ESR dating of a new paleolithic find layer of the travertine site of Weimar-Ehringsdorf (Central Germany). *Terra Nostra*. **2**, pp. 233–235.
- SHACKLETON, N.J., A. BERGER and W.R. PELTIER 1990. An alternative astronomical calibration of the lower Pleistocene timescale based on ODP Site 677. *Transactions of the Royal Society of Edinburgh: Earth Sciences Transactions of the Royal Society of Edinburgh: Earth Sciences*. **81** (4), pp. 251–261.

- SIMÁN, K. 1995. La grotte Szeleta et le Szélétien. In: *Les industries à pointes foliacées d'Europe centrale, Actes du Colloque de Miskolc, 10-15 septembre 1991. Paléo, supplément.1*. Liège: Université de Liège, pp. 37–43.
- SIRAKOV, N. 1979. Analytical study on blanks from the cave Samuilitsa II (an example of application of attribute correlation method). *Prace Archaeologiczne*. **28**, pp. 65–76.
- SIRAKOV, N. 1983. *Reconstruction of the middle palaeolithic flint assemblages from the cave Samuilitsa II (Northern Bulgaria) and their taxonomical position seen against the palaeolithic of South-Eastern Europe*. Folia Quaternaria 55, Kraków: Ossolineum.
- SIRAKOVA, S. and S. IVANOVA 1988. Le site paléolithique près du village Muselievo, département de Pleven. *Studia praehistorica*. **9**, pp. 63–77.
- SIRAKOVA, S. 1990. Leaf-points of Musselievo. In: J. K. KOZŁOWSKI, ed. *Feuilles de pierre: les industries à pointes foliacées de Paléolithique supérieur européen: actes du colloque de Cracovie, 1989, ERAUL*. 42., pp. 189–198.
- SIRAKOVA, S. 2009. Middle Palaeolithic leaf points from Bulgaria. In: N. GACOV, ed. *Saxa Loquuntur: Essays in Honour of Nikolay Sirakov on his 65th Birthday*. Sofia: Abalon, pp. 119–139.
- SMOLÍKOVÁ, L. 2009. Mikromorfologie fosilních půd z Moravského Krumlova IV. In: P. NERUDA and Z. NERUDOVÁ, eds. *Moravský Krumlov IV: vícevrstevná lokalita ze středního a počátku mladého paleolitu na Moravě*, *Anthropos*. 29. Brno: Moravské Zemské Muzeum, pp. 54–58.
- SOERGEL, W. 1926. Exkursion ins Travertingebiet von Ehringsdorf. *Paläontologische Zeitschrift*. **8**, pp. 7–33.
- SOERGEL, W. 1940. Die als Pseudopariser bekannte Einlagerung im Travertinprofil von Ehringsdorf bei Weimar. *Beiträge zur Geologie von Thüringen*. **5**, pp. 269–289.
- SORESSI, Marie, Harold Lewis DIBBLE and J. CLARK 2003. *Multiple approaches to the study of bifacial technologies*. University of Pennsylvania, Museum of Archaeology and Anthropology.
- SORESSI, Marie and M.A. HAYS 2003. Manufacture, transport and use of Mousterian bifaces. A case study from the Perigord (France). In: Marie SORESSI and Harold Lewis DIBBLE, eds. *Multiple approaches to the study of bifacial technologies*. Philadelphia: The University of Pennsylvania Museum Press, pp. 125–147.
- STEINER, W. 1979. *Der Travertin von Ehringsdorf und seine Fossilien*. Wittenberg: Ziemsen.
- STREET, M., T. TERBERGER and J. ORSCHIEDT 2006. A critical review of the German Paleolithic hominin record. *Journal of human evolution* [online]. **51** (6), pp. 551–79. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/17014890>.

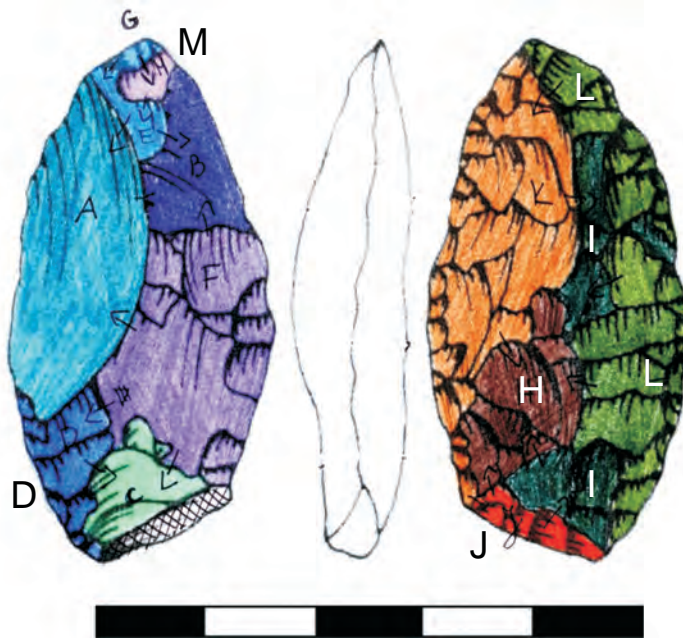


- SVOBODA, J.A. 1983. Raw material sources in Early Upper Paleolithic Moravia. The concept of lithic exploitation areas (Brno). *Anthropologie*. **21**, pp. 147–158.
- SVOBODA, J.A. 1987. Stránská skála: bohunický typ v brněnské kotlině. *Studie Archeologického ústavu Československé akademie věd v Brně*. **82** (1), pp. 5–47.
- SVOBODA, J.A. 2001. La question szélétienne. In: *Les industries à outils bifaciaux du Paléolithique moyen d'Europe occidentale. Actes de la table-ronde internationale organisée à Caen (Basse-Normandie - France) - 14 et 15 octobre 1999. Liège, ERAUL*. 98. Liège: Université de Liège, pp. 221–230.
- SVOBODA, J.A., S. JELINEK and V. LOŽEK 1991. Stránská Skála. Výsledky výzkumu v letech 1985-1987. *Památky archeologické*. **82** (1), pp. 5–47.
- SVOBODA, J.A. 2005. The Neandertal extinction in eastern Central Europe. *Quaternary International*. **137** (1), pp. 69–75.
- SVOBODA, J.A. and H. SVOBODA 1985. Les industries de type Bohunice dans leur cadre stratigraphique et écologique. *L' Anthropologie*. **4**, pp. 505–514.
- SVOBODA, J.A. and P. ŠKRDLA 1995. The Bohunician technology. In: Harold L DIBBLE and O. BAR-YOSEF, eds. *The Definition and Interpretation of Levallois Technology*., pp. 429–438.
- ŠKRDLA, P. 2003. Comparison of Boker Tachtit and Stránská skála MP/UP transitional industries. *Journal of the Israel Prehistoric Society*. **33**, pp. 37–73.
- ŠKRDLA, P. and G.B. TOSTEVIN 2003. Brno. *Přehled výzkumů*. **44**, pp. 188–192.
- ŠKRDLA, P. and G.B. TOSTEVIN 2005. Brno-Bohunice, analysis of the material from the 2002 excavation. *Přehled výzkumů*. **46**, pp. 35–61.
- TOSTEVIN, G.B. 2003. Attribute analysis of the lithic technologies of Stránská skála IIIc and IIId in regional and interregional context. In: J. A. SVOBODA and O. BAR-YOSEF, eds. *Stranska Skala: Origins of the Upper Paleolithic in the Brno Basin Moravia, czech Republic*. Cambridge, Massachusetts: Harvard University Peabody Museum of Archaeology and Ethnology, pp. 77–118.
- TOSTEVIN, G.B. and P. ŠKRDLA 2006. New Excavations at Bohunice and the Question of the Uniqueness of the Type-site for the Bohunician Industrial Type. *Anthropologie*. **44** (1), pp. 31–48.
- TOURLOUKIS, V. 2009. New bifaces from the Palaeolithic site of Kokkinopilos , Greece and their stratigraphic significance. *Antiquity* [online]. **83** (320). Available from: <http://www.antiquity.ac.uk/projgall/tourloukis320/>.
- TOURLOUKIS, V. 2010. *The Early and Middle Pleistocene Archaeological Record of Greece*. Leiden: Archaeological Studies Leiden University 23, Leiden University Press.

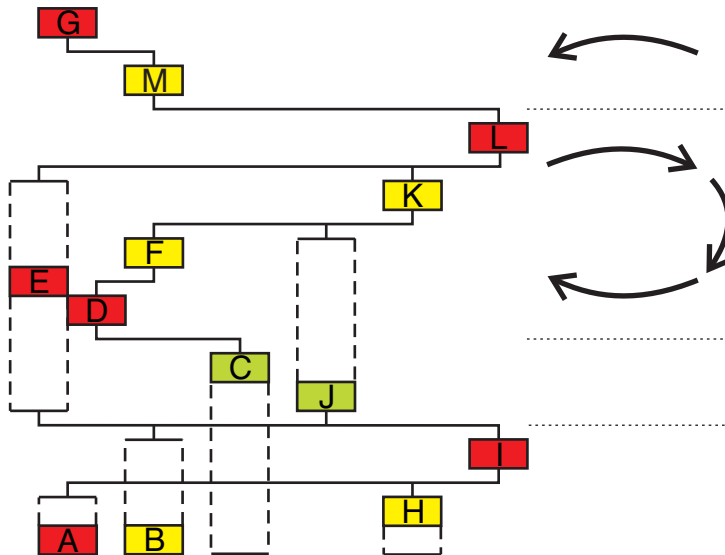
- TOURLOUKIS, V. and P. KARKANAS 2012. The Middle Pleistocene archaeological record of Greece and the role of the Aegean in hominin dispersals: new data and interpretations. *Quaternary Science Reviews*. **43**, pp. 1–15.
- UNDERHILL, D. 2007. Subjectivity Inherent In By-Eye Symmetry Judgements and the Large Cutting Tools at the Cave of Hearths, Limpopo Province, South Africa. *Papers from the Institute of Archaeology*. **18**, pp. 101–113.
- URBANOWSKI, M. 2004. *Pradnik knives as an element of Micoquian techno-stylistic specifics*. Ph.D. Thesis. Warsaw University.
- UTHMEIER, T. 2004. *Micoquien, Aurignacien und Gravettien in Bayern: eine regionale Studie zum Übergang vom Mittel- zum Jungpaläolithikum (Archäologische Berichte)*. Kerpen-Loogh; Bonn: Rudolf Habelt.
- VALOCH, K. 1961. Altpaläolithische Steingeräte aus der Umgebung von Brno, Brünn. *Anthropozoikum*. **11**, pp. 163–184.
- VALOCH, K. 1968. Evolution of the Palaeolithic in Central and Eastern Europe. *Current Anthropology*. **9** (5), pp. 351–390.
- VALOCH, K. 1969. Das Mittelpaläolithikum mit Blattspitzen (Schicht 9b) aus der Höhle Kulna bei Sloup in Mähren. *Acta Musei Moraviae, Scientiae Sociales*. **54-55**, pp. 5–30.
- VALOCH, K. 1976. *Die altsteinzeitliche Fundstelle in Brno-Bohunice*. Praha: Academia.
- VALOCH, K. 1982. Neue paläolitische Funde von Brno-Bohunice. *Acta Musei Moraviae, Scientiae Sociales*. **67**, pp. 31–48.
- VALOCH, K. 1984a. Vyzkum paleolitu ve Vedrovicich V (okr. Znojmo). *Časopis Moravského muzea. Vedy spolecenské*. **69**, pp. 5–22.
- VALOCH, K. 1984b. *Die Grabung auf der paläolithischen Fundstelle Vedrovice V*. Brno: Anthropologie 22.
- VALOCH, K. 1990. La Moravie il y a 40 000 ans. *Mémoires du Musée de Préhistoire d'Ile-de-France*. **3**, pp. 115–124.
- VALOCH, K. 1993. Vedrovice V, eine Siedlung des Szeletien in Südmähren. *Quartär*. **43-44**, pp. 7–93.
- VALOCH, K. 2000. L'histoire de la connaissance et les questions des industries paléolithiques à pointes foliacées sur le territoire de l'ancienne Tchécoslovaquie. *Præhistoria*. **1**, pp. 95–107.
- VALOCH, K. 2008. Brno-Bohunice, eponymous Bohunician site: new data, new ideas. In: Z. SULGOSTOWSKA and A. J. TOMASZEWSKI, eds. *Man–Millennia–Environment: studies in honour of Romuald Schild*. Warsaw: Institute of Archaeology and Ethnology, Polish Academy, pp. 225–236.

- VALOCH, K., Z. NERUDOVIČ and P. NERUDA 2000. Stránská skála III–Ateliers des Bohunicien. *Památky archeologické*. **91** (1), pp. 5–113.
- VLČEK, E. 1993. *Fossile Menschenfunde von Weimar-Ehringsdorf*. Stuttgart: K. Theiss.
- VÉRTES, L. 1955. Paläolithische Kulturen des Würm I/II-Interstadials in Ungarn. *Acta Archaeologica Academiae Scientiarum Hungaricae*. **5**, pp. 261–278.
- VÉRTES, L. 1956. Problematika szeletienü. *Slovenska Archeologia*. **4**, pp. 328–340.
- VÉRTES, L. 1968. Szeleta-Symposium in Ungarn. *Quartär*. **3** (September), pp. 381–391.
- WAGENBRETH, O. and W. STEINER 1974. Zur Feinstratigraphie und Lagerung des Pleistozäns von Eringsdorf bei Weimar. *Abhandlungen des Zentralen Geologischen Instituts*. **21**, pp. 77–156.
- ZDZIEBŁOWSKI, S. 2013. „Wielkie wymieranie” to mit – przekonuje polski paleontolog. *PAP - Nauka w Polsce* [online]. Available from: <http://www.naukawpolsce.pap.pl/aktualnosci/news,393904,wielkie-wymieranie-to-mit--przekonuje-polski-paleontolog.html> [Accessed February 15, 2013].
- ZHOU, L. and A. LANG 2000. A Luminescence Dating Study of Open-Air Palaeolithic Sites in Western Epirus, Greece. *Journal of Archaeological Science*. **27** (7), pp. 609–620.
- ZOTZ, L. 1951. *Altsteinzeitkunde Mitteleuropas*. Stuttgart: F. Enke Verlag.
- ZOTZ, L. 1955. *Das Paläolithikum in den Weinberghöhlen bei Mauern*. Bonn: L. Röhrscheid Verlag.
- ZOTZ, L. 1959a. *Kösten, ein Werkplatz des Praesolutréen in Oberfranken*. Bonn: L. Röhrscheid Verlag.
- ZOTZ, L. 1959b. Noch eine Blattspitze von Mauern, Ldkr. Neuburg a. d. D. *Bayerische Vorgeschichtsblätter*. **24**, pp. 78–79.

# Plate 1 Musilievo M.42



Symmetrical tool made on a flake with cortical base, poorly exposed tip and no traces of intensive rejuvenation. One of edges is straight in profile; the other is slightly more S-shaped in profile.

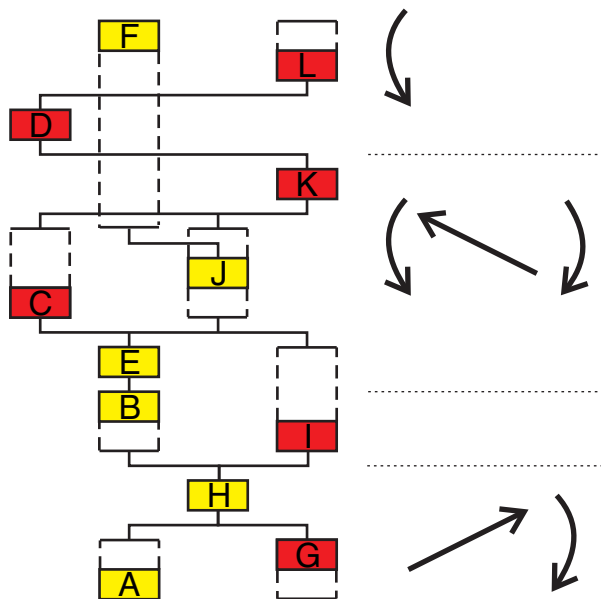


- G. small, marginal retouch near the tip on the lower face, near-the-tip part formation
- M, E. single, small removals near the tip on the lower face, near-the-tip part formation
- L. semi-flat, regular retouch on the upper face, edge formation, sharpening
- K. semi-flat, irregular, partly hinged removals on the upper face, edge formation, sharpening
- F. semi-flat removals on the lower face, edge thinning
- D. flat removals on the lower face near the base, edge formation, thinning and shaping (?)
- C. flat, partly hinged removals on the lower face derived from the base, surface thinning
- I, H. flat removals on the upper face, surface formation
- A. semi-flat scar, ventral surface of a flake or its butt
- B. ventral surface of a flake (?)
- J. small, marginal retouch on the upper face at the base, base edge formation

## Plate 2 Musilievo M.55



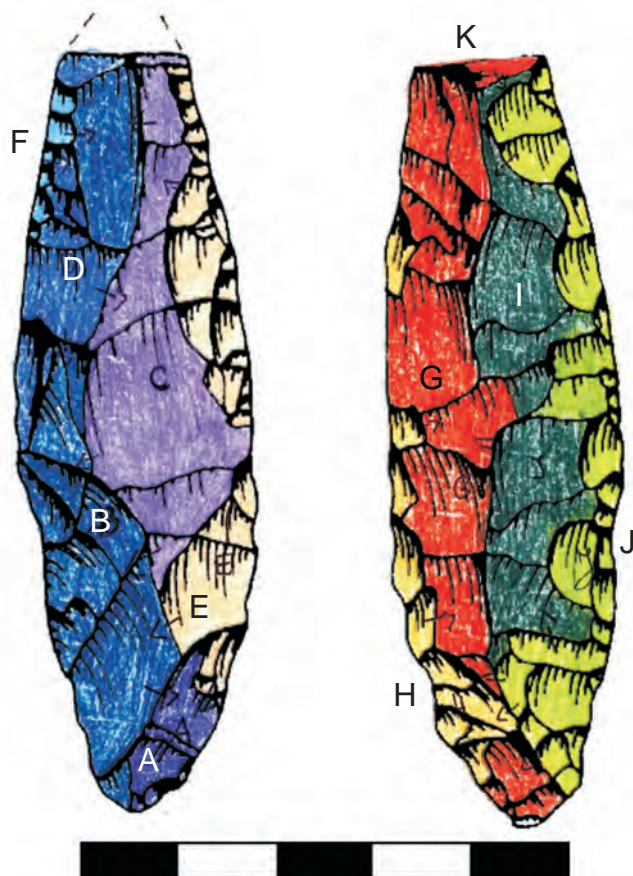
Biconvex tool with cortical base, poorly exposed tip and no intensive rejuvenation sequences. It was formed alternately.



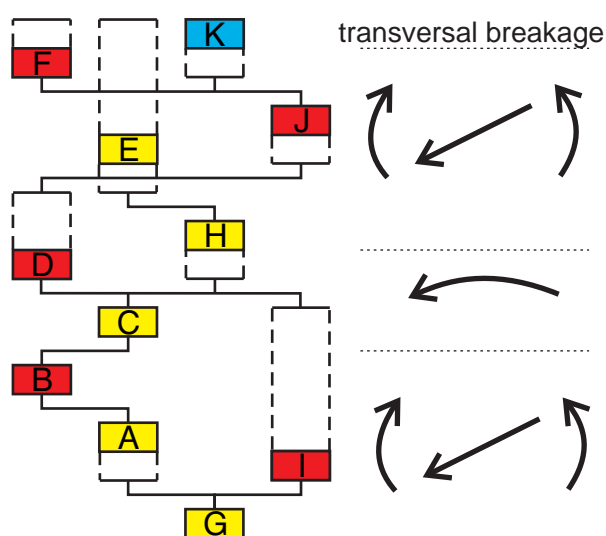
- F. semi-steep and semi-flat, marginal retouch on the upper face, edge resharpener, created a notch in the middle of edge length
- L. flat, partly hinged removals on the lower face, unsuccessful edge resharpener
- D. flat and semi-flat, partly hinged removals on the upper face, edge angle correction, thinning
- K. single, flat removal on the lower face near the base, surface thinning
- J. flat retouch, more steep near the tip, edge resharpener
- C. semi-flat, broad removals on the upper face, surface formation (?)
- I. single, flat, broad removal on the lower face, surface formation
- E. semi-flat removals on the upper face, edge sharpening
- B. semi-flat removals on the upper face, surface formation (?)
- A. flat scar, earlier stages of manufacturing process
- H, G. flat scars, earlier stages of manufacturing process



# Plate 3 Musilievo M.56

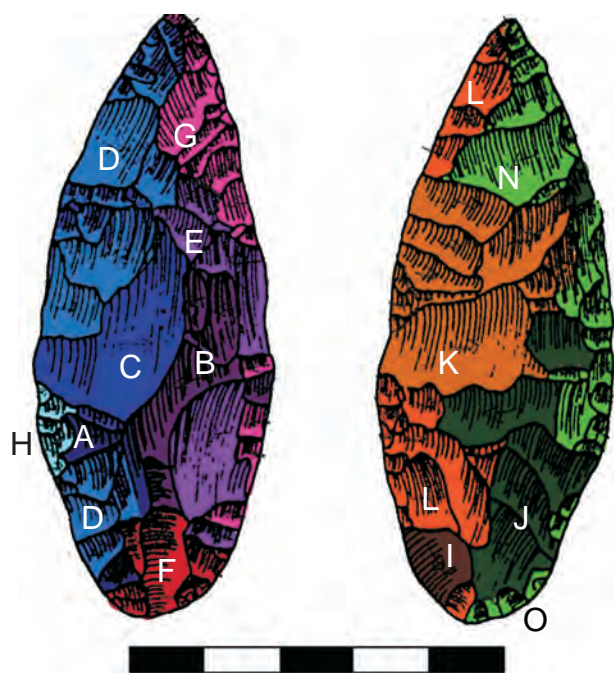


Plano-convex leafpoint with broken tip, both edges worked alternately and no traces of rejuvenation.

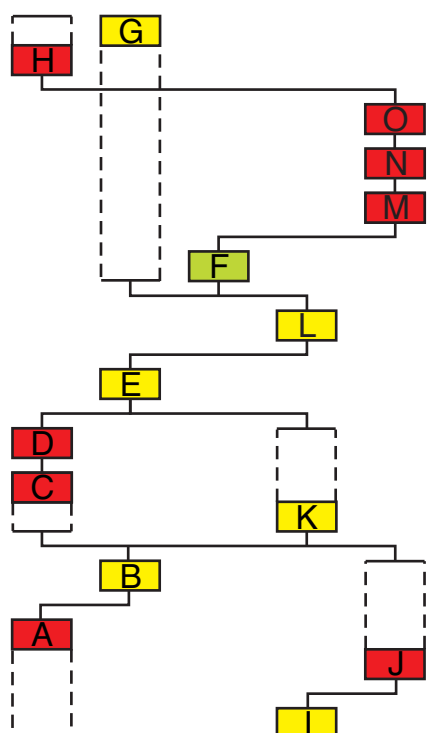


- K. transversal breakage at the tip
- F. very fine, marginal retouch on the upper face near the tip, edge correction
- E. flat, marginal retouch on the upper face, shaping, sharpening, analogical to sequence J
- J. flat, marginal retouch on the lower face, shaping, sharpening, analogical to sequence E
- H. flat/semi-flat, marginal removals near the base on the lower face, edge correction
- D, C. semi-flat removals on the upper face, edge thinning, formation
- A. semi-flat/semi-steep removals on the upper face, earlier stages of manufacturing process
- B. flat and semi-flat removals on the upper face, surface formation, thinning
- I, G. flat removals on the lower face, edge/surface formation

## Plate 4 Musilievo M.67

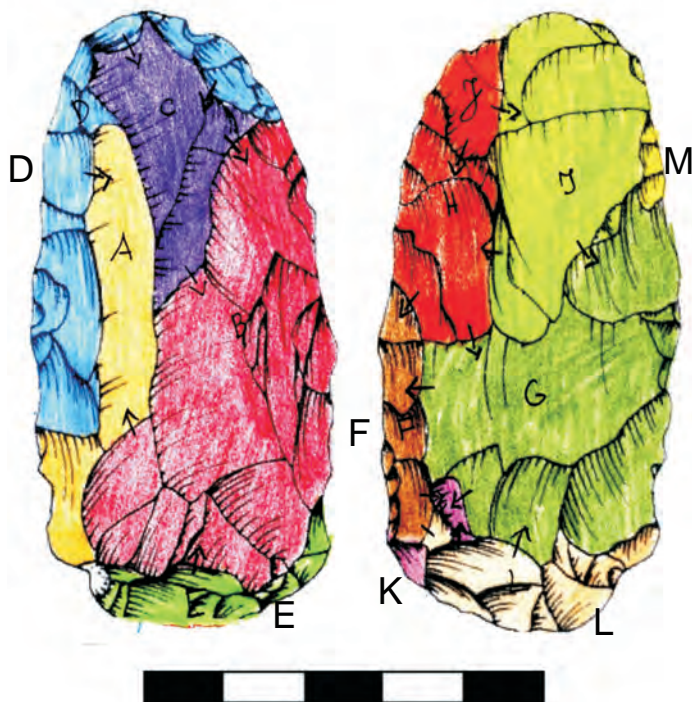


Symmetrical, biconvex, laurel leaf-shape leafpoint with thinned base. Shaping sequences G, L, N and D were derived alternately, especially near the tip.

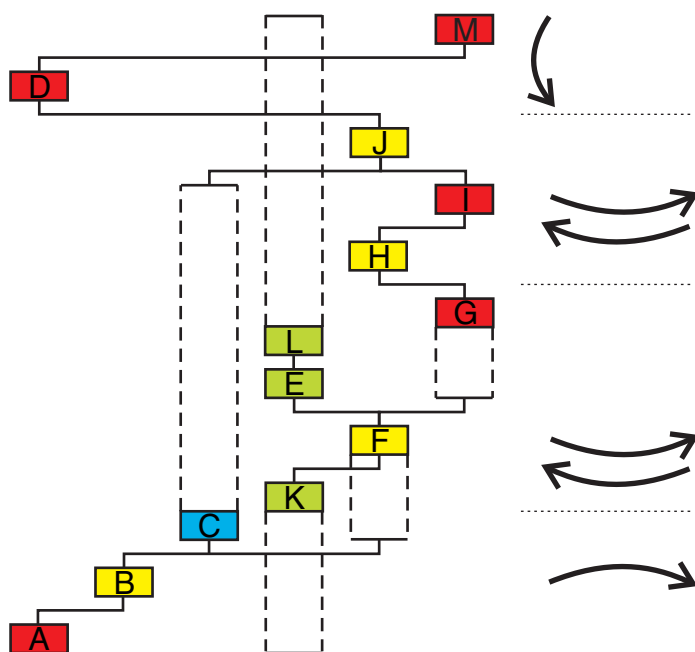


- G. flat, long removals on the upper face near the tip and marginal removals along the edge, shaping
- H. flat, marginal removals on the upper face, edge correction
- O. marginal retouch on the lower face at the base, base formation
- N. flat, long removals on the lower face near the tip, shaping, analogical to sequence G
- M. marginal, partly hinged removals, edge shaping, less regular than sequence N
- L. flat removals on the lower face near the tip and the base, shaping
- F. flat, partly hinged removals on the upper face derived from the base, thinning, base formation
- E. flat, partly hinged removals on the upper face, partly unsuccessful thinning, edge shaping
- K. flat, broad, long removals on the lower face, surface thinning, formation
- D. flat, partly hinged removals on the upper face near the tip and the base, shaping, edge formation
- B, C, A. flat, broad removals on the upper face, surface formation
- J, I. flat removals on the lower face, surface formation

## Plate 5 Musilievo M.183

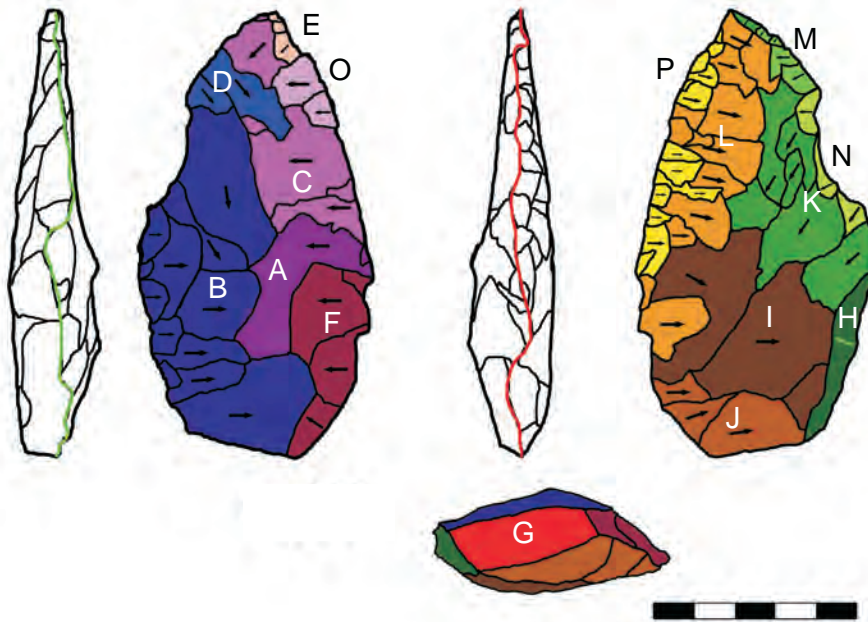


Plano-convex tool with convex edge at the tip which was retouched abruptly. It was retouched along edge II and the edge at the tip. The tool was unsuccessfully thinned.

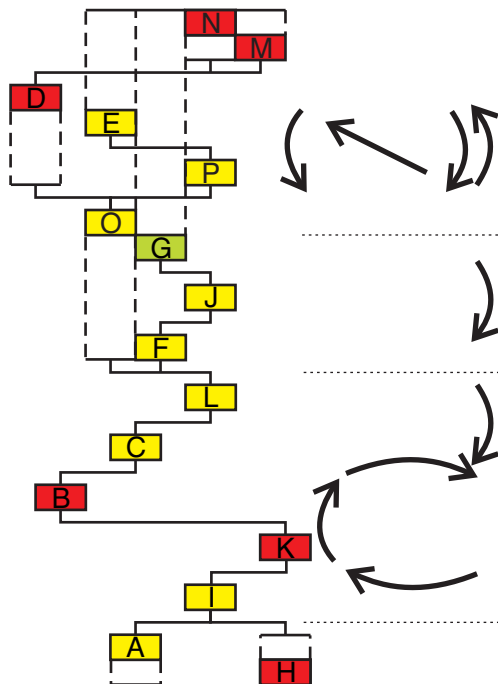


- L. semi-steep removals on the lower face derived from the base, base formation
- E. flat, partly high (>5mm) hinged removals on the upper face, derived from the base, unsuccessful thinning, edge angle formation before sequence L
- M. flat, marginal retouch on the lower face, edge correction
- D. semi-steep retouch on the upper face along edge II and the edge at the tip, edge sharpening
- J, I. flat removals on the lower face near the tip, edge angle correction, near-the-tip part thinning
- H, G. flat removals on the lower face, surface formation, thinning
- F. steep removals on the lower face, back formation, edge blunting
- K. semi-flat scar on the lower face, earlier phases of manufacturing process
- C. flat, long removals on the upper face derived from the tip, probably derived before obtaining the flake, if a tool was made on a flake, aimed at removing steep scar of sequence A
- B. semi-steep removals on the upper face, surface formation, thinning, removing scar of sequence A
- A. single, steep, broad removals on the upper face, earlier phases of manufacturing process

## Plate 6 Musilievo M.233



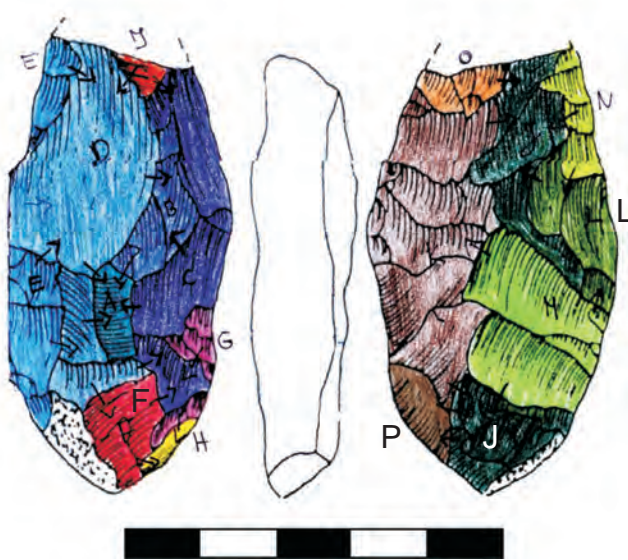
Inverse knife with cutting edge retouched on the lower face, base formed by transversal breakage and back blunted. Big notch was created on distal posterior edge. Cutting edge was resharpened several times, mostly near the tip.



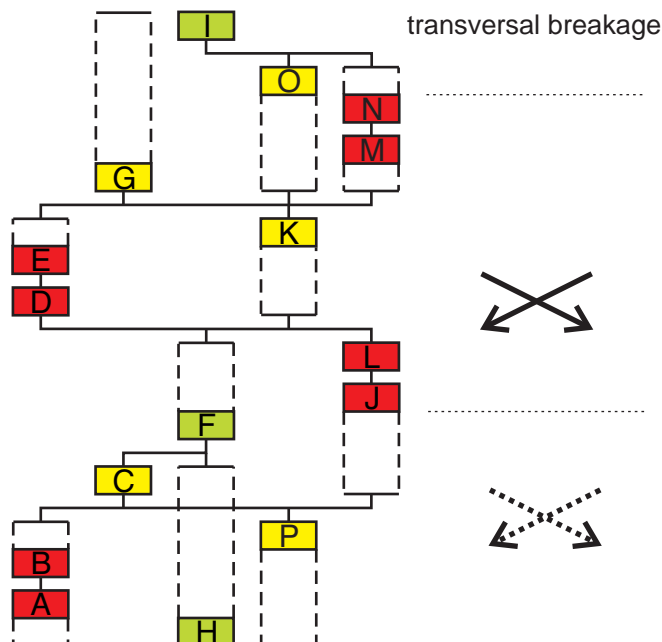
- N. steep removals on the lower face, created a notch at the distal posterior edge
- M. flat removals on the lower face, edge rejuvenation
- D. flat removals on the upper face, edge angle correction
- E. semi-steep, marginal retouch on the upper face near the tip, edge resharpening
- P. flat, marginal retouch on the lower face, edge resharpening
- O. flat removals on the upper face, edge angle correction
- C. flat removals on the upper face near the tip, surface thinning, edge angle formation
- F. semi-steep removals on the upper face near the base, edge formation
- L. flat removals on the lower face, edge resharpening
- G. transversal breakage at the base
- J. flat removals on the lower face near the base, base formation, thinning, surface flattening
- B. semi-flat removals on the upper face, surface and edge formation
- A. single, semi-flat removal on the upper face, surface formation
- K. flat removals on the lower face near the tip, edge/surface formation
- I. flat, broad removals on the lower face, surface formation
- H. single, semi-steep removal on the lower face, back formation



## Plate 7 Musilievo M.237



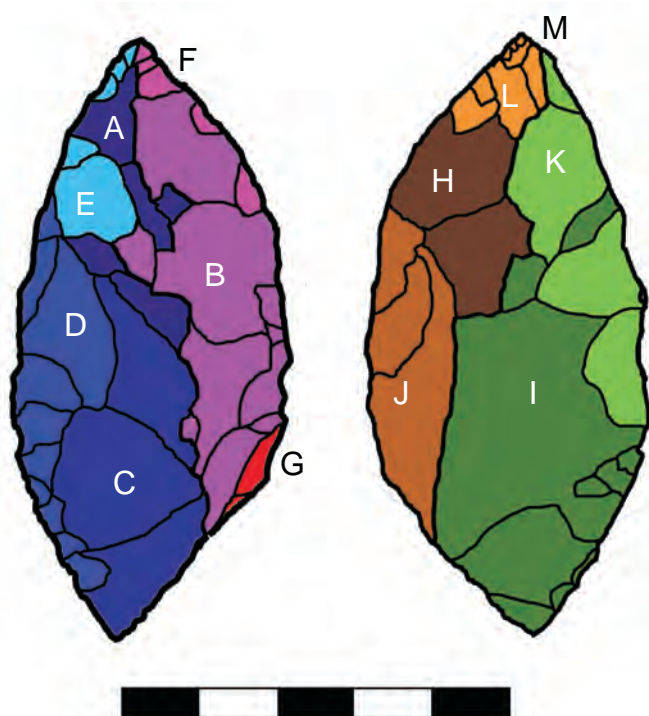
Tool knapped in plano-steep alternate manner, with partly cortical base; unfinished and broken in the middle.



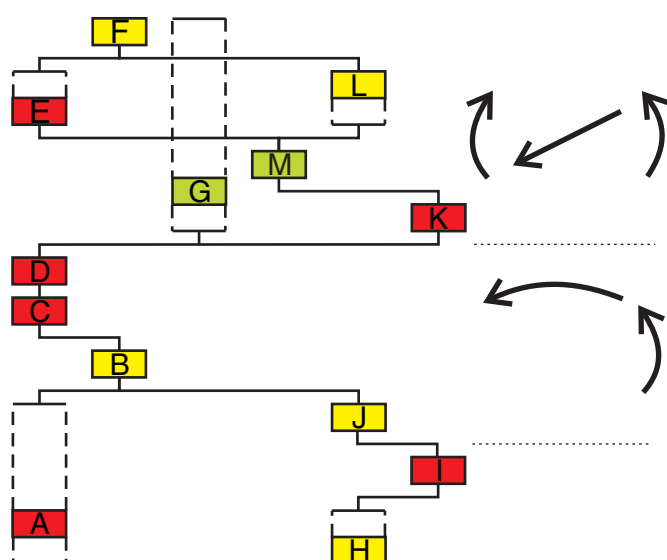
- I. transversal breakage caused by one of removals belonging to sequence O
- O. deep, hinged removals on the lower face, caused transversal breakage
- N. small, thinning, hinged removals on the lower face, unsuccessful thinning
- M. flat, long removals on the lower face, surface thinning after unsuccessful sequence K
- K. very high (>5mm) hinged removals, unsuccessful surface thinning
- E. flat, partly hinged removals on the upper face, edge formation
- D. deep removals on the upper face, surface thinning
- G. steep, marginal retouch on the upper face, edge correction
- C. steep removals, surface formation, edge angle formation before sequence K
- F. single, flat removal on the upper face near the base, surface formation
- L. flat, partly hinged removals on the lower face, surface formation, thinning and edge angle formation before sequence D
- J. semi-steep removals on the lower face and surface formation, edge angle formation before sequence D
- P. single, flat removals on the lower face, surface formation
- B, A. flat removals on the upper face, surface formation
- H. transversal breakage at the base



## Plate 8 Musilievo M.287

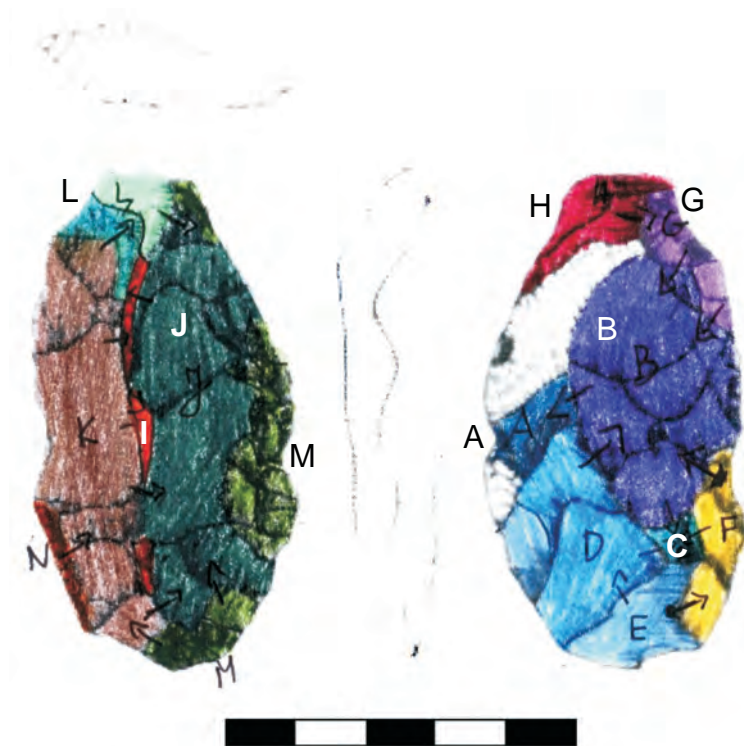


Plano-convex knife with transversal breakages at the tip and at the base. Both breakage scars are located angularly. Cutting edge is located on the left side of the upper face.

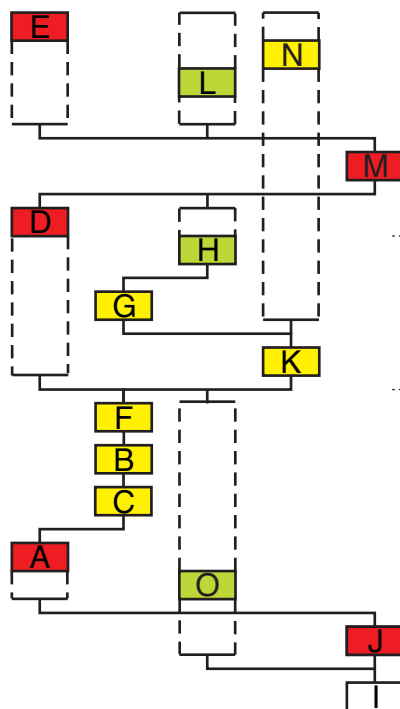


- F. marginal, irregular retouch on the upper face near the tip
- L. flat, small removals on the lower face near the tip, edge rejuvenation
- E. flat removals and marginal retouch near the tip, tip exposure
- K. flat and semi-flat, irregular, partly hinged removals on the lower face, edge angle correction
- G. transversal breakage created the base/back with steep removals correcting the back
- M. transversal breakage at the tip
- D. flat, partly hinged removals on the upper face, edge formation
- C, A. flat, broad, partly hinged removals on the upper face, surface formation
- B. semi-steep removals on the upper face, more flat near the tip, back edge formation
- J. flat, high hinged removals on the lower face, surface formation, thinning
- I, H. flat, broad removals on the lower face, surface formation

## Plate 9 Musilievo M.354

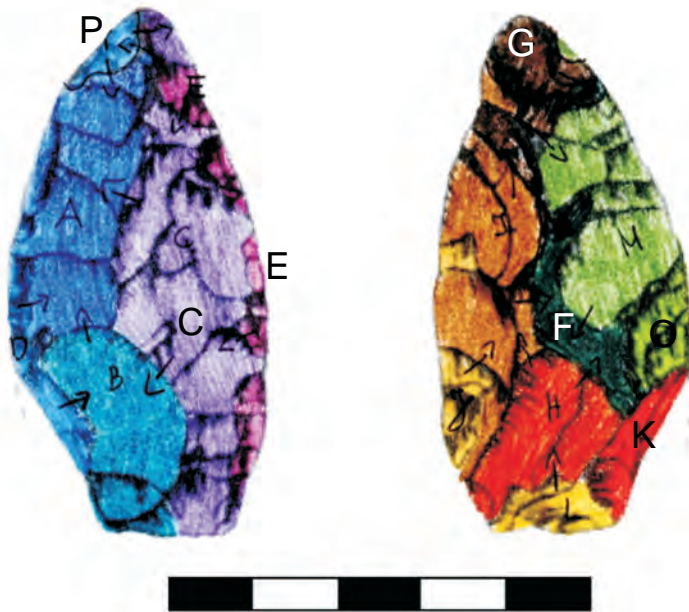


Heavily exhausted tool with both edges damaged by subsequent resharpening sequences. Orientation probably changed during rejuvenation.

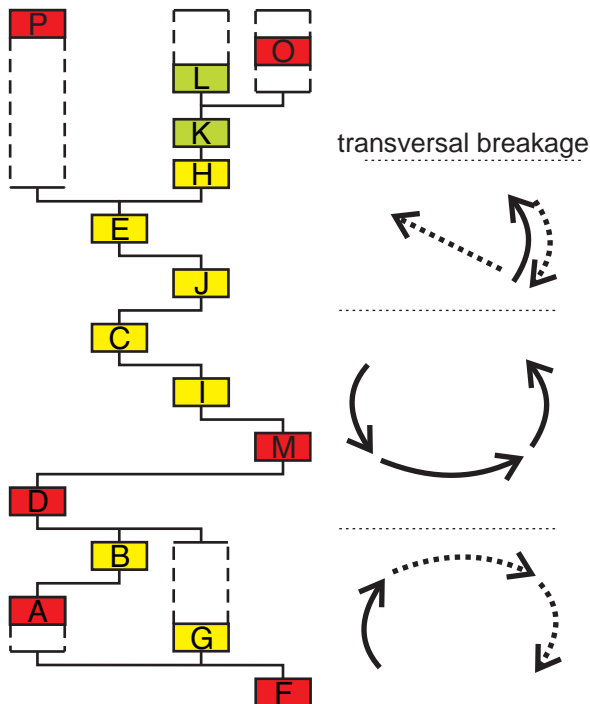


- E. flat removals on the lower face at the base, base remodeling
- N. flat, marginal retouch, edge resharpening
- L, O. single, semi-steep removal near the tip, tip thinning
- M. semi-flat, marginal retouch, edge resharpening
- D. flat removals derived from the base, surface thinning, base remodeling
- H. deep, hinged removals (>3mm), unsuccessful thinning near the tip
- G. steep removals near the tip, edge resharpening
- K. semi-steep removals, edge resharpening
- F. flat, marginal retouch, edge resharpening
- B, C, A. flat removals, edge resharpening, thinning
- I, J. semi-flat removals, earlier phases of edge resharpening (?)

## Plate 10 Musilievo M.469

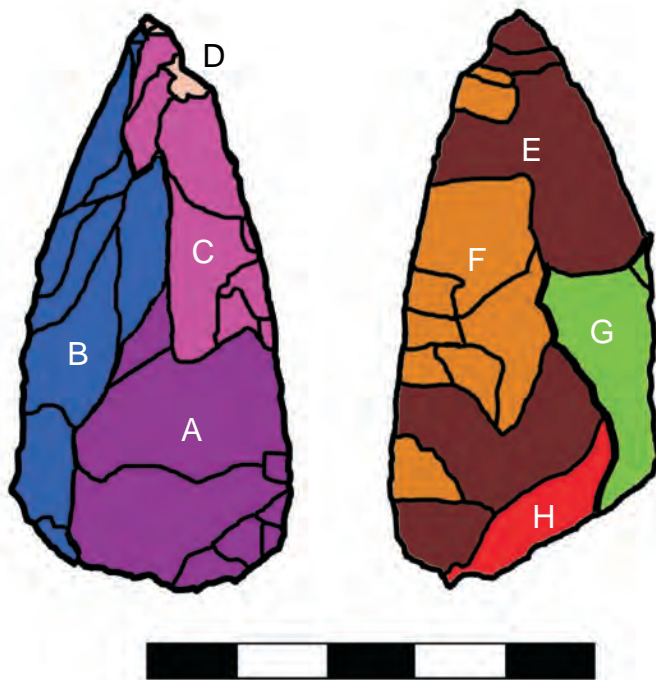


Plano-convex tool with broken base and exposed tip. It was remodeled after breakage by steep removals which created transversal surface at the base, and resharpener on both edges. Lower surface was used for edge angle correction and thinning. All sharpening sequences were derived on the upper face.

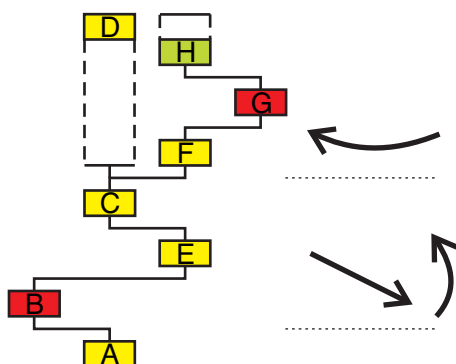


- P. marginal retouch on the upper face near the tip, edge resharpener
- D. marginal retouch on the upper face, edge resharpener/formation (?)
- O. semi-steep removals on the lower face near breakage, edge remodeling, tang creation
- L. steep removals on the lower face derived from the base, base formation after transversal breakage
- K. transversal breakage at the base, angular to main axis
- H. flat, long removals on the lower face near the base, surface thinning, formation
- E. semi-steep, marginal retouch on the upper face, edge resharpener, created a notch near the tip
- J. flat, small removals on the lower face, edge angle correction
- I, G, M, F. flat removals on the lower face, edge angle correction, thinning
- C, A. semi-flat removals on the upper face, edge formation
- B. flat removals on the upper face, earlier stages of manufacturing process

# Plate 11 Musilievo M.502



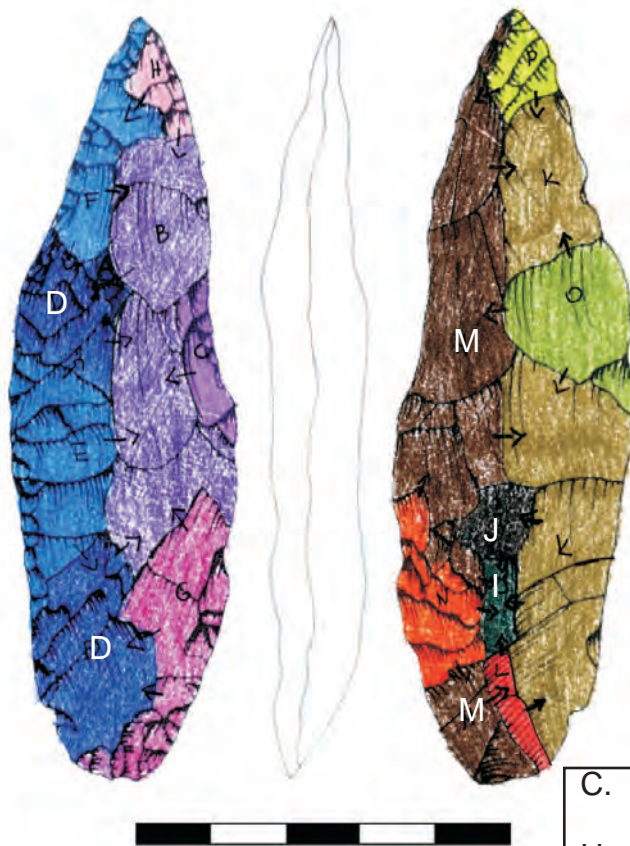
Plano-convex, triangular knife with exposed tip and single cutting edge resharpened on the upper face. Lower face was used for edge angle correction.



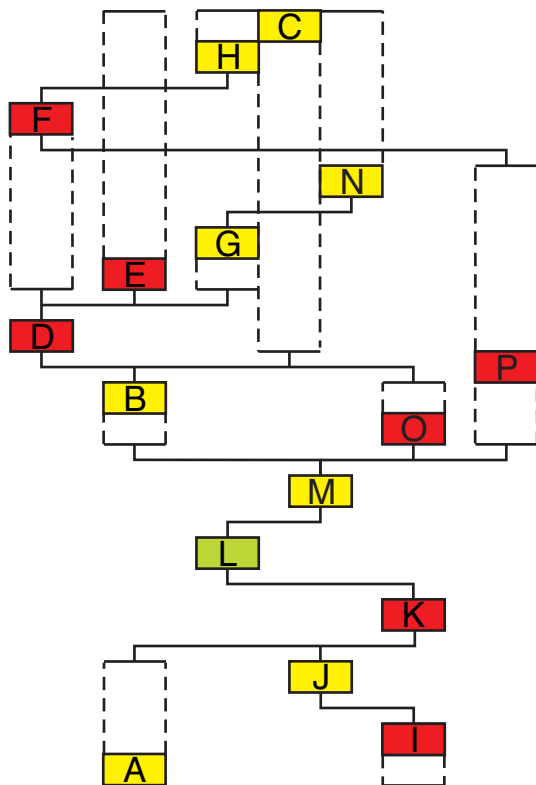
- D. small truncation on the upper face near the tip
- H. angular removals on the lower face derived from the base, base formation
- G. semi-flat removals on the lower face near the base, edge angle correction, thinning
- F. flat removals on the lower face, edge angle correction
- C. semi-steep, partly hinged removals on the upper face, edge resharpening
- E. flat removals on the lower face reaching the opposite edge, surface formation, thinning
- B. semi-steep removals on the upper face, back edge formation
- A. semi-steep removals on the upper face, cutting edge formation



## Plate 12 Musilievo M.519



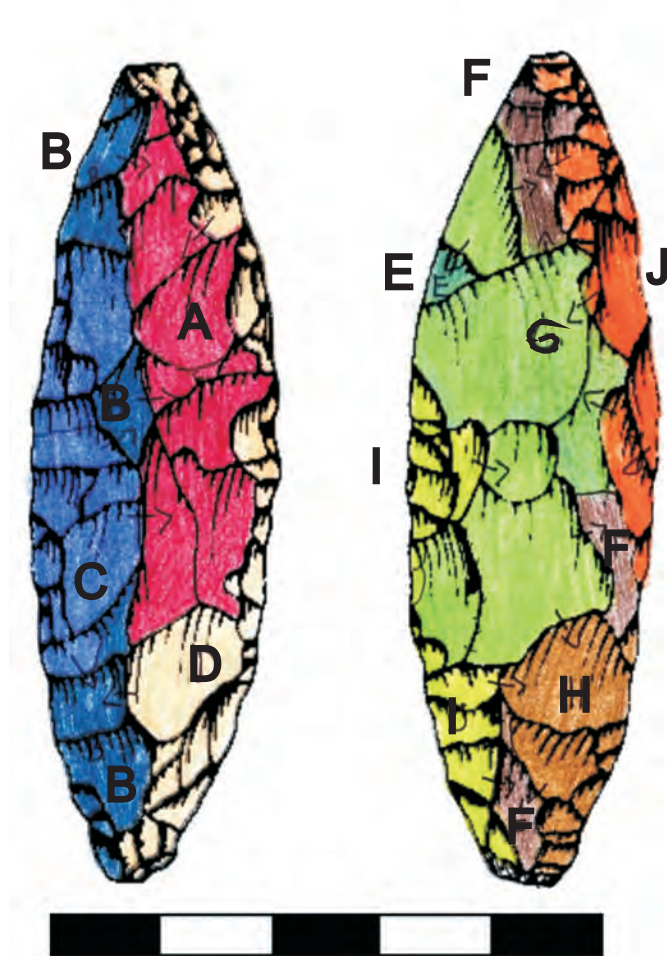
Elongated tool with exposed tip and near-the-tip part narrower than near-the-base part. It was retouched on the upper face. It bears traces of non-intensive resharpening.



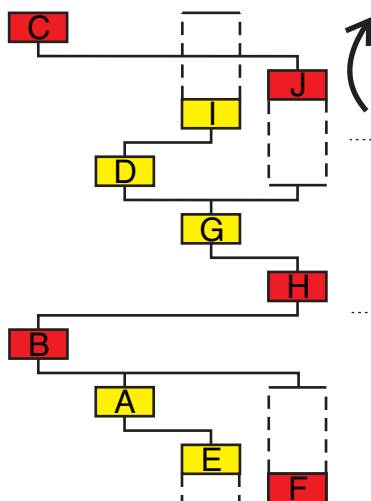
- C. flat, hinged removals on the upper face created a notch at the edge
- H. marginal retouch on the upper face near the tip, edge resharpening
- F. semi-steep, marginal retouch near the tip on the upper face, edge resharpening
- E. semi-steep/semi-flat, regular removals on the upper face, edge resharpening
- G. flat removals on the upper face near the base, shaping, base formation
- N. semi-steep, hinged removals on the lower face, edge angle correction, thinning
- D, B. flat and semi-flat removals on the upper face, edge formation
- P. flat, regular, long removals on the lower face near the tip, edge angle correction
- O. semi-flat, broad removals on the lower face, edge angle formation, thinning
- M, K. flat, broad removals on the lower face, surface thinning
- J, I. flat scars on the lower face, earlier stages of manufacturing process
- L. single, flat, long removal on the lower face near the base, surface formation
- A. earlier phases of surface formation



# Plate 13 Musilievo M.627

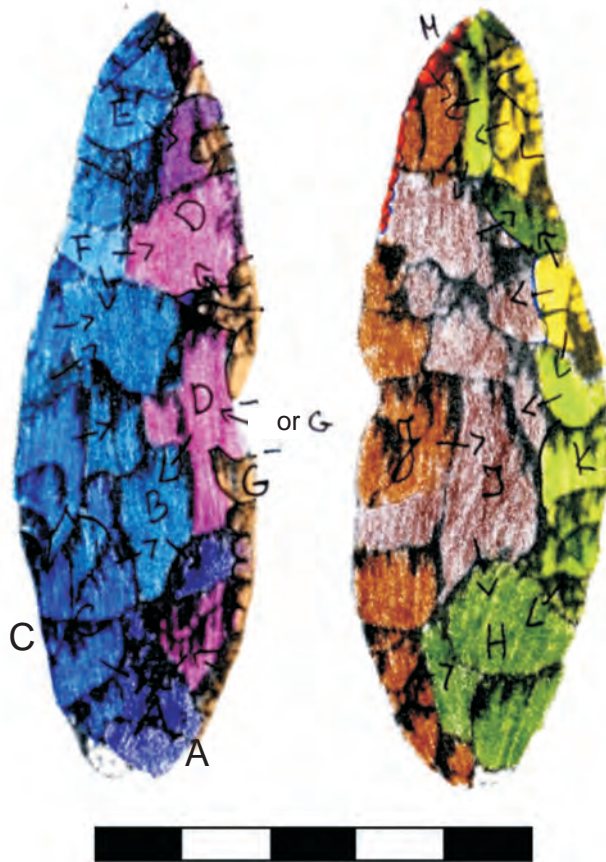


Symmetrical, biconvex, laurel leaf-shape leafpoint with shaping sequences H, G, I, C and D. The tool is partly cortical near the base, tip is not well exposed. Near-the-base sequences were derived alternately.

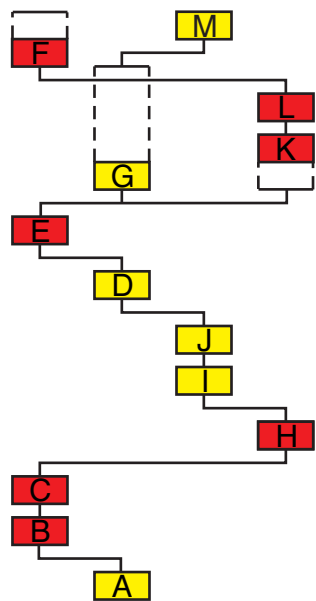


- C. semi-flat removals in the middle of edge, shaping, thinning
- J, I. flat, hinged removals on the lower face near the tip, shaping
- D. flat, partly hinged removals on the upper face, shaping, thinning
- H. semi-flat removals on the lower face near the base, shaping
- G. flat, broad removals on the lower face in the middle of edge, flattening, thinning
- E, F. flat removals on the lower face, surface formation
- A, B. semi-flat removals on the upper face, surface/edge formation, sequence B partly hinged near the tip

## Plate 14 Musilievo M.640

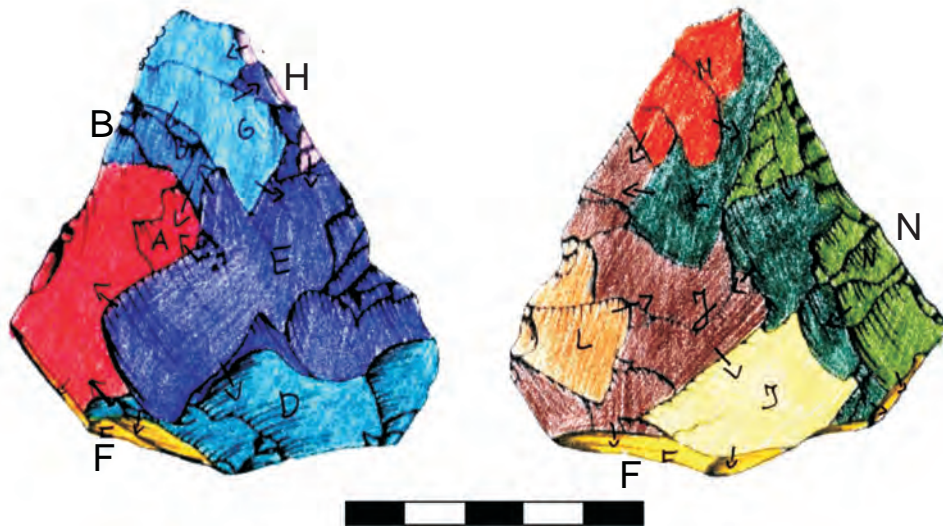


Plano-convex tool with near-the-tip part slightly less wide than near-the-base part. Base is partly cortical and tip slightly exposed. Both edges were retouched and reshaped. One of edges has a deep notch in the middle of its length.

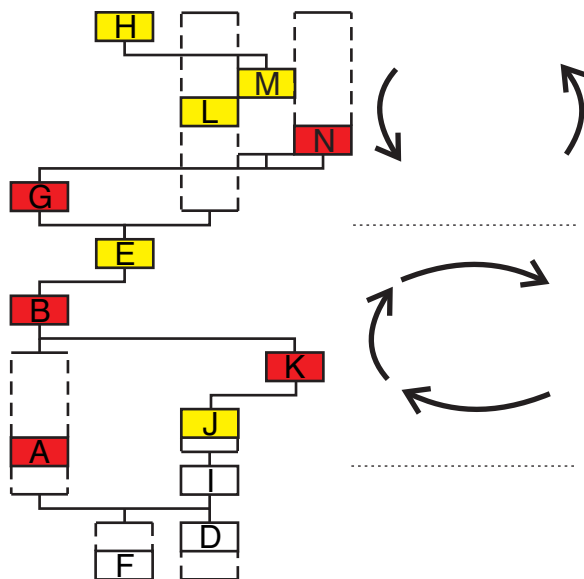


- M. marginal retouch on the lower face near the tip, edge reshaping and usewear
- F. marginal retouch on the upper face, edge correction and probably usewear
- L, K. semi-flat, marginal retouch on the lower face, edge reshaping
- G. semi-flat, partly hinged, marginal retouch, edge reshaping, deepening the notch in the middle of edge
- E. semi-flat, partly hinged removals on the upper face near the tip, edge formation, thinning
- D. semi-flat removals on the upper face, edge formation, sharpening (?)
- J. flat removals on the lower face, edge angle correction
- I, H. flat, broad removals on the lower face, surface formation, thinning
- A, B, C. semi-flat removals on the upper face, surface formation, earlier stages of edge formation (?)

## Plate 15 Musilievo M.651

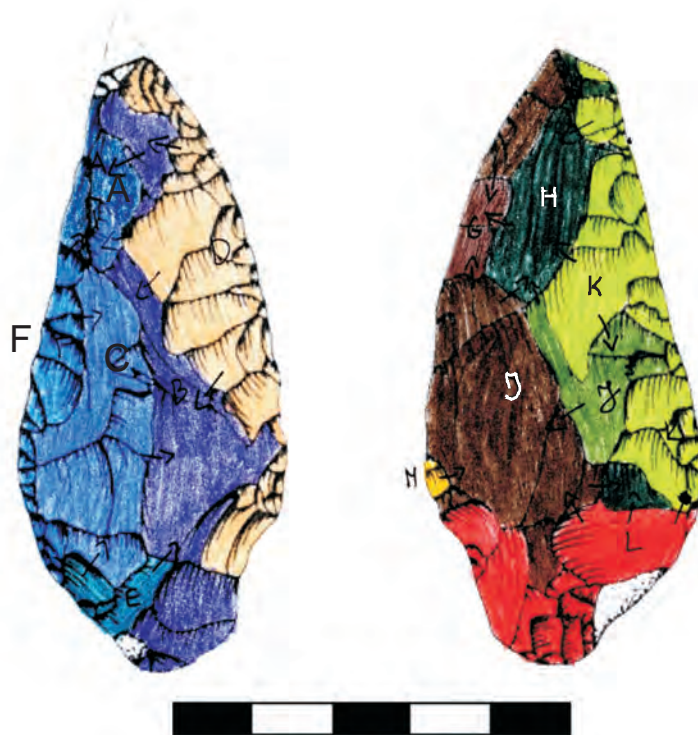


Triangular tool made on a flake, with thick base and straight edges worked alternately. No intensive traces of reshaping, unretouched tip.

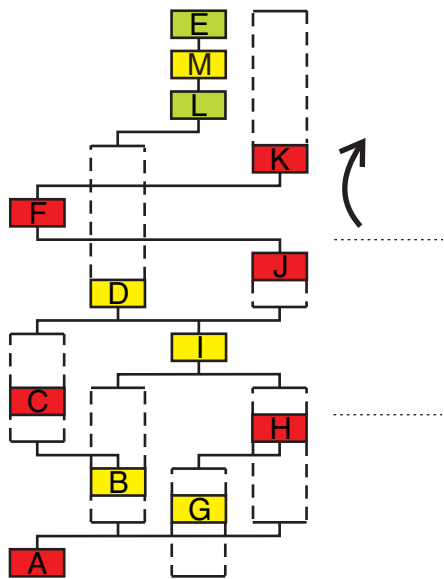


- H. marginal truncations on the upper face
- M. flat, long, angular removals on the lower face near the tip analogous to sequence G, near-the-tip part thinning
- N. flat, regular, long removals along the edge and marginal retouch on the lower face, edge sharpening
- G. flat, long, angular removals on the upper face near the tip analogous to sequence M, near-the-tip part thinning
- L. semi-steep removals on the lower face near the base, edge correction
- E. flat, deep, long removals on the upper face, surface formation, thinning
- B. flat removals on the upper face, edge formation, thinning
- A. deep scar of broad removal on the upper face, probably derived before obtaining the blank
- K. semi-flat, long removals on the lower face, surface formation, ventral surface thinning
- J. flat removals on the lower face, surface formation, bulb removal and flattening
- I. ventral surface of a flake
- F. steep removals at the base, probably a flake butt
- D. flat removals on the upper face, derived before obtaining the flake

## Plate 16 Musilievo M.654



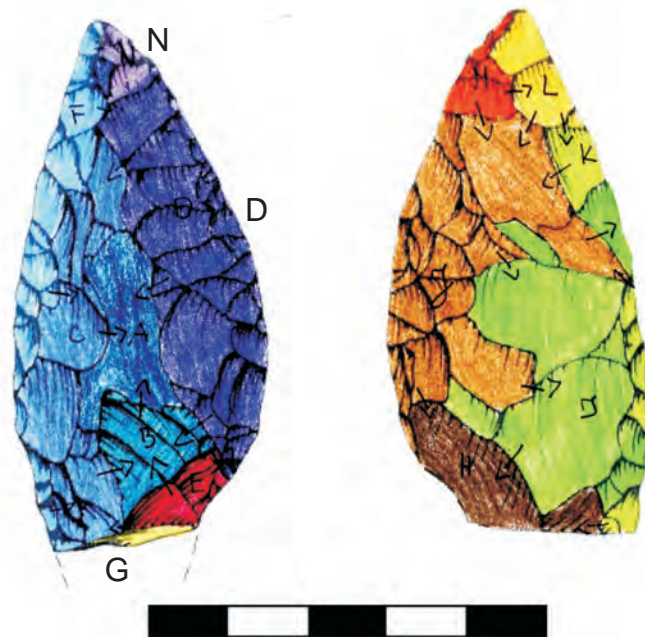
Plano-convex tool with exposed, broken tip and a tang near the base, formed by semi-steep notches. One edge is concave and the other is convex; both were retouched and resharpened.



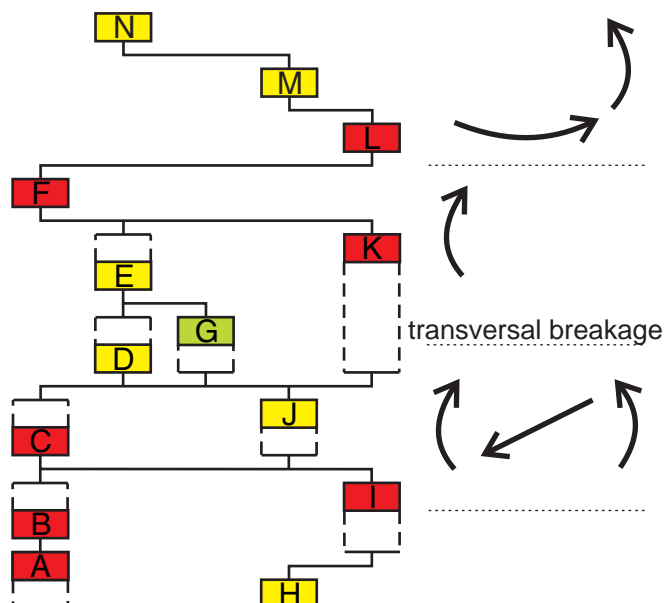
- E. thinning removals on the upper face near the base
- L. semi-steep, deep removals on the lower face derived from the base, base formation, thinning
- M. small, marginal removals on the lower face, edge correction
- K. semi-flat, marginal retouch on the lower face, edge resharpening, analogical to sequence D, but less regular
- J, H, G, I. semi-flat removals on the lower face, surface thinning, rejuvenation
- F. flat, regular, marginal retouch on the upper face, edge resharpening
- D. semi-flat, regular retouch on the upper face, analogical to sequence K, a few phases of edge resharpening
- C, A. semi-flat removals on the upper face, edge formation, rejuvenation (?)
- B. deep removals on the upper face, flat and semi-flat near the tip and semi-steep near the base, surface formation



## Plate 17 Musilievo M.714



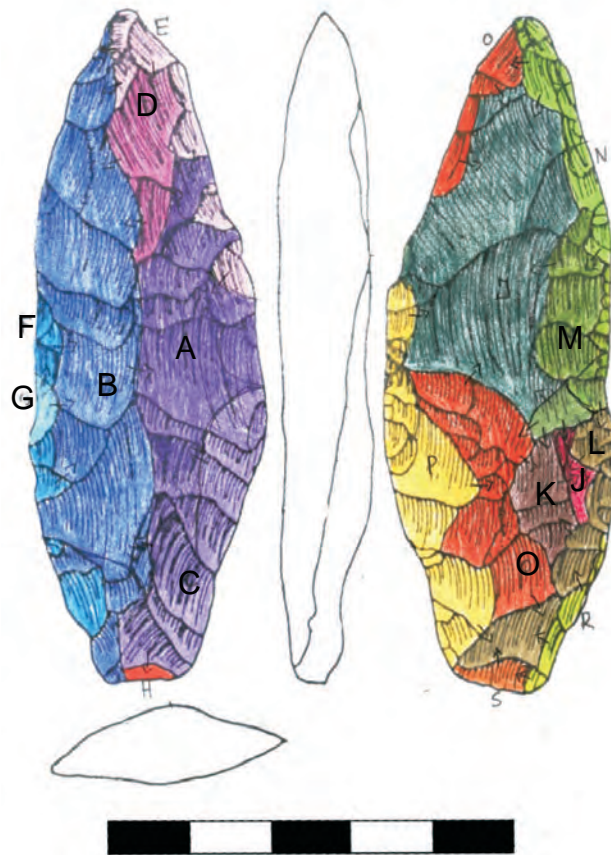
Plano-convex tool with broken base, one of edges is straight and the other is convex. Exposed tip bears traces of precise work. It was remodeled after breakage by creating a kind of tang near the base, and resharpened on both edges. Breakage at the base could have been intentional due to high hinged removals (sequence B) which prevented further tool thinning.



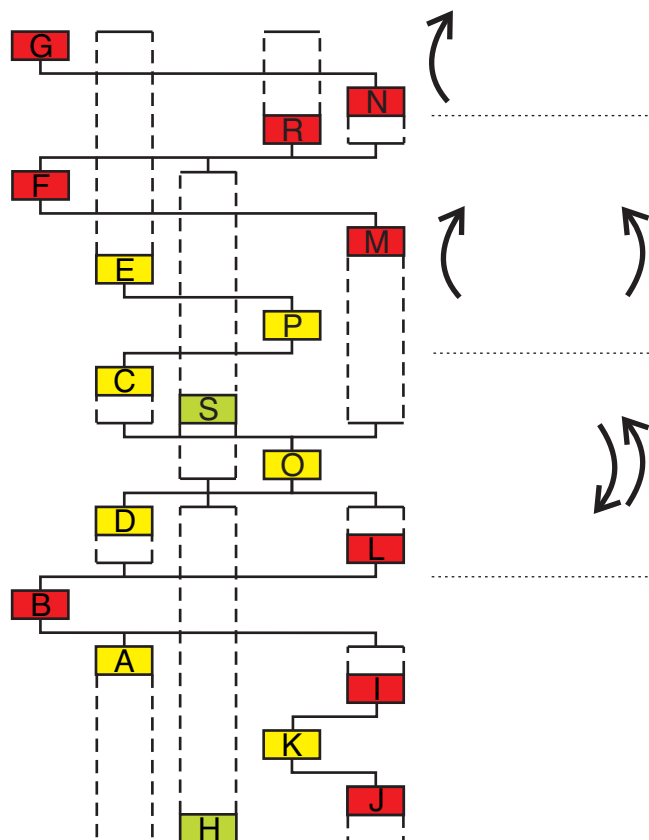
- N. marginal removals on the upper face near the tip, edge resharpening
- M, L. flat removals on the lower face near the tip, edge angle correction
- F. flat, marginal retouch on the upper face, edge resharpening
- K. flat, partly hinged removals on the lower face, edge angle correction
- E. steep removals on the upper face near breakage, created a notch, edge remodeling
- D. semi-steep, regular removals on the upper face, edge formation/resharpening (?)
- J, I. flat removals on the lower face reaching the opposite edge, edge angle formation, thinning and surface flattening
- G. transversal breakage at the base
- C. semi-flat removals on the upper face, edge sharpening
- H. flat removals on the lower face, surface formation
- B. single, flat, hinged (>7mm high) removal, unsuccessful surface thinning
- A. semi-flat, broad removals on the upper face, surface formation



## Plate 18 Musilievo M.721

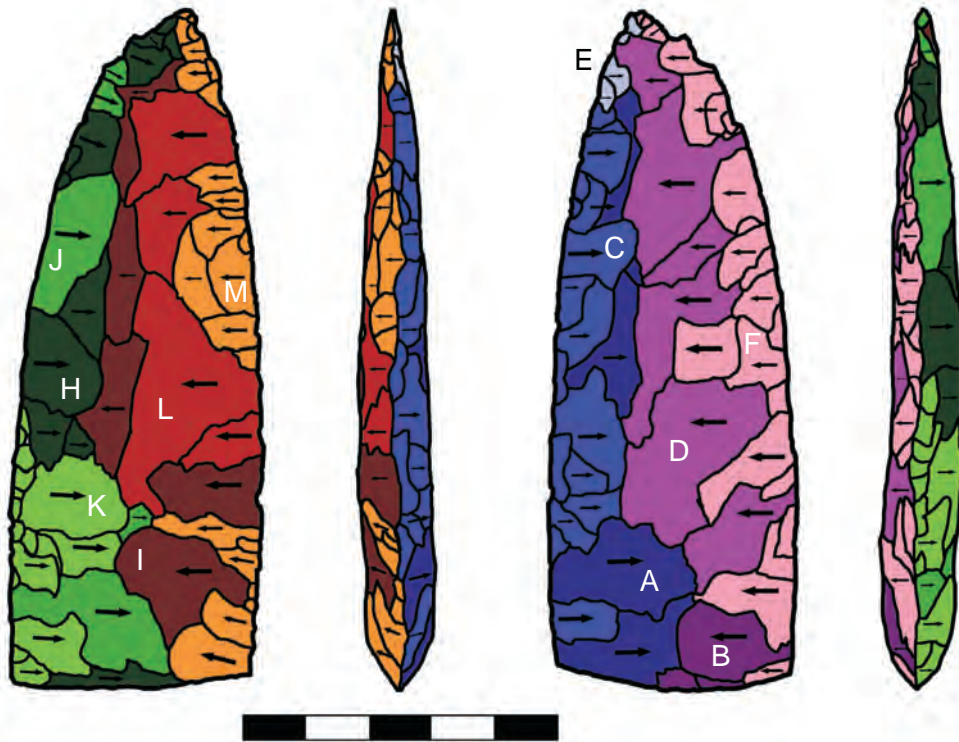


Elongated tool with exposed tip and both edges retouched alternately near the tip. Base was broken and edges were marginally blunted near the base. Both edges bear traces of resharpening.

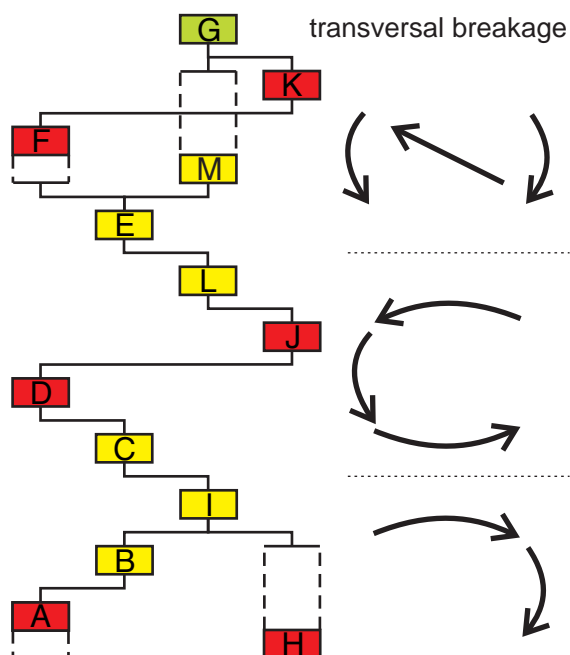


- G. small removals created a notch on the upper face
- N, M. flat, partly hinged, marginal retouch near the tip on the lower face, edge resharpening
- F. flat removals on the upper face, edge angle correction
- R. steep, marginal retouch on the lower face near the base, near-the-base part formation
- E. partly blunting, irregular retouch on the upper face near the tip, edge resharpening
- P. flat, regular removals on the lower face near the base, more steep near the base, edge resharpening, near-the-base edge formation
- C. flat removals on the upper face near the base, edge formation, shaping
- H. transversal breakage at the base
- S. transversal breakage at the base or thinning removal
- O. flat removals on the lower face, edge sharpening, surface thinning near the base
- D. semi-flat, long, angular removals on the upper face near the tip, near-the-tip part thinning
- L. flat, hinged removals on the lower face near the base, unsuccessful surface thinning
- A, B. semi-flat removals on the upper face, surface formation
- I, K, J. flat, broad removals on the lower face, surface formation, thinning

# Plate 19 Musilievo M.1207

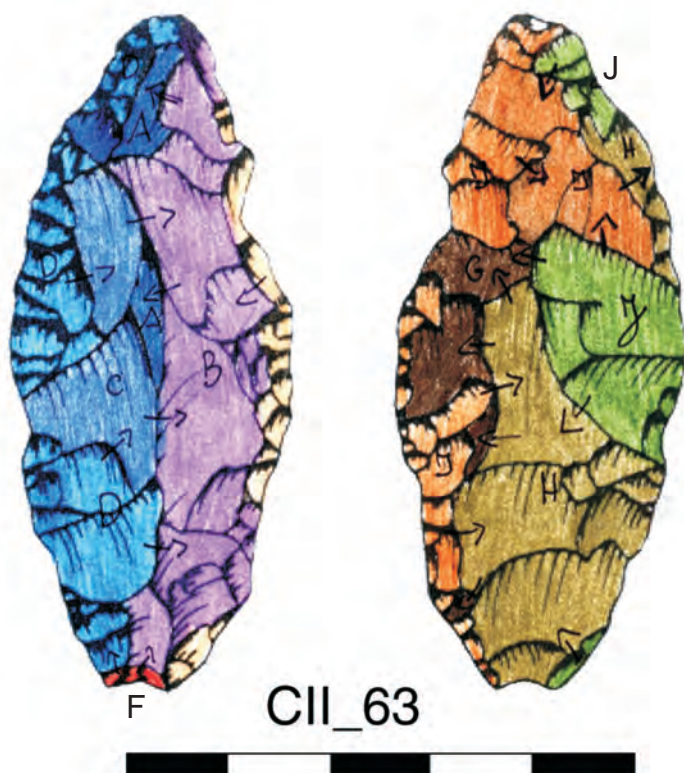


Biconvex tool broken in its half, with exposed tip, one edge vertical and another convex. Both edges were shaped to get their line. There are no traces of intensive rejuvenation.

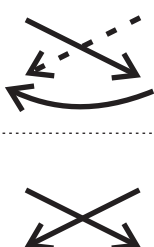
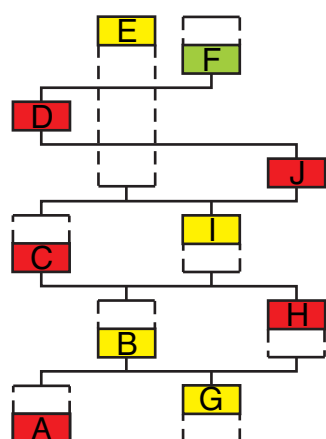


- G. transversal breakage
- K. flat, partly hinged retouch on the upper face, shaping, edge formation
- F. flat retouch on the lower face, denticulated near the tip, shaping
- M. flat removals on the upper face along the edge, edge sharpening
- E. flat, small, marginal retouch on the lower face near the tip, edge reshaping (?)
- L, J. flat and semi-flat, broad removals on the upper face, edge formation
- D. flat, broad removals on the lower face, edge formation
- C. semi-flat removals on the lower face, edge formation
- A, B. flat, broad removals on the lower face, surface thinning
- H, I. flat and semi-flat, broad removals on the upper face, surface formation

## Plate 20 Samuilica II CII.63

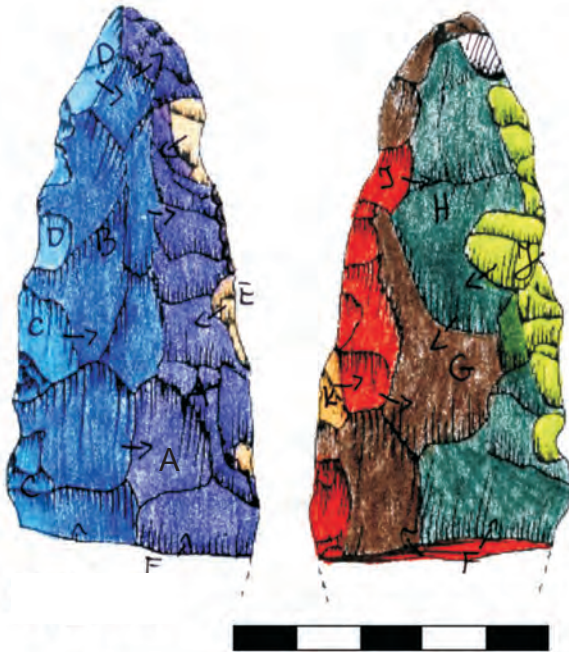


Plano-convex tool with unexposed, blunted tip and highly exhausted edges with steep, denticulated, irregular retouch.

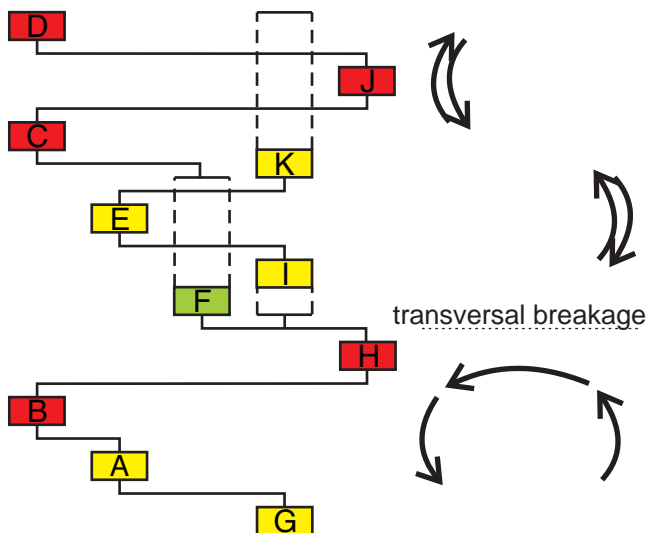


- E. steep, irregular, partly hinged retouch created notches on the upper face along the edge
- F. steep, marginal retouch on the upper face at the base, created a notch at the base
- D. flat removals on the upper face, edge sharpening
- J. flat removals on the lower face, edge angle correction, edge correction
- I. flat removals on the lower face, marginal near the base and more broad near the tip, surface thinning/correction and edge correction, perhaps two different sequences
- C. flat, deep removals on the upper face, thinning and surface formation
- A. flat, broad removals on the upper face, surface formation, earlier stages of manufacturing process
- H, G. flat, broad removals on the lower face, surface formation
- B. flat and semi-flat, irregular removals, deeper near the tip, surface thinning/formation

## Plate 21 Samuilica II CII.1115



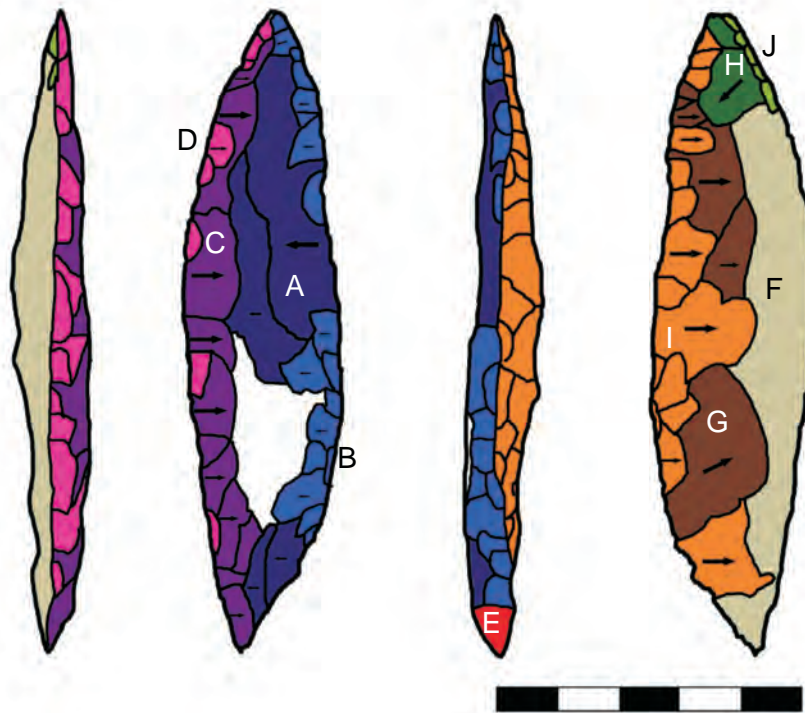
Biconvex tool with transversally broken base. The tool was retouched on both edges after breakage. Tip is located out of axis. Edge II is more straight in profile.



- D. semi-flat, irregular, marginal retouch near the tip
- J. semi-flat and flat removals, marginal retouch on the lower face along the edge, one of removals near the base is steep and created a notch
- C. flat removals on the upper face, edge correction, resharpening (?)
- K. small, marginal removals on the lower face, edge correction
- E. semi-steep removals on the upper face, created notches along the edge
- I. flat removals on the lower face, edge correction
- F. transversal breakage, small removals on the scar derived after breakage to flatten the scar
- H. flat and semi-flat, broad removals on the lower face, more steep near breakage, surface formation, analogical to sequence A
- A. semi-flat and semi-steep removals on the upper face, surface formation, analogical to sequence H
- B. semi-flat removals on the upper face, surface formation, analogical to sequence G
- G. flat removals on the lower face, surface formation, analogical to sequence B

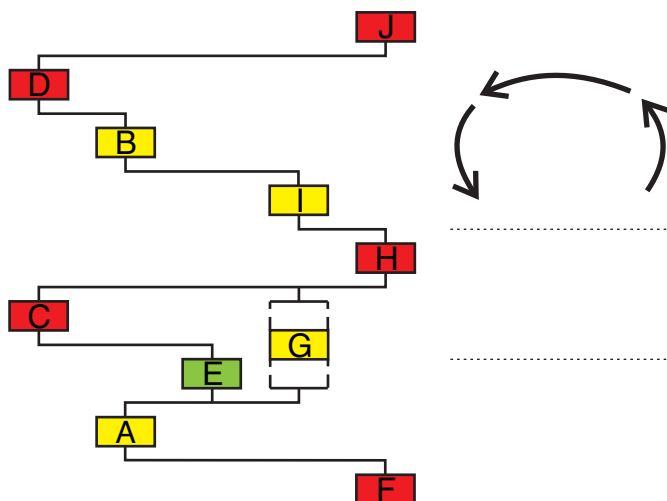


## Plate 22 Samuilica II CII.1116



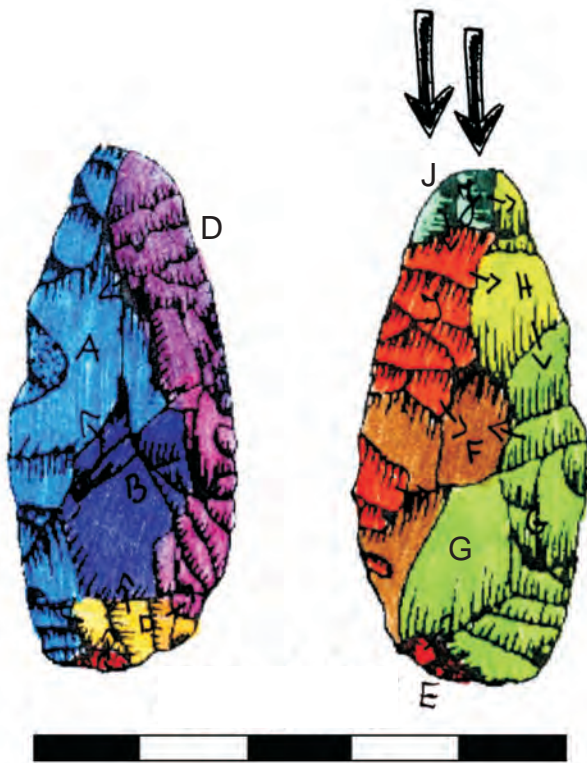
Plano-convex, slim tool made of flake, with exposed tip and blunted, angular base. One of edges was retouched only on the upper face; therefore, it remains straight; the second edge because of deriving removals on both faces is slightly S-shaped. The tool bears traces of shaping.

- J. marginal, hinged retouch on the lower face near the tip, edge correction
- D. semi-steep, partly hinged, marginal retouch along the edge on the upper face, edge sharpening and thinning, only partly successful near the base
- B. marginal retouch on the upper face, flat and semi-flat near the tip and more steep near the base, edge sharpening, correction
- I, G. semi-flat and flat removals on the lower face, surface thinning, ventral surface flattening, edge formation
- H. flat removals on the lower face near the tip, surface flattening
- C. removals on the upper face, semi-steep along the edge and more flat near the tip, surface formation, shaping
- E. steep removals near the base, angular base formation
- A. flat, broad removals, surface formation or derived before obtaining the blank
- F. ventral surface of a flake

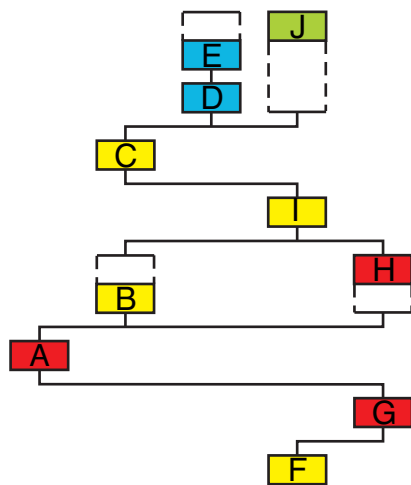




# Plate 23 Samuilica II CII.1117

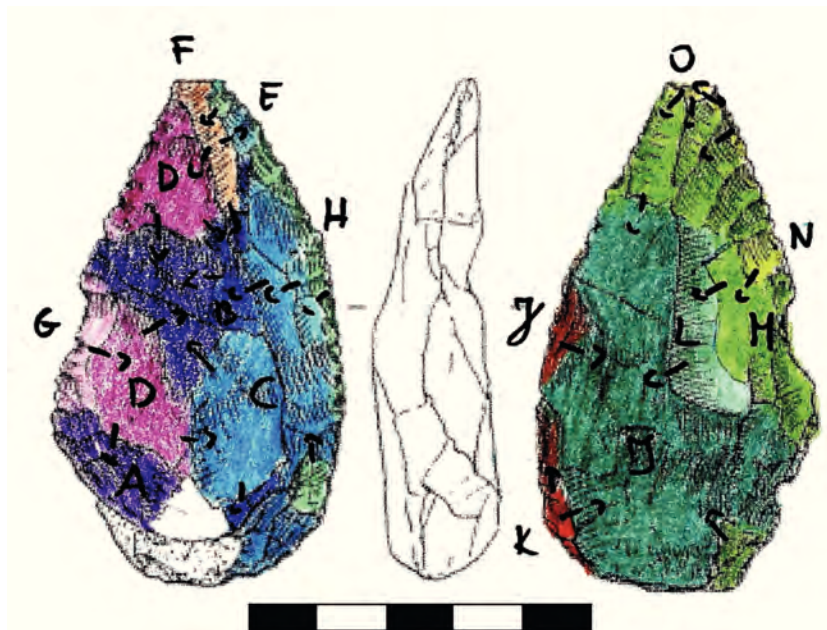


Tool with partly cortical base, one edge retouched finely and possibly resharpened, and the second edge retouched only near the tip. Tip is not exposed; part of rejuvenation process was based on deriving flat removals on the lower face from the tip.

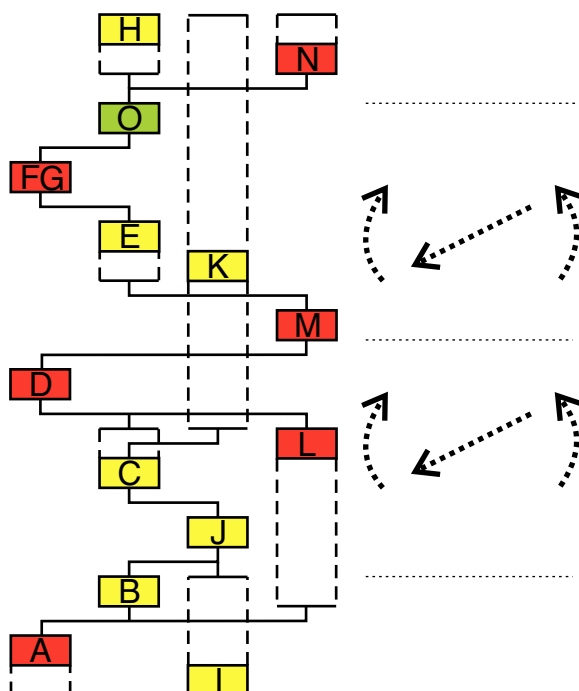


- J. flat, removals on the lower face derived from the tip, tip thinning, resharpening
- E. steep removals on the upper face of base, base blunting, correction
- D. flat removals on the upper face of base, base formation, thinning
- C. semi-steep, regular removals on the upper face along the edge, edge sharpening, perhaps a few stages of resharpening
- I. flat removals on the lower face, edge angle correction
- F, G. flat, broad, partly hinged removals on the lower face, surface/edge formation
- H. semi-flat removals on the lower face, edge formation
- B, A. flat, broad removals on the upper face, more steep near the base, surface formation

## Plate 24 Brno Bohunice BB1

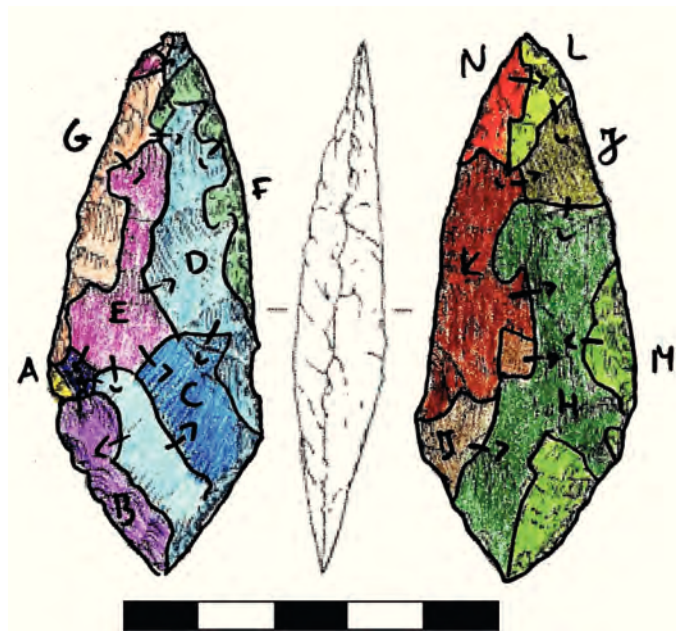


Plano-convex knife with single retouched and resharpened cutting edge and exposed tip. Base is partly cortical and unworked, the tool has no blunted back, the whole edge opposite the cutting edge was a distal posterior edge aimed at surface thinning and cutting edge angle correction on the lower face.

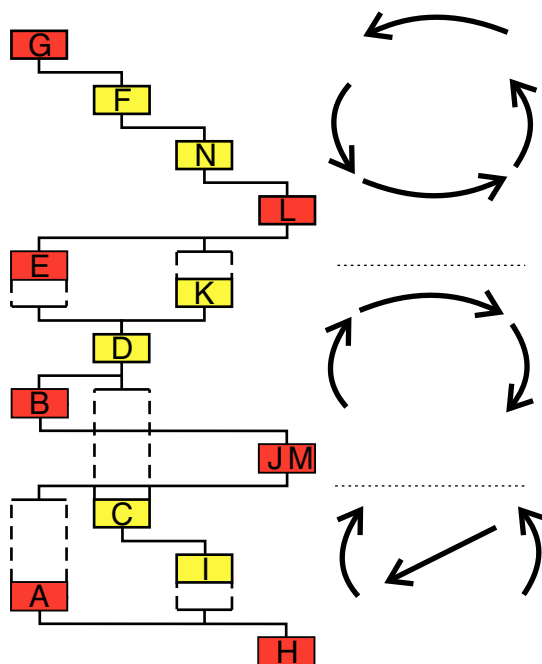


- H, E. semi-steep, intensive, marginal retouch on the upper face along the edge
- N. flat, small removals on the lower face, edge correction
- O. tip breakage, impact point in the middle of the upper surface
- F. flat, long removals on the upper face, near the tip thinning, rejuvenation
- G. semi-steep, marginal removals on the upper face, edge correction
- K. semi-flat, marginal removals on the lower face, edge correction
- M, L. flat, long, parallel removals on the lower face derived from the distal posterior edge, surface thinning, cutting edge angle correction on the lower face
- D. semi-flat removals on the upper face, surface thinning after the hinged removals of sequence A
- J. flat, broad removals on the lower face, surface formation, thinning
- C. semi-steep removals on the upper face, cutting edge formation, sharpening
- B. flat removals on the upper face, surface, edge formation
- A. semi-steep, broad, hinged removals on the upper face, surface formation
- I. ventral surface of a blank

## Plate 25 Brno Bohunice BB2



Biconvex tool with exposed tip and two biangular edges, unsuccessfully thinned near edge II. The rest of semi-steep scar of sequence A not displaced by further thinning removals of sequences B, D and E. Both edges formed similarly, intensive shaping sequences.



G. flat retouch along the edge of the upper face near the tip, edge shaping, sharpening, semi-steep removal near the tip might be usewear truncation created a notch

F. flat, marginal retouch near the tip on the upper face, edge sharpening and shaping

N, L. flat removals on the lower face near the tip, thinning, near-the-tip surface correction

E, semi-flat removals on the upper face near the tip, edge formation, thinning, shaping

D. flat removals on the upper face near the tip, edge formation, thinning, shaping, near the base, single long removal aimed at thinning the semi-steep scar of sequence A

K, J. semi-flat removals on the lower face, edge thinning, edge angle correction

B. semi-flat, marginal retouch on the upper face near the base, shaping

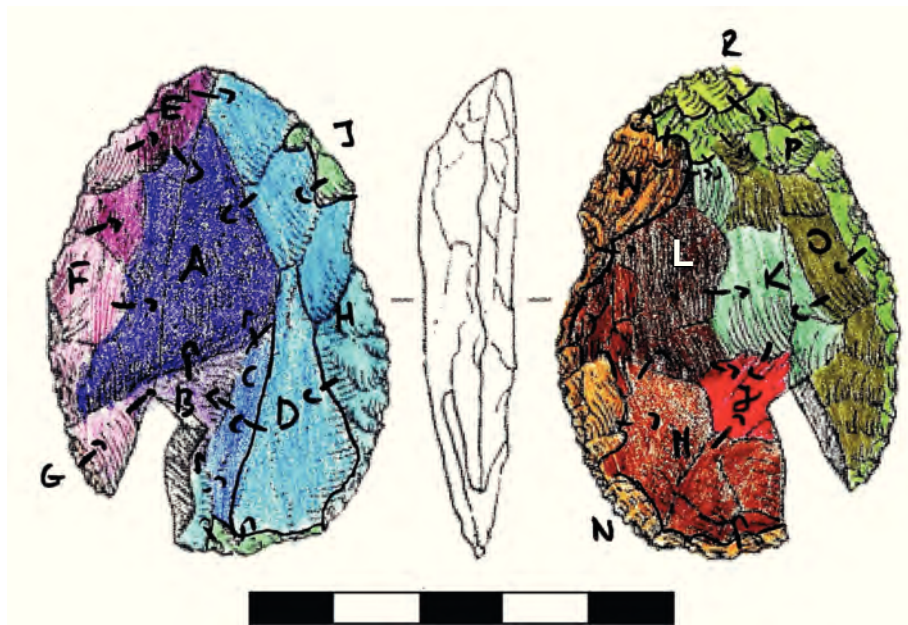
M. semi-flat removals on the lower face near the base, edge shaping

C. flat, broad removals on the upper face, shaping, surface thinning

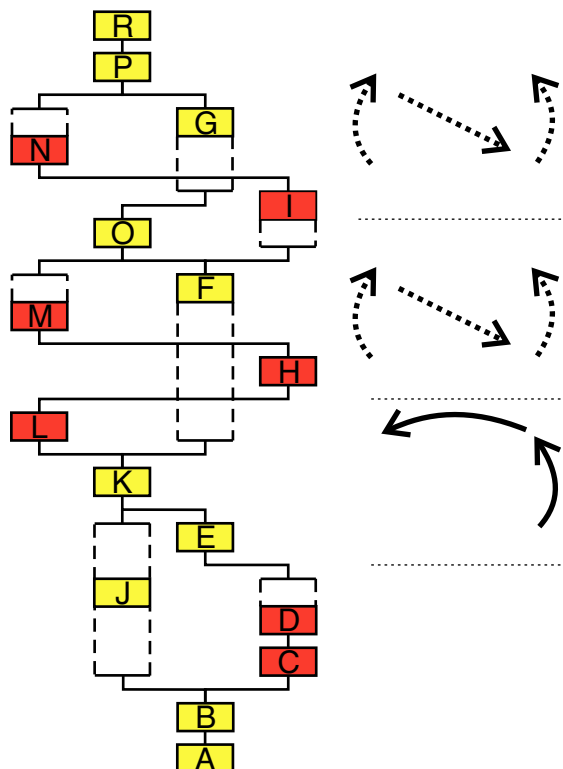
I, H. flat, broad removals on the lower face, shaping, surface thinning

A. single semi-steep removal from earlier

## Plate 26 Brno Bohunice BB3



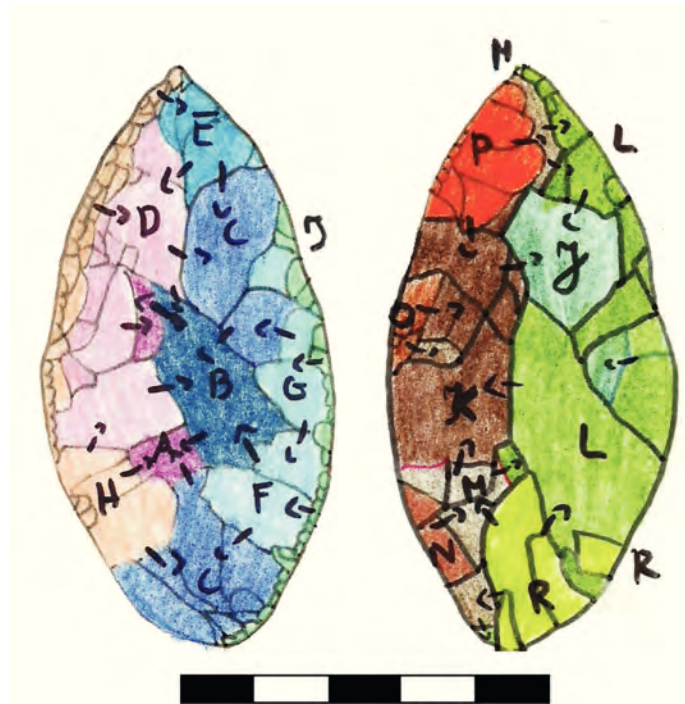
Bifacial plano-convex tool with unexposed tip, separate tip edge and retouch around all edges, resharpened along edges onto the upper face with edge angle correction on the lower face.



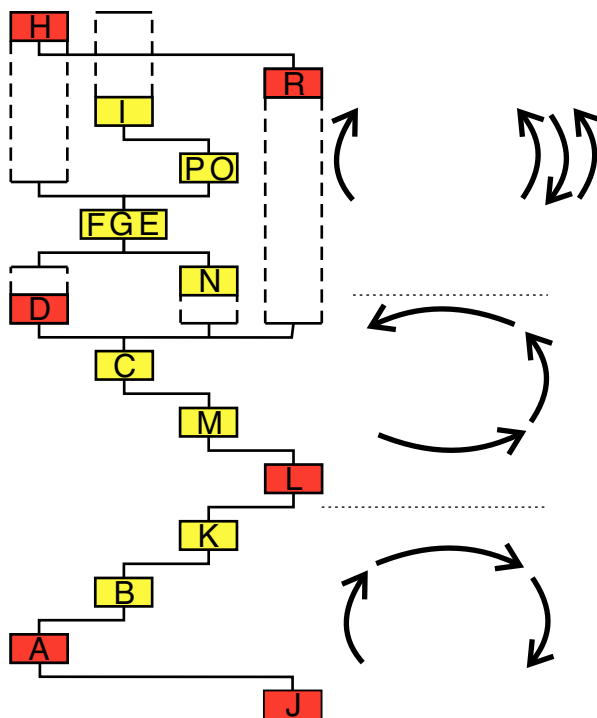
- R. semi-steep, marginal retouch on the upper face at the tip
- P. semi-steep, marginal retouch on the upper face along the edge
- G. very small, marginal removals on the lower face near the base
- N. semi-steep removals on the upper face along the edge and the base
- I. flat, marginal removals on the lower face, edge angle correction
- O, M. semi-flat removals on the upper face, edge sharpening
- E, F. flat removals on the lower face, edge angle correction
- B, A, C. flat, broad removals on the lower face, surface formation, thinning
- D, H. flat removals on the lower face, edge/edge angle formation
- K, L, J. semi-flat removals on the upper face, surface formation, thinning



# Plate 27 Brno Bohunice BB4



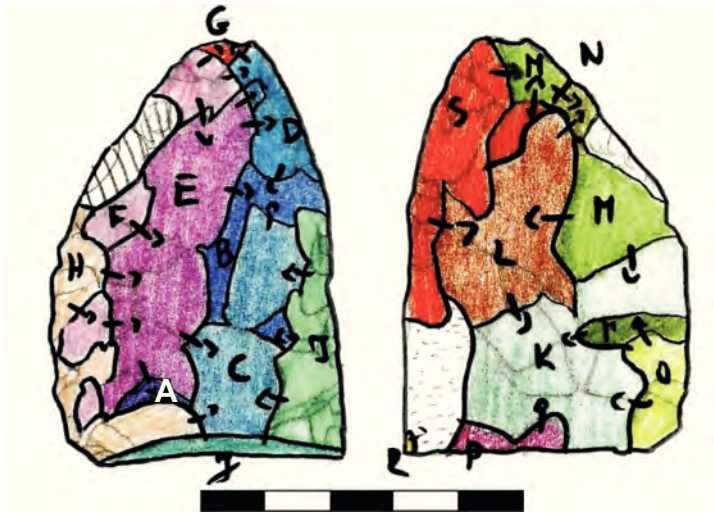
Plano-convex, symmetrical tool with very fine, marginal retouch of both edges, exposed tip and intensive shaping, no traces of resharpening.



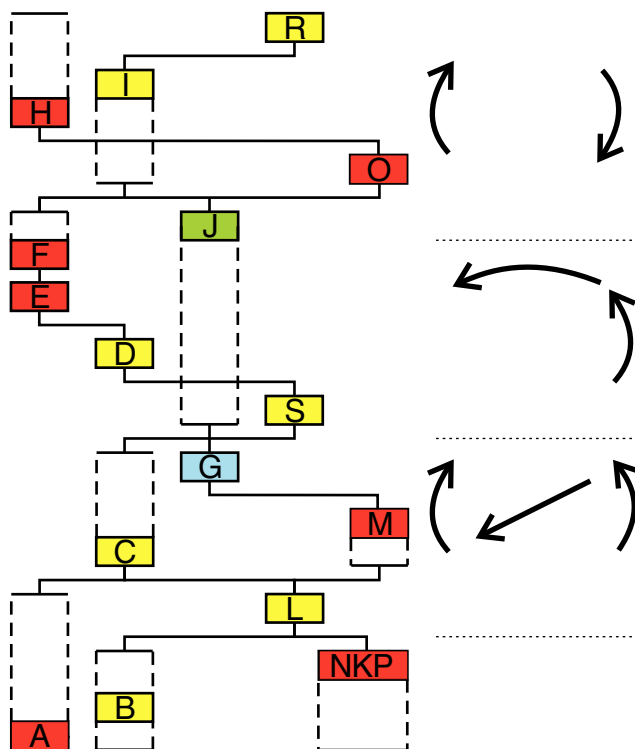
- H. semi-flat, partly hinged, marginal removals on the upper face, intensive edge shaping, correcting
- R. flat removals on the lower face near the base, shaping
- I. semi-flat, fine, marginal retouch along the edge and at the near-the-tip part
- P, O. flat thinning removals on the lower face near the tip, shaping
- E. flat removals on the upper face near the tip, edge formation, shaping
- F, G. flat removals on the upper face, edge formation
- N. flat removals on the lower face, edge correction
- D. flat removals on the upper face, shaping, edge formation near the tip
- C. semi-flat removals near the tip and the base on the upper face, shaping
- M, L. flat removals on the lower face, surface formation, shaping
- K, J. flat removals on the lower face, surface formation, thinning
- B, A. flat removals on the upper face, surface formation, thinning



## Plate 28 Brno Bohunice 64587



Plano-convex tool with flat upper face and convex, partly cortical lower face. Broken in the middle and on the tip. Tip breakage caused the remodeling of near the-tip part, but the tip remained unexposed. Both edges were also rejuvenated after transversal breakage at the base. Working edge seems to be edge I and retouch sequences D, S.



R. single, flat, small removal on the lower face, derived from the breakage scar

I. flat, partly hinged removals near the breakage, edge sharpening

H. semi-flat removals along the edge on the upper face near the breakage, partly aimed at edge correction, partly at breakage scar removing, unsuccessful, only an angle near the breakage was removed and retouched

O. small, flat removal near the breakage on the lower face, edge correction, edge angle formation for sequence H

J. transversal breakage, impact point in the middle of the upper surface

F. semi-flat removals on the upper face along the edge, edge sharpening

E, B, A. flat, broad removals on the upper face, surface formation

C. flat removals on the upper face, surface flattening

D. flat retouch on the upper face near the tip, edge rejuvenation/remodeling after tip breakage (sequence G)

S. semi-flat removals on the lower face near the tip, edge remodeling after tip breakage (sequence G)

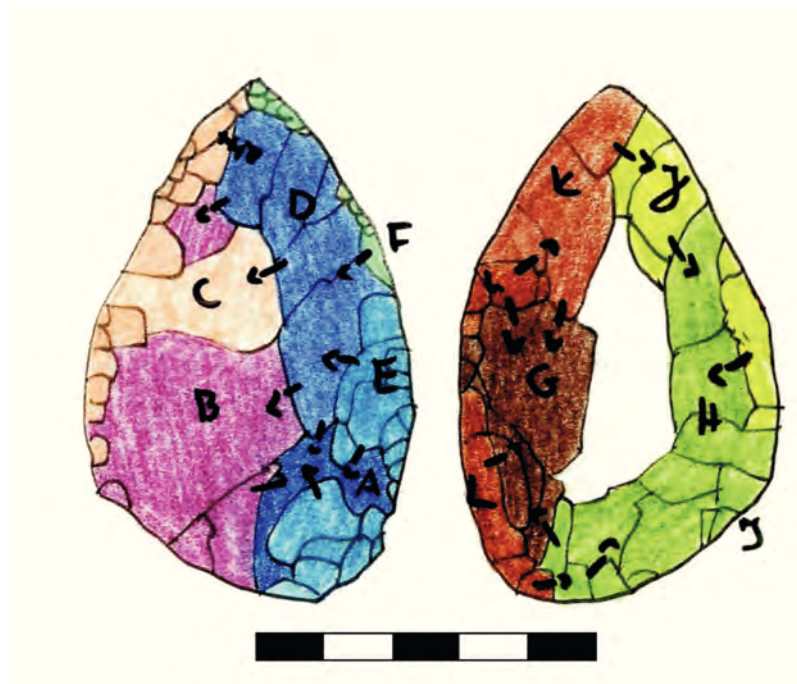
G. transversal breakage or semi-steep removal at the tip

M. semi-flat removal on the lower face, surface formation

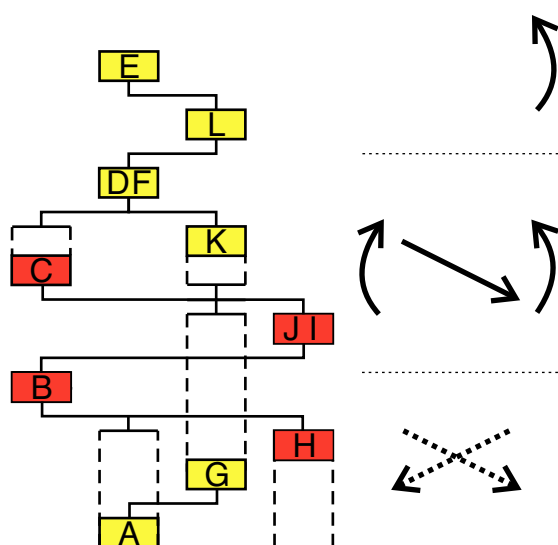
L, N, K. semi-flat removals on the lower face, surface formation, decorticating

P. small removal on the lower face derived from the breakage scar edge, base edge correction

# Plate 29 Brno Bohunice 64588

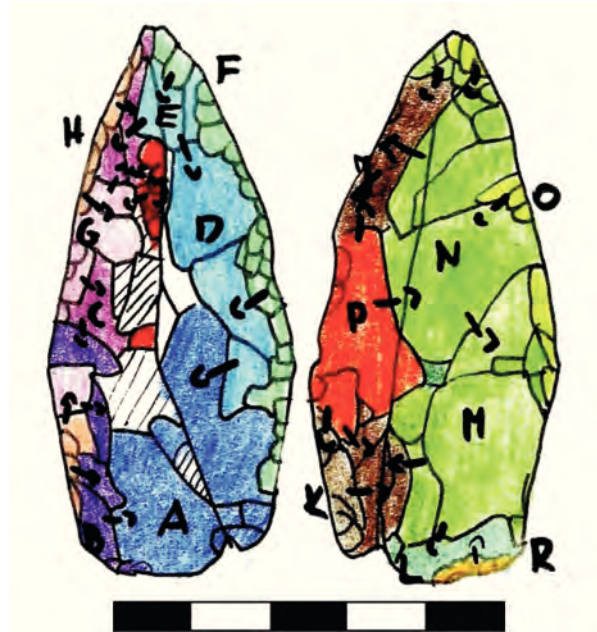


Thick, plano-convex tool with flat upper face and convex lower face, unsuccessfully thinned, only near-the-tip part retouched and worked more precisely. It might have been a flake, a Levallois type core before, with the lower face as a striking platform.

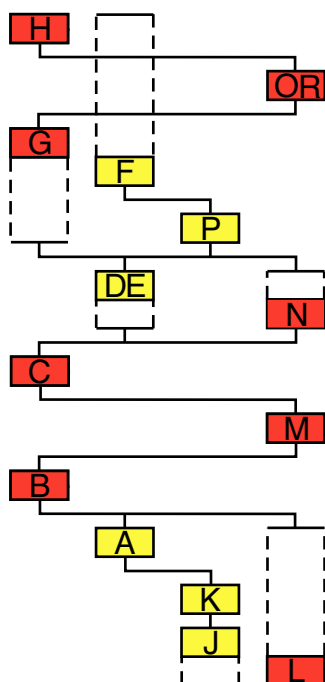


- E. flat removals on the upper face near the base, edge correction
- L. steep, hinged removals on the lower face near the base, unsuccessful thinning
- D. semi-flat removals on the upper face near the tip, edge/surface formation
- F. marginal retouch on the upper face near the tip
- K. flat removals on the lower face near the tip, edge/surface flattening near the tip
- C. flat removals on the upper face, edge formation
- I. semi-steep removals on the lower face near the base, edge correction
- J. removals on the lower face, flat near the tip and semi-steep near the base, edge formation
- B, A. flat, broad removals on the upper face, thinning
- H, G. semi-steep removals along the edge and at the base on the lower face, unsuccessful thinning, tool decorticating

# Plate 30 Brno Bohunice 64590

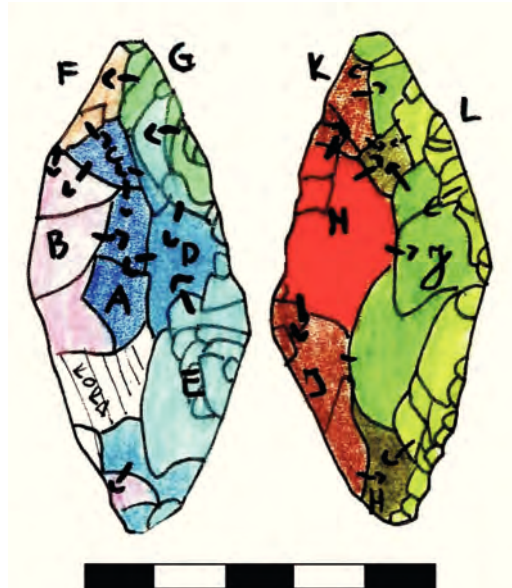


Thick, plano-convex tool probably made on a flake, with two straight edges convergent at the exposed tip. Both edges with subsequent resharpening and rejuvenation sequences derived on both surfaces.

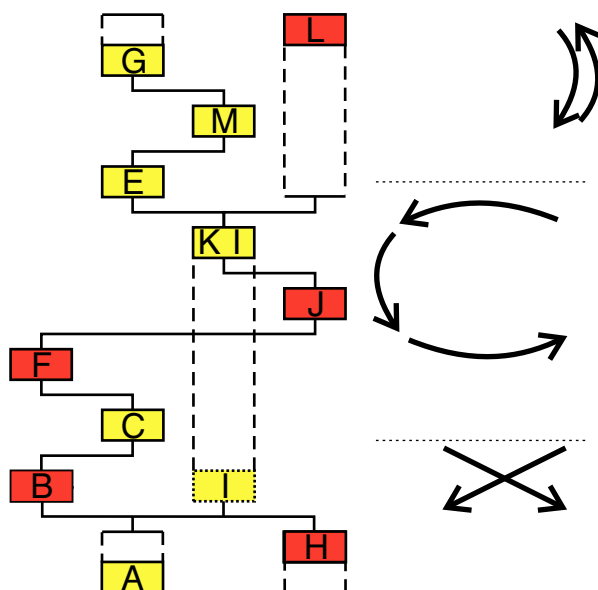


- H, F. semi-steep, marginal retouch on the upper face near the tip, edge resharpening
- R. flat, marginal truncations on the lower face at the base
- O. flat removals on the lower face, edge angle correction
- G. semi-steep removals on the upper face, edge resharpening
- E. flat removals on the upper face near the tip, thinning the near-the-tip part
- D. flat removals on the upper face, edge thinning, resharpening (?)
- P. semi-steep removals on the lower face, edge angle correction, thinning
- N. flat, broad removals on the lower face near the tip, edge angle correction, thinning, tool rejuvenation
- C, B. steep removals on the upper face, edge formation/rejuvenation (?)
- M, K, J. flat removals on the lower face, surface thinning, edge formation
- A. semi-steep removals on the upper face, surface formation
- L. ventral surface of a flake
- I. flat, marginal retouch on the edge derived after vertical tool breakage
- S. vertical tool breakage, the tool was glued afterwards, therefore it is not clearly visible

# Plate 31 Brno Bohunice 64591



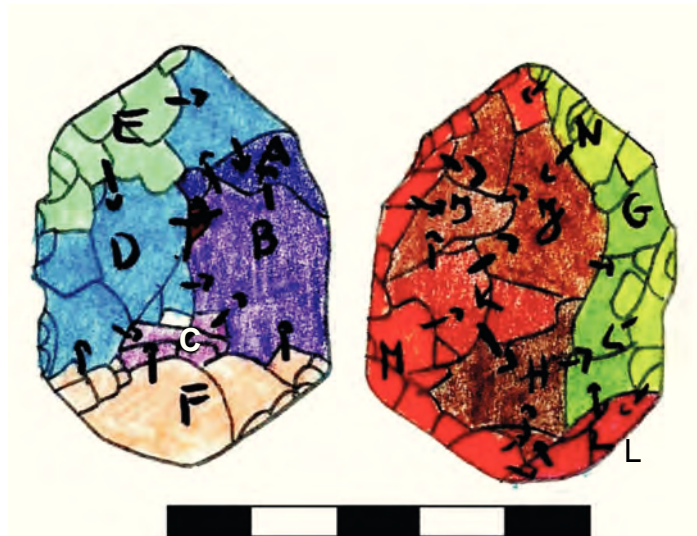
Biconvex, unfinished tool, abandoned after unsuccessful thinning and few hinged sequences from the surface formation stage of manufacturing process. Shows traces of shaping and tip exposing removals. At the last stage, symmetry was removed due to tool thinning, sequences E, M.



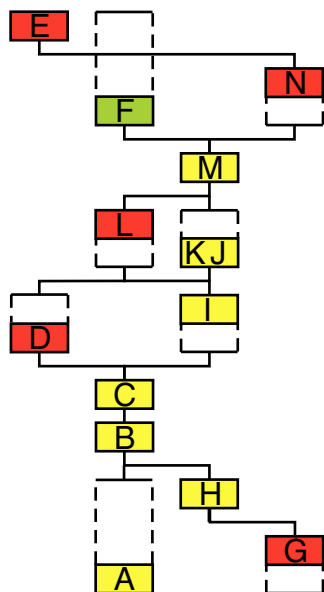
- L. semi-flat, irregular retouch on the lower face, edge correction after unsuccessful thinning
- G. semi-steep, partly hinged removals on the upper face near the tip, unsuccessful thinning
- M. semi-flat, deep removals on the lower face, partly successful sequence aimed at removing hinged scars of sequence J
- E. semi-flat, deep removals on the upper face near the base, edge angle preparation for sequence M
- K. flat removals on the lower face near the tip, edge formation, shaping
- I. semi-steep removals on the lower face near the base, surface formation
- J. flat, hinged removals on the lower face, unsuccessful thinning, surface formation, smaller near the tip
- F. semi-flat removals on the upper face near the tip, edge formation, shaping
- C. flat, broad, hinged removal on the upper face near the tip, surface formation
- B. flat and semi-flat removals on the upper face, surface formation
- A. flat removals on the upper face, surface formation, thinning
- H. flat removals on the lower face, surface formation, thinning



# Plate 32 Brno Bohunice 64592



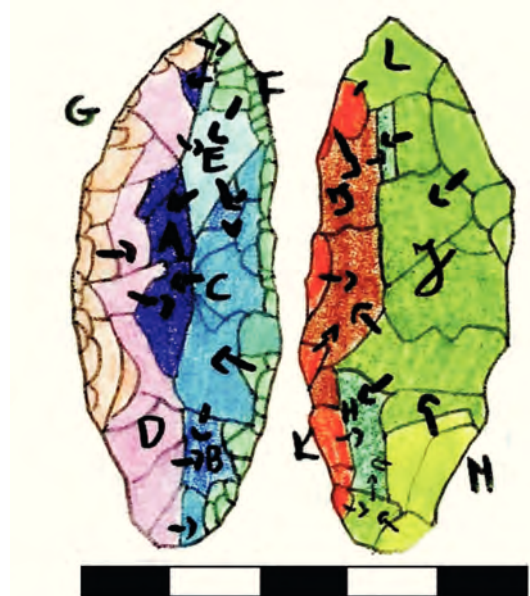
Tool with unsuccessfully thinned base, with poorly exposed tip and one retouched edge (edge I), the second edge has no marginal, sharpening retouch.



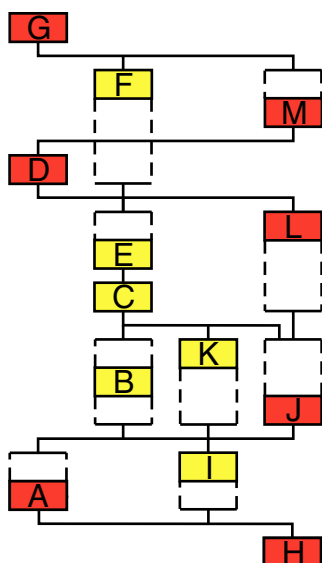
- E. flat removals on the lower face near the tip
- N. semi-flat near the base and flat near the tip, irregular, marginal removals along the edge on the upper face
- M. semi-flat and flat, regular, marginal retouch along the edge on the upper face
- F. flat, partly high hinged removals on the lower face derived from the base, surface thinning
- L. steep removals on the upper face near the base, base formation
- J, I, K, H, G. flat and semi-flat removals on the upper face, surface formation, thinning
- D. flat and semi-flat removals on the lower face, surface thinning, edge angle correction
- C. flat, hinged removals derived from the base, surface thinning
- B. semi-steep removals on the lower face, surface formation
- A. semi-flat removals on the lower face,



# Plate 33 Brno Bohunice 64593

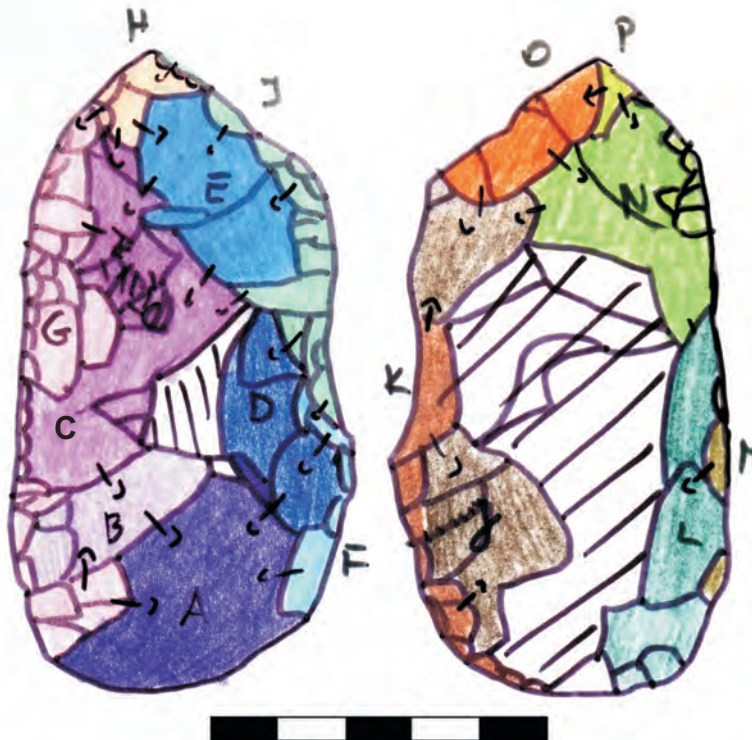


Plano-convex tool with both edges resharpended several times on the upper face, with edge angle correcting sequences on the lower face. Exposed tip is located out of axis; the tool was unsuccessfully thinned near the tip (sequence G).

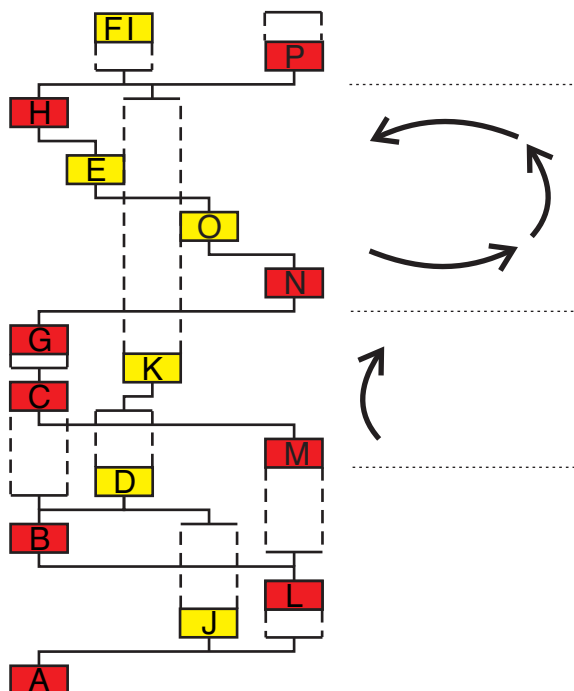


- G. semi-steep, partly hinged, marginal retouch along the edge on the upper face, edge resharpening
- F. steep, marginal retouch on the upper face along the edge, edge resharpening
- M. semi-steep, deep removals on the lower face near the base, thinning, surface correction
- D, C, E, B. semi-steep removals on the upper face, edge formation/resharpening (?)
- L. flat removals on the lower face, edge angle correction near the tip
- K, I. flat, marginal removals on the lower face, edge/edge angle correction
- J, H. flat removals on the lower face, surface formation, edge angle correction (?)
- A. semi-flat removals on the upper face, surface formation

# Plate 34 Moravsky Krumlov IV 115 670

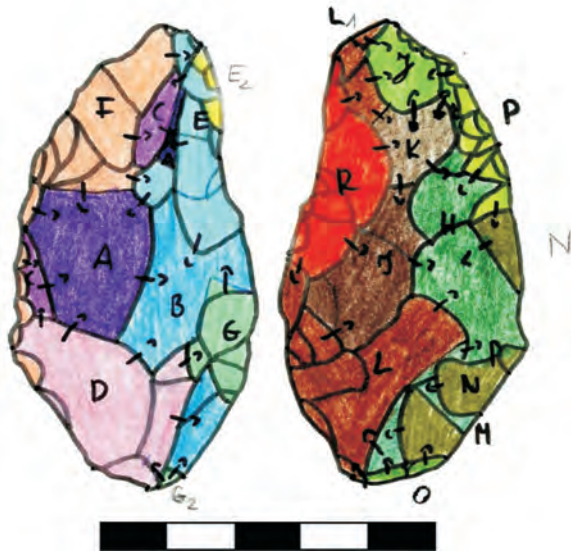


Unfinished knife, cortical on both faces, unsuccessfully thinned on the lower face (sequence K damages edge I). One of edges (edge II) was retouched at the end and the tool was probably used.

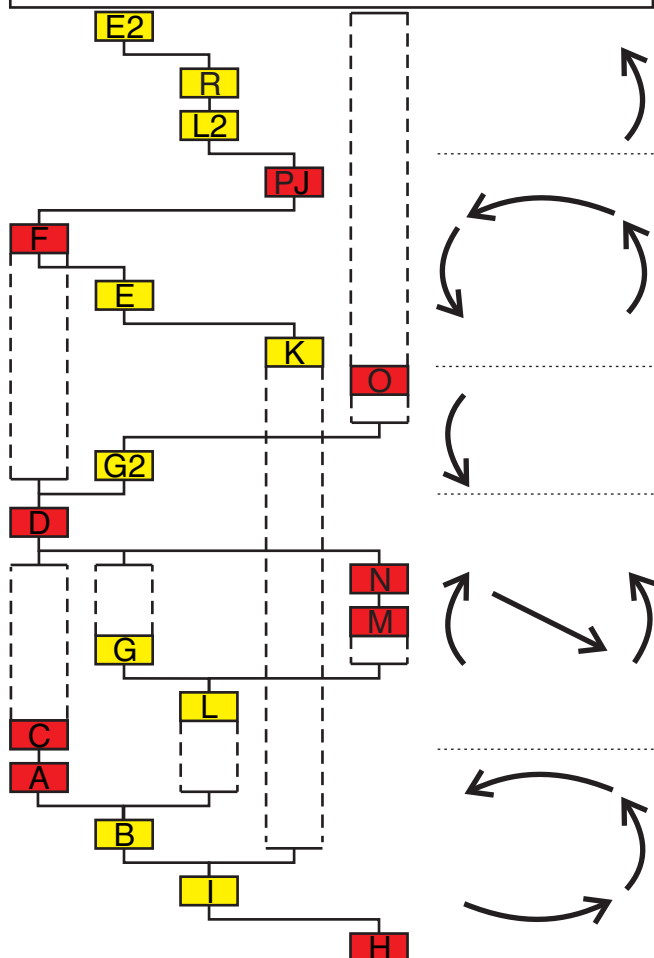


- F, I. flat, hinged, marginal retouch, edge formation
- O. semi-steep removals on the lower face near the tip, distal posterior edge formation
- P. semi-flat removals on the lower face, edge correction
- H, G. flat retouch on the upper face, edge sharpening
- N, M. semi-flat removals on the upper face, surface thinning, edge angle formation
- K. deep, hinged removals on the lower face, unsuccessful edge angle formation before sequences F, I
- C, B, E. flat, partly hinged removals on the upper face, surface thinning
- L. semi-flat removals on the lower face, surface formation, decortication and thinning
- J. flat removals on the lower face, surface formation, decortication and thinning
- D. semi-steep, hinged removals on the upper face, surface/edge formation
- A. flat, broad removals on the upper face, surface formation, thinning or ventral surface of a flake

# Plate 35 Moravsky Krumlov IV 115 671



Unfinished, partly cortical knife with poorly exposed tip and only one edge retouched and resharpened near the tip (sequences R, E1 and E2). The tool was unsuccessfully thinned on the lower face (sequences P, N). The tool bears traces of shaping (sequences D, L).



E2. semi-steep, marginal retouch on the upper face near the tip, edge resharpening

R. flat, hinged removals on the lower face, edge angle correction, thinning

L2, L1. flat removals on the lower face, edge angle correction, thinning

P. semi-steep removals on the lower face, unsuccessful edge correction, thinning

J. flat removals on the lower face, edge angle correction, thinning

F. semi-flat removals on the upper face near the tip, edge thinning, rejuvenation

E1. semi-steep removals on the upper face near the tip, edge resharpening

N, M. flat removals on the lower face, edge angle correction

K, I, H. flat, broad removals on the lower face, surface formation

O. semi-steep removals on the lower face at the base, base formation

G1. flat removals on the upper face, edge sharpening

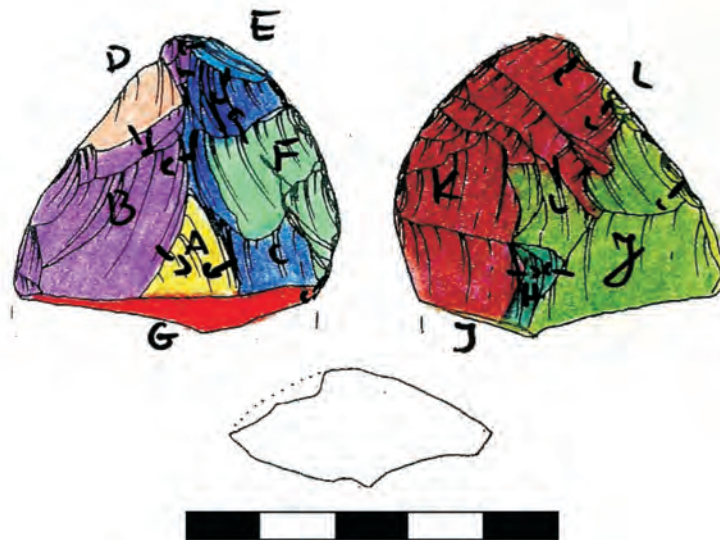
G2. semi-steep removals on the upper face at the base, base formation

D. semi-steep and semi-flat removals on the upper face near the base, surface thinning, edge formation

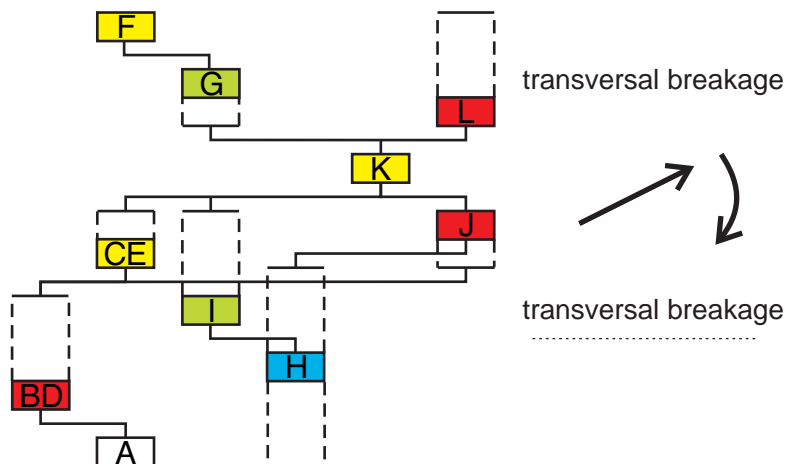
C. flat removals on the upper face, edge formation, thinning

A, B. flat and semi-flat, broad removals on the upper face, surface formation, decortication

# Plate 36 Moravsky Krumlov IV 115 711



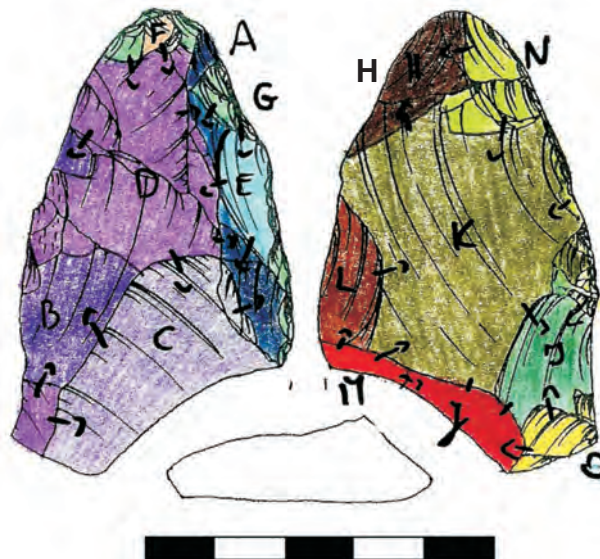
Plano-convex tool made on a flake (?) with broken base, two breakage scars at the base, and poorly exposed tip. It was thinned by flat, angular removals derived from the tip.



- F. flat, partly hinged removals on the upper face, surface rejuvenation after breakage
- E. flat, partly hinged removals on the upper face near the tip, thinning
- K. flat, regular, angular removals on the lower face near the tip, edge thinning, edge angle correction
- G. transversal breakage, impact point probably on edge I
- L. flat, irregular, marginal retouch on the lower face, edge sharpening
- D. single, semi-flat, hinged, angular removal, unsuccessful thinning near the tip
- J. flat removals on the lower face, surface formation, thinning
- I. abrupt surface at the base, previous transversal breakage scar (?)
- C, B. semi-flat removals on the upper face, edge formation
- A. single, flat, broad removal on the upper face, surface formation, thinning
- H. ventral surface of a flake (?)



# Plate 37 Moravsky Krumlov IV 115 736



Plano-convex tool with unexposed tip and cutting edge retouched several times on the upper face. Lower face was used for edge angle correction. The tool was broken in its half and remodeled/resharpened after breakage.

- O. semi-steep removals on the lower face near breakage, base part remodeling after breakage
- M. steep removals at the base, base part remodeling after breakage
- G, F, E. semi-steep and steep, marginal retouch on the upper face along the edge and the tip, edge resharpening
- N, L, I. flat and semi-flat removals on the lower face, edge angle correction
- J. transversal breakage at the base
- K, H. flat, broad removals on the lower face, surface thinning
- D. semi-flat, broad removals on the upper face, surface thinning, near-the-tip part formation
- C. single, flat, hinged removal on the upper face, surface thinning
- B. semi-flat removals on the upper face, surface formation, thinning
- A. semi-steep removals on the upper face, edge sharpening (previous stages of

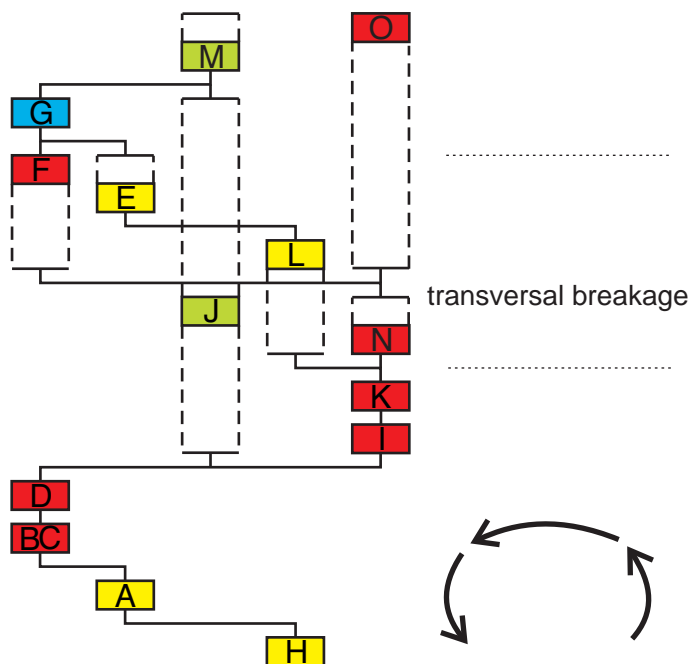
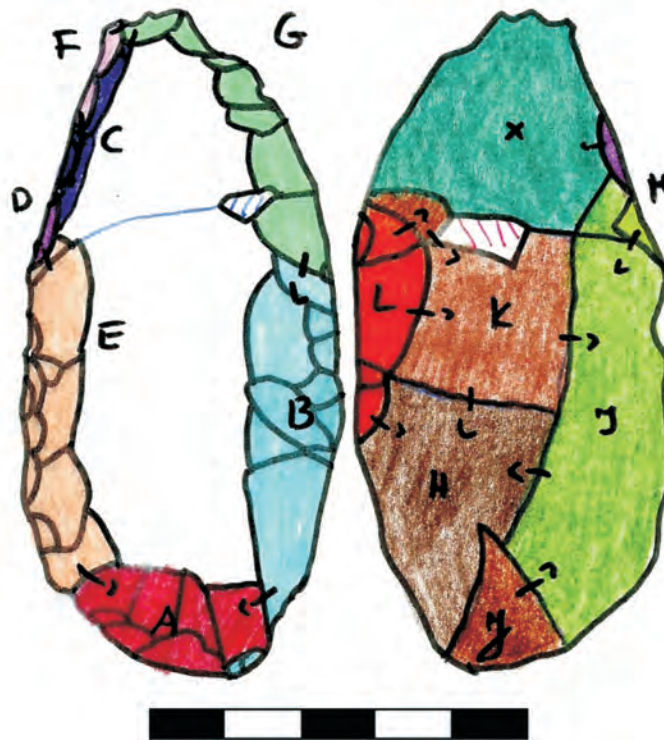


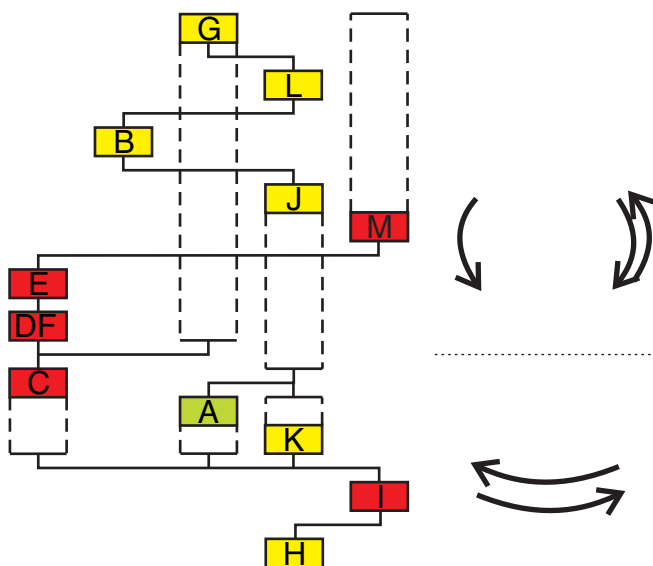


Plate 38 Moravsky Krumlov IV 115 769

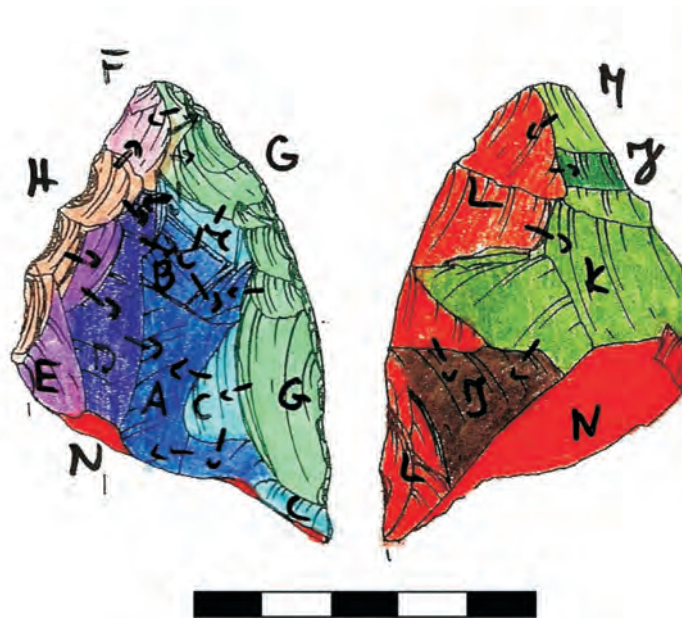


Unfinished, plano-convex tool with unexposed tip, abandoned at the stage of decortication and edge formation. Lower face was unsuccessfully thinned and used for edge angle correction. Edge II was blunted, perhaps so as to create appropriate angle for flat, thinning removals on the lower face.

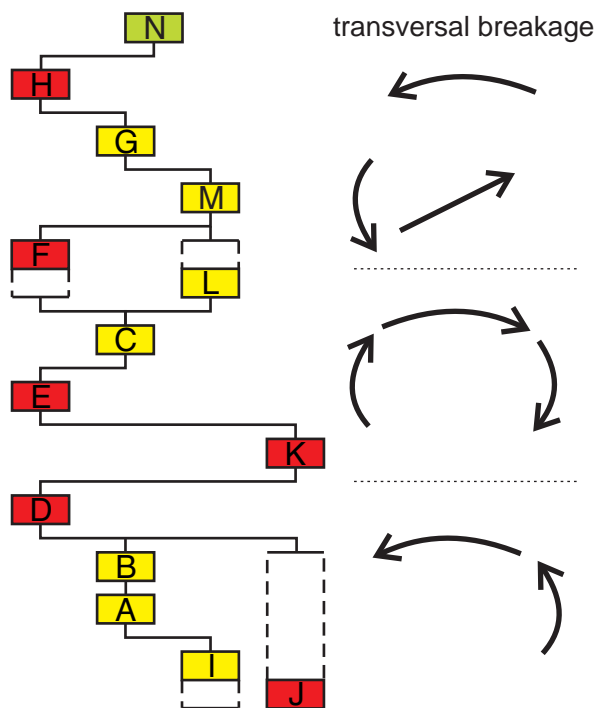
- G. semi-steep removals on the upper face near the tip, edge formation, decortication
- L, M. flat, hinged removals on the lower face, edge angle correction
- B, E. semi-steep removals on the upper face, edge formation, decortication
- J, K. flat removals on the lower face, thinning, edge angle formation
- A. steep removals on the upper face at the base, decortication, base formation
- C. semi-flat removals on the upper face near the tip, surface formation, decortication
- F. steep removals on the upper face near the tip, edge blunting, edge angle formation (?)
- D. steep removals on the upper face near the tip, edge blunting, or transversal breakage
- I, H. flat, broad removals on the lower face, surface formation, thinning



# Plate 39 Moravsky Krumlov IV 115 778

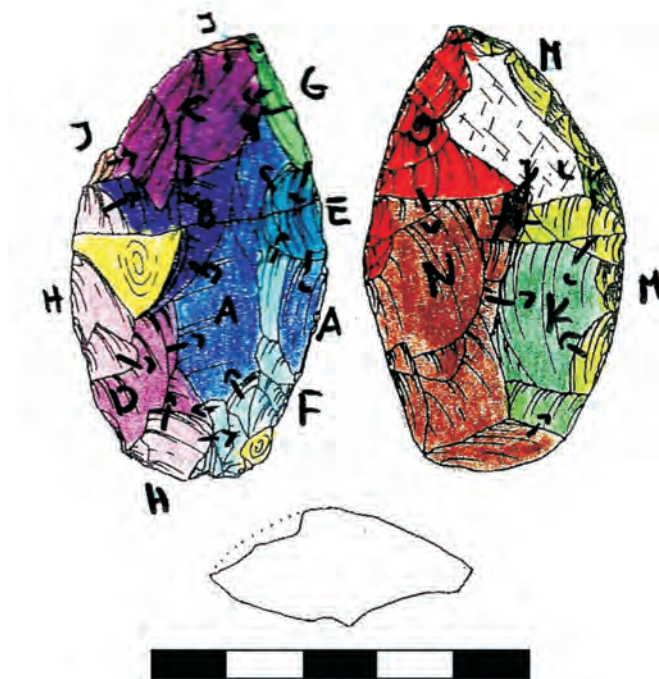


Plano-convex tool broken in its half, with poorly exposed tip and both edges rejuvenated several times. Edge II has denticulated retouch on the upper face. Lower face was used for edge angle correction.

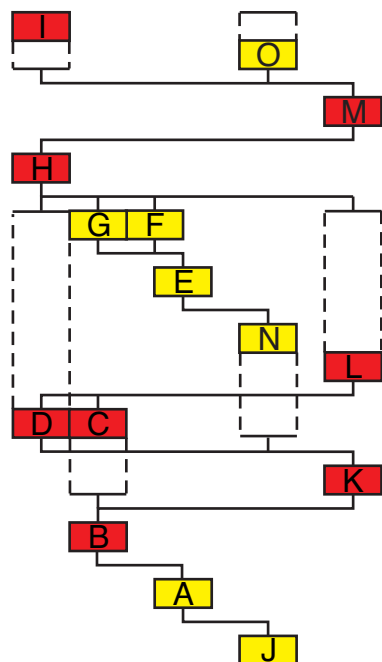


- N. transversal breakage
- H. semi-steep, deep, hinged removals on the upper face, denticulated retouch
- G. semi-flat, hinged removals on the upper face, edge resharpening
- F. semi-steep retouch on the upper face, edge resharpening
- M. flat removals on the lower face, edge angle correction
- L. semi-flat removals on the lower face, edge angle correction
- E. flat, hinged removals on the upper face, edge rejuvenation/formation (?)
- B, C. flat, hinged scars, earlier stages of edge resharpening
- A, D. flat, broad removals on the upper face, surface formation
- K, I. flat removals on the lower face, surface thinning
- J. flat scar, surface formation or ventral surface of a flake (?)

# Plate 40 Moravsky Krumlov IV 115 828

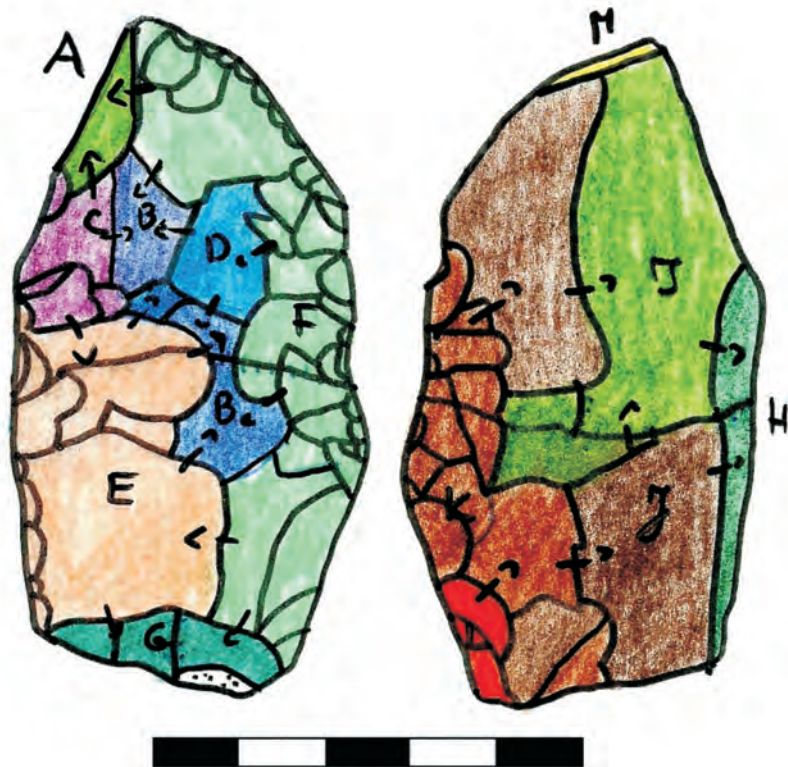


Biconvex, thick tool with exposed tip, one nearly vertical edge and another more convex one. The tool was unsuccessfully thinned on the lower face (sequence J was not removed). It was intensively thinned from cutting edge side onto the lower face (sequence N).

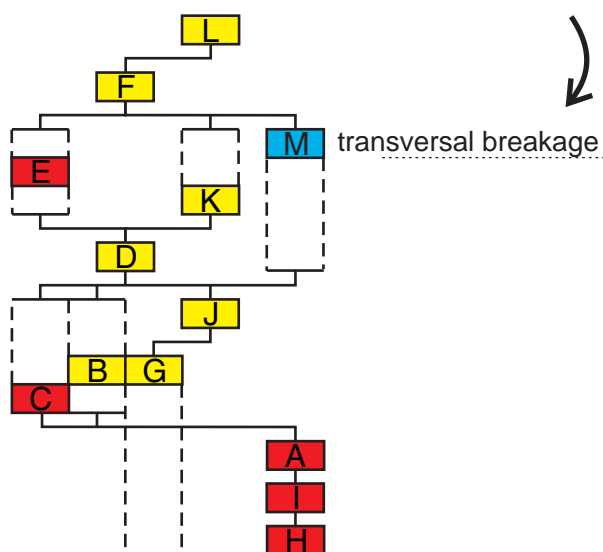


- I. flat, small truncations on the upper face near the tip, edge correction
- O. semi-flat removals on the lower face, edge angle correction, near-the-tip part thinning
- M. semi-flat, partly hinged removals on the lower face, unsuccessful thinning near the tip
- H. flat removals on the lower face near the base, thinning
- G. flat removals on the upper face near the tip, edge angle correction before sequence O
- F. semi-flat retouch on the upper face near the base, edge sharpening
- E. flat removals on the upper face, edge formation, thinning
- N, K, J. flat removals on the lower face, surface formation, thinning
- C. flat removals on the upper face near the tip, near-the-tip part thinning
- D. semi-flat removals on the upper face near the base, surface/edge formation
- L. single, semi-steep removal on the lower face, edge thinning
- A, B. flat, broad removals on the upper face, surface formation

Plate 41 Moravsky Krumlov IV 115 907



Unfinished tool, abandoned at the stage of thinning and removing abrupt surface (sequences H, A).



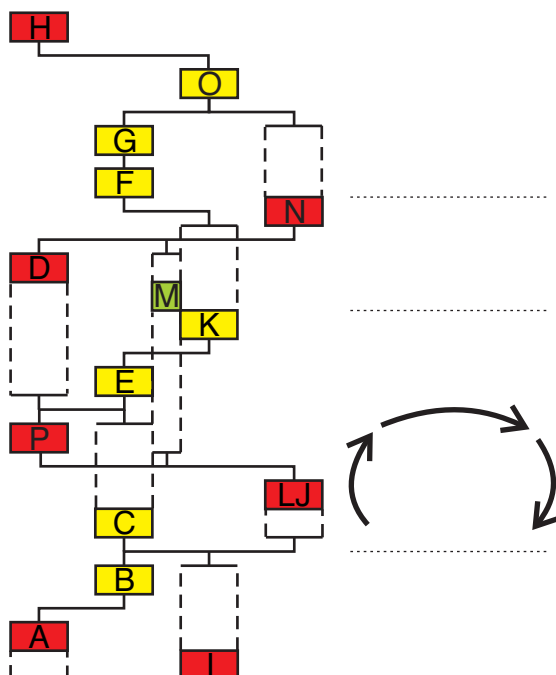
- L, K. flat removals on the lower face, edge angle formation, thinning
- F. flat removals near the tip and more steep near the base, surface thinning, edge formation
- E. flat removals on the upper face near the base, surface formation, thinning and abrupt surface (sequences H, A) removing
- D, B. flat removals on the upper face, surface formation, thinning
- I, J. flat, broad removals on the lower face, surface thinning
- G. flat, irregular removals at the base, partly cortical, surface thinning
- C. semi-steep/steep removals on the upper face, edge thinning, abrupt surface A removal
- A. steep, blunting removal on the upper face, edge angle formation before surface thinning
- H. steep, blunting removal on the lower face, edge angle formation before surface thinning
- M. transversal breakage at the tip



# Plate 42 Vedrovice V 16840



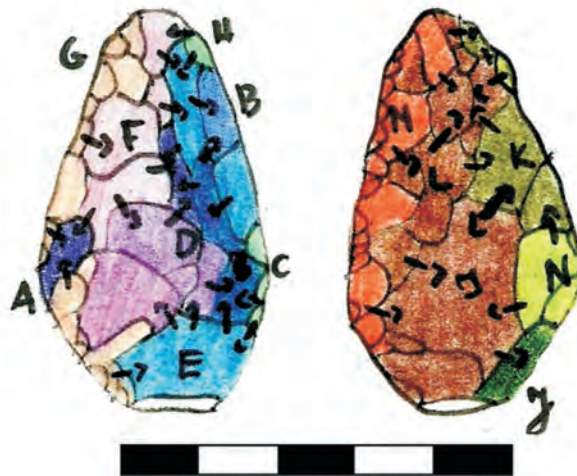
Plano-convex tool with exposed tip and straight cutting edge. The tool was rejuvenated subsequently on cutting edge and distal posterior edge. The tool was precisely worked.



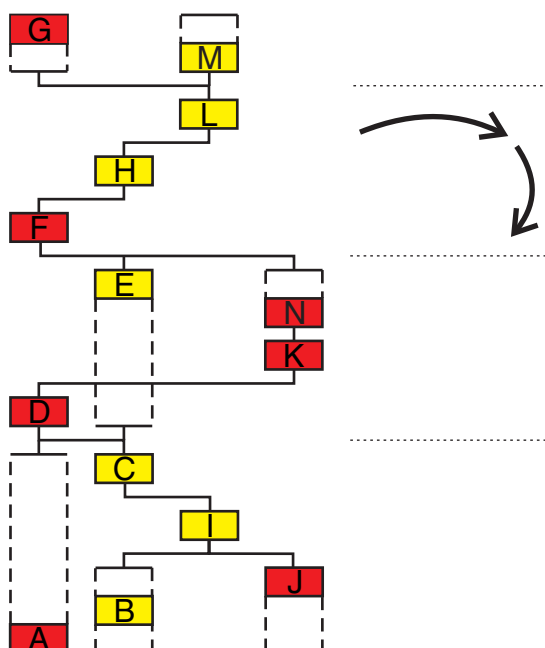
- H. semi-steep, marginal retouch on the upper face, near-the-tip part thinning
- O, K. flat removals on the lower face, edge resharpening, thinning
- G, F. semi-flat, marginal retouch on the upper face, edge resharpening
- N, L, J. flat removals on the lower face, edge angle correction, thinning
- D. semi-flat/semi-steep retouch on the upper face, edge resharpening
- P. single, semi-flat removal on the upper face near the tip, near-the-tip part thinning
- M. flat, far going removals on the lower face derived from the base, surface thinning,
- E. flat removals on the upper face, semi-steep near the base, edge resharpening
- B, C. flat removals on the upper face, subsequent edge resharpening
- A. flat scar on the upper face, earlier stages of manufacturing process
- I. flat, hinged scar on the lower face, earlier stages of manufacturing process



# Plate 43 Vedrovice V 16841

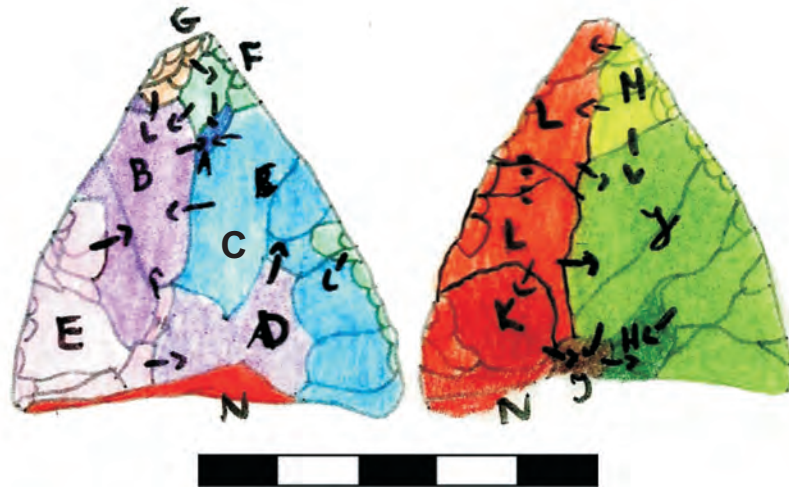


Plano-convex tool with cortical base and unexposed tip. Both edges were resharpened alternately. Cutting edge was resharpened by flat retouches applied on the lower face and distal posterior edge by retouches derived on the upper face. Possibly, such manner was used only for the last stages of rejuvenation, and previously, cutting edge was resharpened on the upper face (sequences B, E).

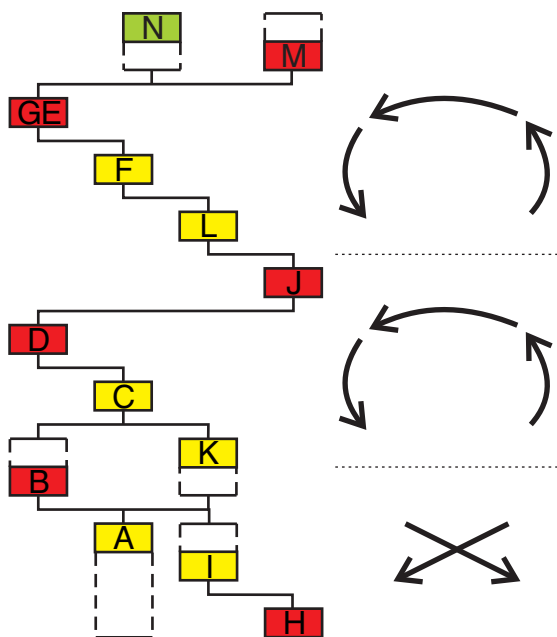


- G. semi-flat, partly hinged, marginal retouch on the upper face, edge resharpening
- M. flat, deep, marginal retouch on the lower face, edge rejuvenation, resharpening
- L. flat, deep removals on the lower face, edge rejuvenation, resharpening
- H. semi-flat removals on the upper face, edge correction
- F. semi-flat removals on the upper face, analogical to sequence L, edge resharpening
- E. semi-flat removals on the upper face, edge thinning, resharpening (?)
- N, K. flat removals on the lower face, edge angle correction
- D. flat removals on the upper face near the base, surface thinning
- C. semi-steep removals on the upper face, edge resharpening (?)
- I. flat, broad removals on the lower face, surface formation, edge angle formation (?)
- J. semi-steep removals on the lower face, earlier stages of manufacturing process
- A. scars of broad removals on the upper face, earlier stages of manufacturing process
- B. semi-steep removals on the upper face, earlier stages of manufacturing process

# Plate 44 Vedrovice V 16842

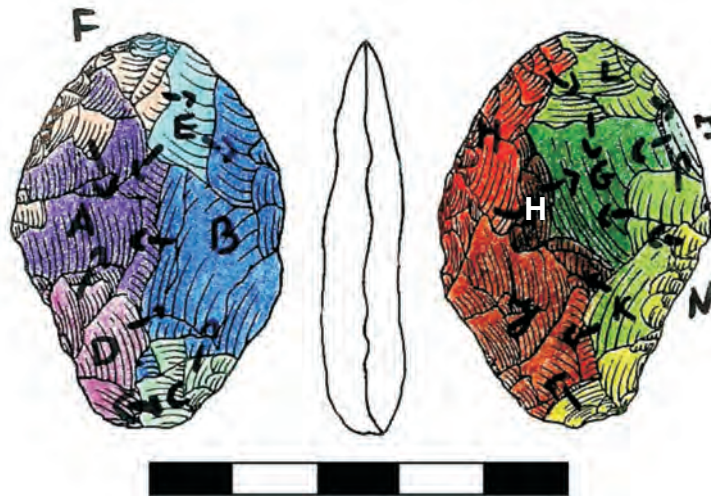


Plano-convex near-the-tip part of broken tool/preform (?) with precise shaping and tip sharpening. Near-the-tip part was probably used and resharpened.

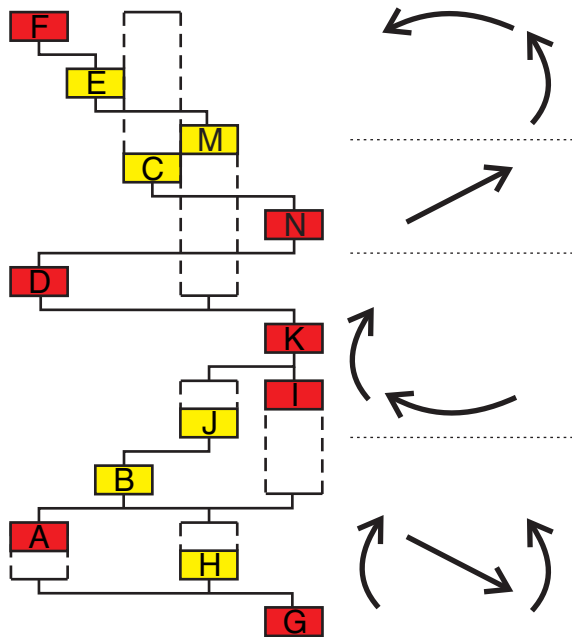


- N. transversal breakage
- M. flat, marginal removals on the lower face near the tip, edge correction
- G. flat, marginal retouch on the upper face at the tip, edge resharpening
- F. semi-flat, marginal retouch on the upper face, edge resharpening
- E. flat removals on the upper face, edge thinning, sharpening
- J, L. flat, angular, far going removals on the lower face, edge angle correction, shaping
- D. flat removals on the upper face, surface thinning
- C. semi-flat/semi-steep removals on the upper face, edge formation
- B. flat removals on the upper face, surface formation, thinning
- K. flat removals on the lower face, edge angle formation
- I. single, flat scar on the lower face, earlier stages of manufacturing process, surface formation, thinning (?)
- H. single, semi-flat scar on the lower face, earlier stages of manufacturing process, surface formation, thinning (?)
- A. flat scar on the upper face, earlier stage of manufacturing process

# Plate 45 Vedrovice V 50140

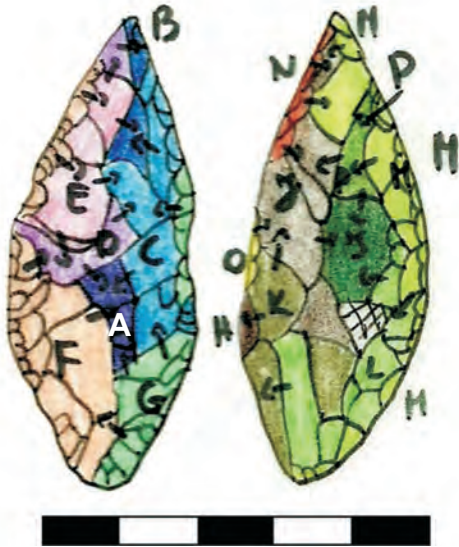


Plano-convex tool with unexposed, rounded tip.  
Tool orientation was changed during rejuvenation phase and base was sharpened afterwards.  
Previously, the tool was retouched on both edges, near the opposite end.

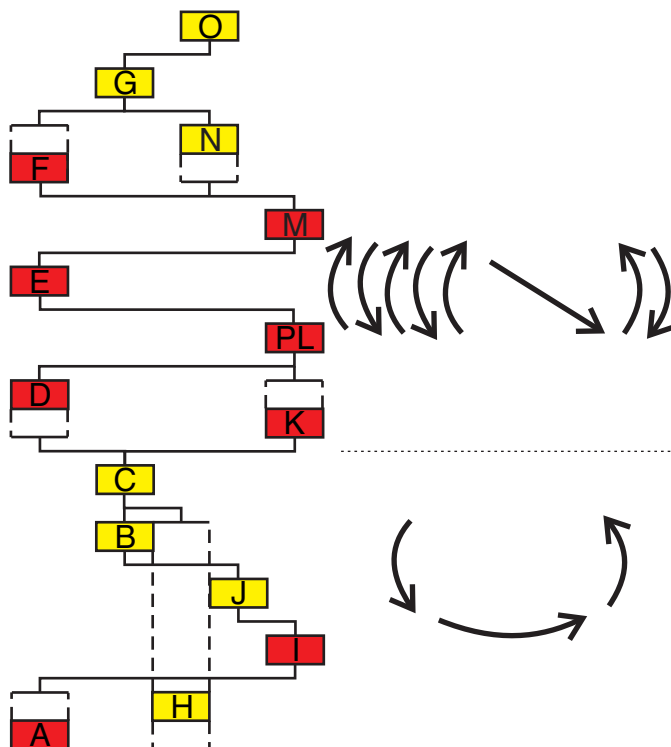


- F, E. flat, marginal retouch on the upper face at the tip, edge sharpening
- M. semi-flat, marginal retouch on the lower face near the tip, edge resharpener
- C. flat, marginal removals on the upper face at the base, edge resharpener
- N. semi-steep, marginal retouch on the lower face near the base, edge resharpener, probably before orientation change
- D. flat removals on the upper face near the base, edge angle correction
- K, L. semi-steep removals on the lower face near the base and flat removals near the tip, edge formation
- J. semi-flat removals on the lower face near the base, edge formation, sharpening (?)
- B. semi-flat removals on the upper face, surface formation, thinning
- A. flat removals on the upper face, surface formation, thinning
- I. flat, hinged removals on the lower face, surface formation, thinning
- H, G. flat, broad removals on the lower face, surface formation, thinning

# Plate 46 Vedrovice V 50142



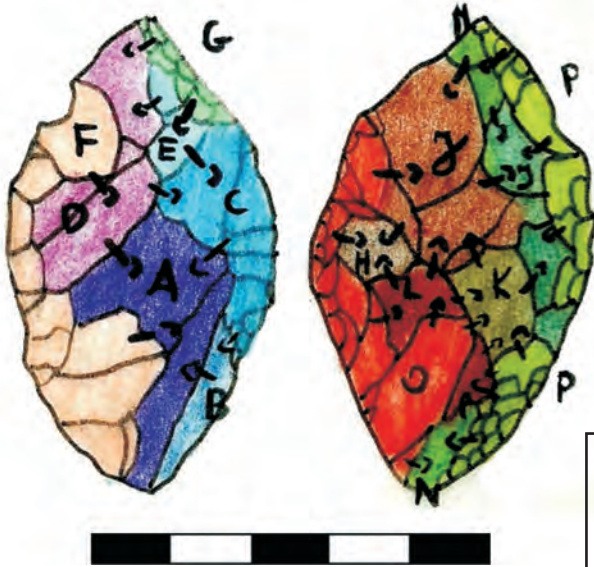
Biconvex leafpoint with heavily exposed tip. One of edges is less concave than the opposite. The tool was heavily shaped and thinned during manufacturing process, but it bears no traces of sharpening or resharpening retouches. All removals were aimed at changing tool shape. Last sequences were derived in near-the-base part. Due to edge scheme of knapping, the knapper was unsuccessful in obtaining fully symmetrical shape.



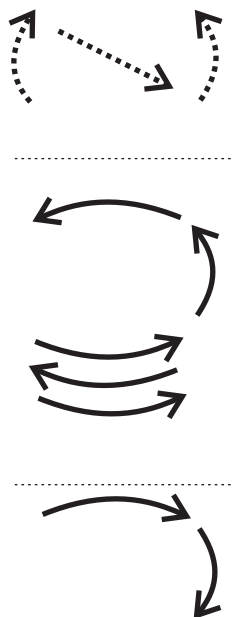
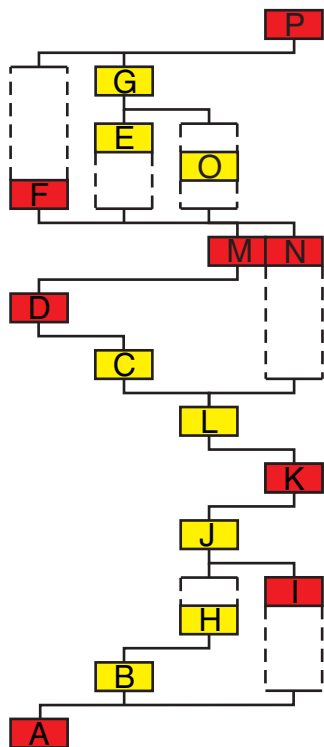
- O. marginal retouch on the lower face, partly usewear (?)
- G. flat, marginal retouch on the upper face near the base, shaping
- N. flat, marginal retouch on the lower face near the tip, edge correction
- F. semi-flat removals on the upper face near the base and marginal retouch along the edge, edge shaping
- M. flat, marginal retouch on the lower face, edge formation, shaping, thinning
- E. semi-flat, deep removals on the upper face near the tip, edge thinning, shaping
- P. single, flat removal on the lower face, edge angle correction, shaping
- L. flat, partly hinged removals on the lower face near the base, shaping
- D, B. flat and semi-flat removals on the upper face, semi-steep near the tip, thinning, shaping
- C. semi-flat removals on the upper face, edge formation, thinning
- K. flat removals on the lower face near the base, thinning
- J. flat, broad removals on the lower face near the tip, thinning, shaping
- H. semi-steep scar on the lower face, earlier stages of manufacturing process
- I. single, flat removal on the lower face, surface formation, thinning
- A. flat scar on the upper face, earlier stages of manufacturing process



# Plate 47 Vedrovice V 50143



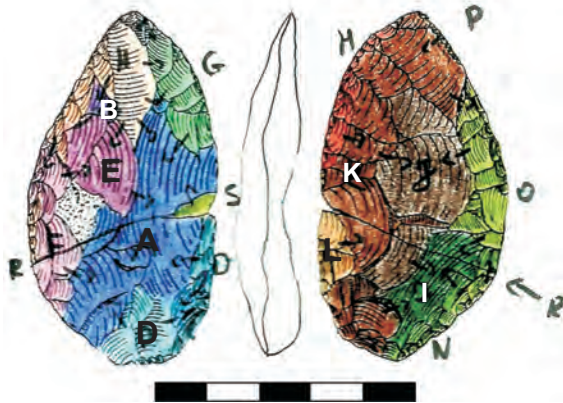
Biconvex tool, only partly successfully thinned, with exposed tip and base. It was shaped by angular removals derived near the tip and near the base, near-the-base part left unthinned (sequence B, C).



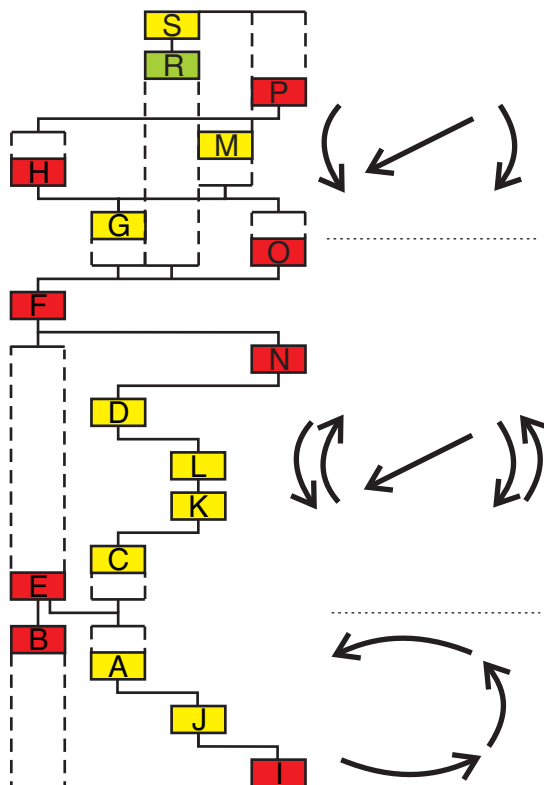
- P. semi-flat, deep, irregular, marginal retouch on the lower face, edge correction
- G. flat, marginal retouch on the upper face near the tip, edge correction
- E. semi-flat removals on the upper face near the tip, edge thinning
- O. flat removals on the lower face near the base, edge thinning, partly successful, analogical to sequence F
- F. flat removals on the lower face near the base, edge thinning, analogical to sequence O
- N. single, semi-flat removal on the lower face at the base, base thinning
- M. semi-steep removals on the lower face at the tip, tip thinning
- D. semi-flat removals on the upper face near the tip, shaping
- S. semi-steep removals on the upper face, aimed at removing the B sequence and thinning, partly successful
- K, L. flat removals on the lower face near the base, surface formation, thinning, shaping
- J, I. semi-flat removals on the lower face near the tip, surface formation, thinning, shaping
- B. single, semi-steep removal on the upper face near the base, surface formation
- A. flat, broad removals on the upper face near the base, surface formation, thinning
- H. semi-flat scar on the lower face, surface formation, thinning



## Plate 48 Vedrovice V 50144



Plano-convex, inverted knife with unsuccessfully thinned near-the-base part. Tip is poorly exposed and located out of vertical axis. It was broken at the end of chaîne opératoire; broken tip part was reused (?). The tool bears traces of rejuvenation on breakage scar. Cutting edge is located on the left side of the upper face and was resharpened several times. Distal posterior edge was used for long removals aimed at thinning the near-the-tip part on the lower face.

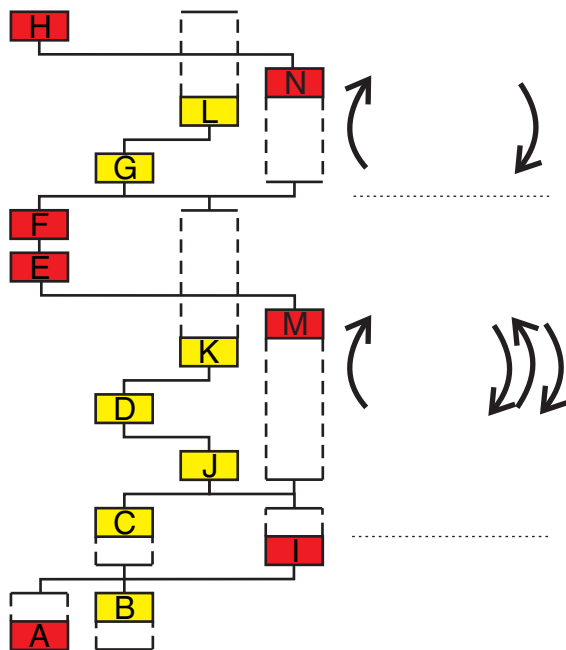


- S. semi-steep removals on the breakage scar derived after breakage
- R. transversal breakage
- P. very fine, marginal retouch on the lower face near the tip, usewear
- H. semi-flat, invasive, marginal retouch on the upper face and far going removals near the tip, edge resharpening and near-the-tip part thinning
- M. flat, marginal retouch on the lower face near the tip, edge correction, resharpening
- G. semi-flat, marginal retouch on the upper face near the tip, edge resharpening
- O. flat removals on the lower face, edge angle correction, thinning
- F. flat retouch on the upper face, edge resharpening
- N. flat removals on the lower face near the base, edge formation, thinning
- D. flat removals at the base and steep, hinged removals near the base along the edge on the upper face, edge formation, unsuccessful thinning
- L. flat removals on the lower face, edge angle correction
- K. flat, partly hinged, far going removals on the lower face, edge thinning, near-the-tip part thinning, edge angle formation
- C. steep removals on the upper face near the base, base formation/unsuccessful thinning (?)
- E, B. flat removals on the upper face, surface thinning
- A. semi-flat, very broad scar on the upper face, surface formation, decortication
- J, I. flat removals on the lower face, surface formation, thinning

# Plate 49 Vedrovice V 50149

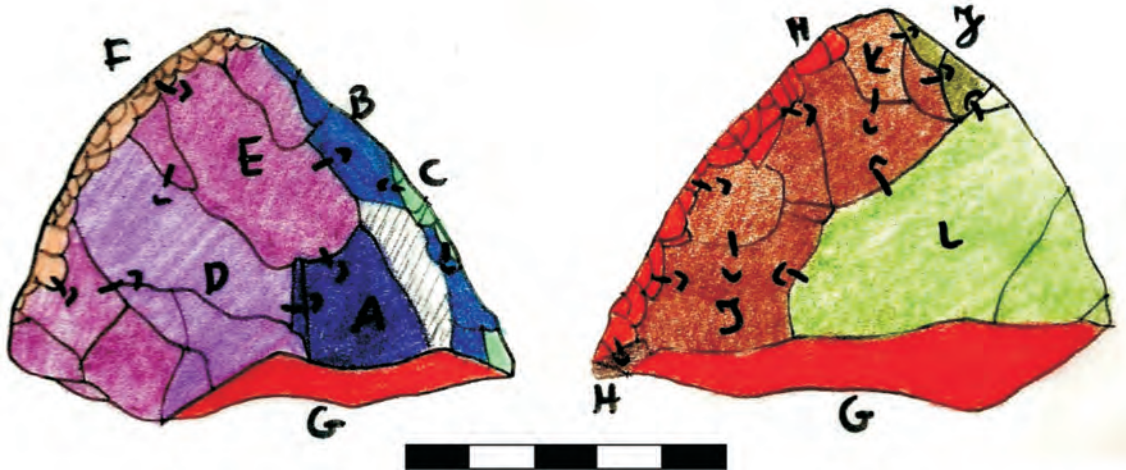


Plano-convex leafpoint made on a flake with exposed tip. Lower face was not totally flattened because of irregular ventral surface of a flake. That was the reason why edge I was formed by semi-steep sequences derived on the lower face, and flat on the upper face. No traces of resharpening.

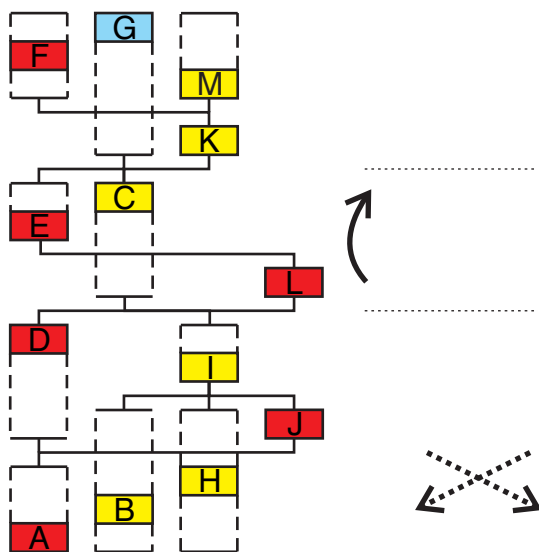


- H. flat retouch on the upper face, edge thinning, shaping
- N, L. semi-steep, marginal removals on the lower face near the tip, edge correction, shaping
- G. flat, hinged, marginal retouch on the upper face near the tip, edge formation, unsuccessful thinning
- F. single, flat removal on the upper face near the tip, thinning, shaping
- E. flat removals on the upper face near the tip, thinning
- M. flat removals on the lower face, edge angle formation, thinning
- K, J. semi-steep removals on the lower face, edge correction, thinning
- D. semi-flat removals on the upper face, edge formation
- C. flat removals on the upper face, surface formation, thinning
- A, B. flat, broad removals derived before obtaining the flake
- I. irregular, concave ventral surface of a flake

# Plate 50 Vedrovice V 50154

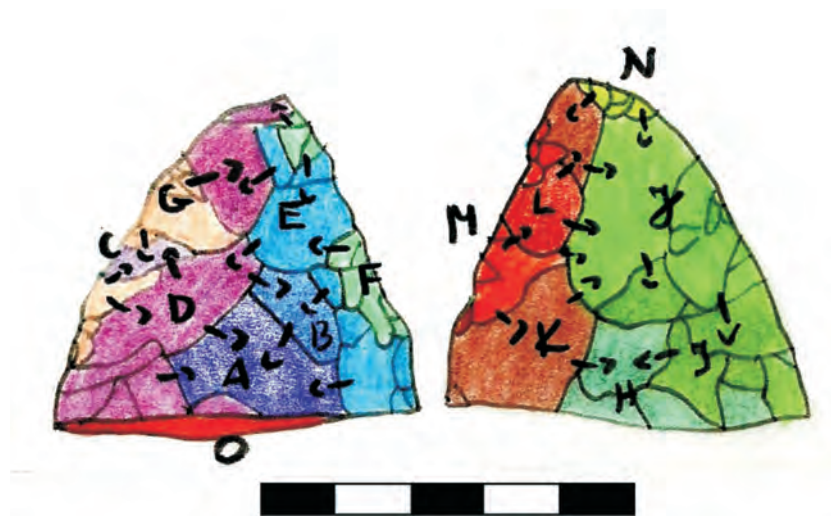


Plano-convex near-the-tip part of broken preform With no traces of rejuvenation after breakage. The tool was formed alternately, in plano-steep manner, and at the end, steep edge was thinned on the lower face.

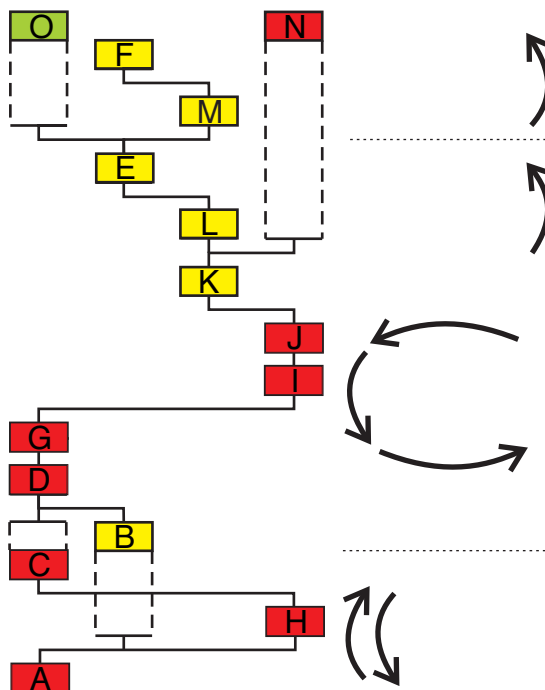


- G. transversal breakage
- F, M. flat, marginal retouch on the upper face, edge correction before further knapping
- K. flat removals on the lower face, aimed at removing high interscar borders of sequence I
- C. semi-steep, partly hinged, marginal removals on the upper face, edge angle correction
- E, D. flat, far going, angular removals on the upper face, surface formation, near-the-tip part thinning, analogical and alternate to sequence I
- I. flat, far going, angular removals on the lower face, surface formation, near-the-tip part thinning, analogical and alternate to sequences D, E
- L. flat, broad removals on the lower face, surface rejuvenation, thinning and flattening after the hinged sequence J
- J. semi-steep, hinged removals on the lower face, edge angle formation before flat sequences D, E
- B. semi-steep, hinged removals on the upper face, edge angle formation before flat sequence I
- H. flat scar, earlier stages of manufacturing process
- A. flat, broad removals, surface formation, decortication

# Plate 51 Vedrovice V 50156



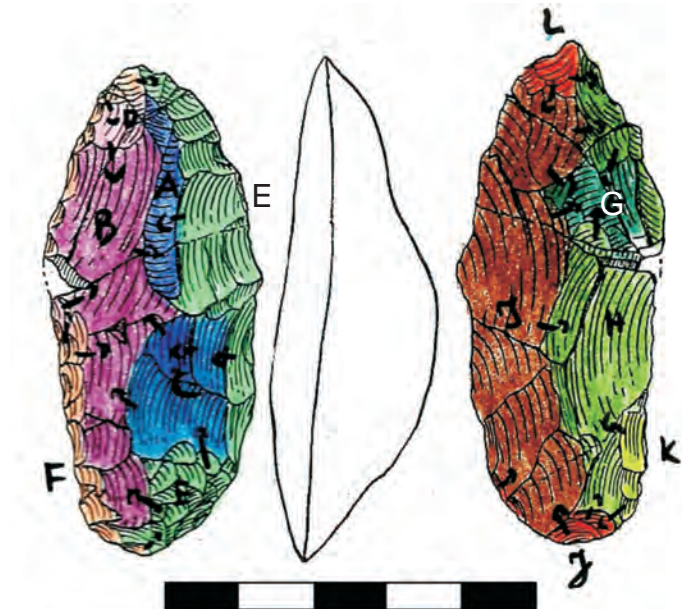
Biconvex near-the-tip part of broken preform. Tip was not precisely worked; most sequences were focused on thinning and shaping by deriving angular, flat removal sequences.



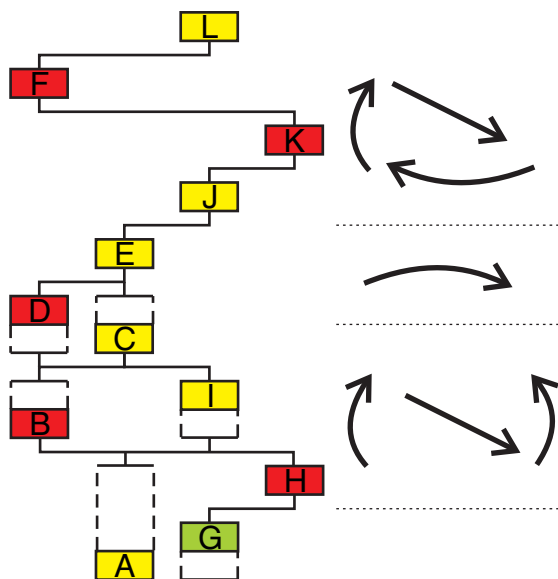
- O. transversal breakage
- N. flat, marginal retouch on the lower face at the tip, edge correction
- F. flat, marginal retouch on the upper face, edge sharpening
- M, L. semi-flat removals on the lower face, edge angle correction
- E. semi-steep removals on the upper face, edge formation/rejuvenation (?)
- K. semi-flat removals on the lower face, edge angle formation
- I, J. flat, far going, angular removals on the lower face near the tip, near-the-tip part thinning
- G, D, C. semi-flat removals on the upper face, edge formation
- B. single, semi-flat removal on the upper face, surface formation, thinning
- A. flat, broad removals on the upper face, surface formation, thinning
- H. flat, broad removals on the lower face, surface formation, thinning



# Plate 52 Vedrovice V 50159



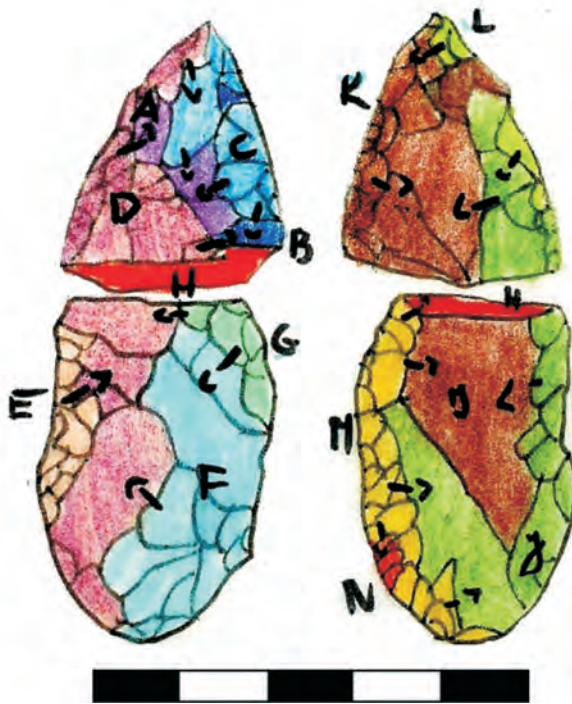
Plano-convex tool with poorly exposed tip and both edges retouched and reshaped. Lower face was used only for edge angle correction. It bears no traces of shaping.



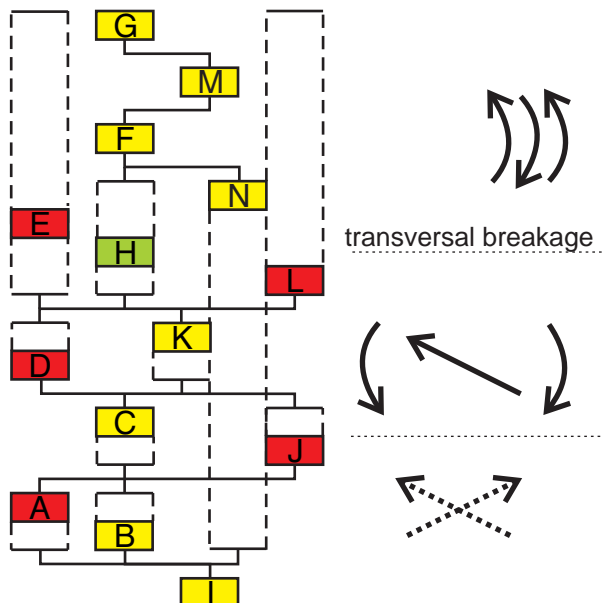
- L. flat removals on the lower face at the tip, edge angle correction, thinning
- F. steep, marginal retouch on the upper face, semi-flat near the tip, edge reshaping
- K, J. flat removals on the lower face near the base, edge angle correction
- E. semi-steep retouch on the upper face, semi-flat near the tip, edge reshaping, thinning
- D. semi-flat removals on the upper face near the tip, near-the-tip part thinning, rejuvenation
- C. semi-steep removals on the upper face, edge formation (?)
- B. semi-steep removals on the upper face, edge formation, sharpening (?)
- I, H. semi-flat removals on the lower face, edge angle formation, surface formation, thinning
- G. flat scar on the lower face, flat removal or ventral surface of a flake
- A. semi-steep removals on the upper face, earlier stages of manufacturing process



# Plate 53 Vedrovce V 50166

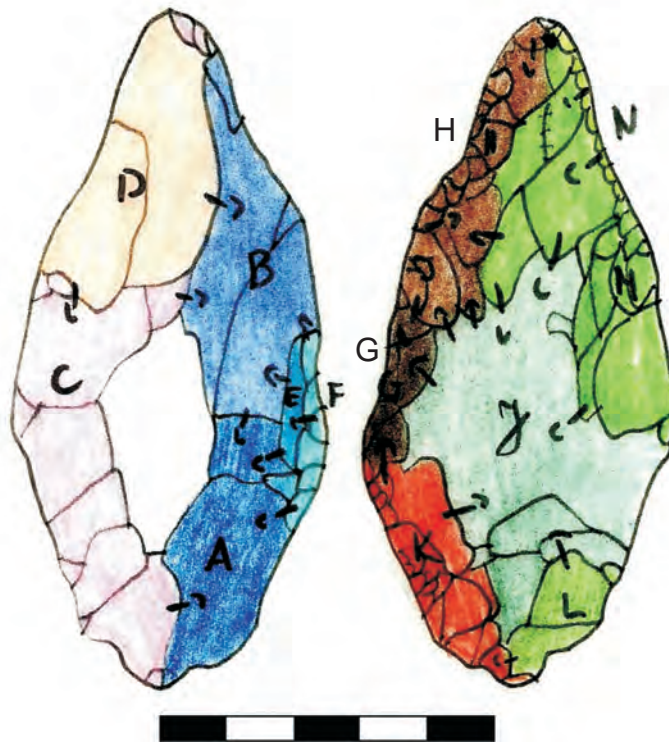


Biconvex, transversally broken leafpoint. Near-the-base part was reused after breakage and resharpened on both edges. Near-the-tip part bears no traces of rejuvenation after breakage. Before breakage, the tool was knapped precisely, in alternate, plano-steep manner.

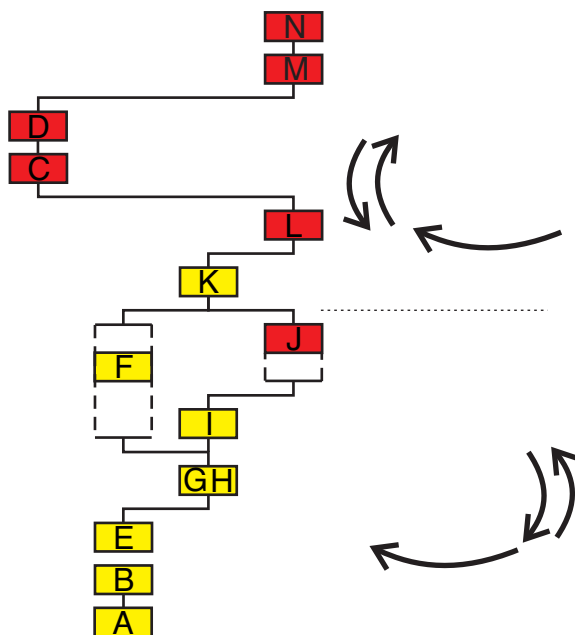


- G. semi-flat, marginal retouch on the upper face near breakage scar, edge rejuvenation
- M. semi-flat and flat, marginal retouch on the lower face along the edge and at the base, edge rejuvenation/resharpening after breakage
- F. flat removals on the upper face, surface thinning
- N. single, semi-steep scar on the lower face, edge angle formation (?)
- E. semi-steep, marginal retouch on the upper face, edge resharpening, created a notch
- H. transversal breakage
- L. flat truncations on the lower face near the tip, edge correction
- K. flat, marginal retouch on the lower face, edge formation, thinning
- D. semi-steep and semi-flat removals on the upper face, edge formation, shaping, thinning, marginal retouch near the tip, tip exposure
- C. semi-flat removals on the upper face, semi-steep near the tip, shaping, edge formation
- J. flat, partly hinged removals on the lower face along the edge and at the base, edge formation, thinning
- I. flat, broad removals on the lower face, surface formation, thinning
- B. semi-steep scars on the upper face, earlier stages of manufacturing process, surface formation
- A. flat scars on the upper face, earlier stages of manufacturing process, surface formation

# Plate 54 Vedrovice V 50188

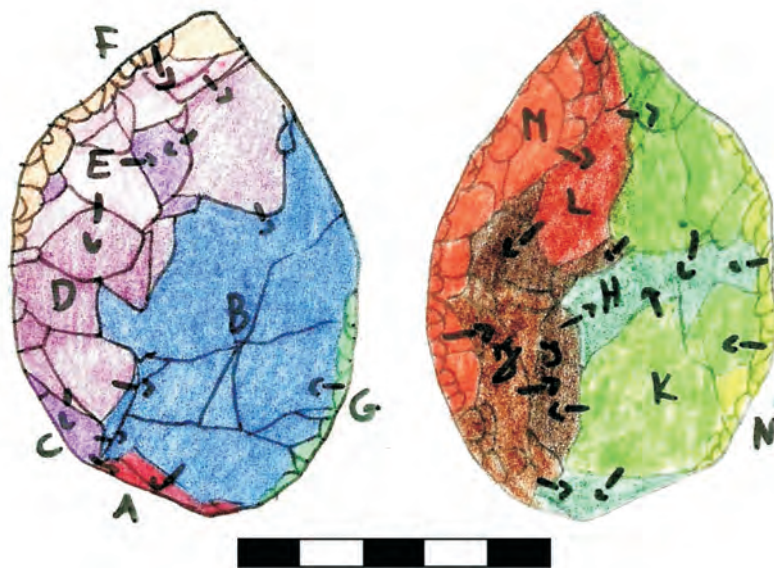


Plano-convex preform, unsuccessfully thinned in its middle part; successfully thinned only in its near-the-tip part which was more precisely worked. It bears traces of shaping and tip exposure.

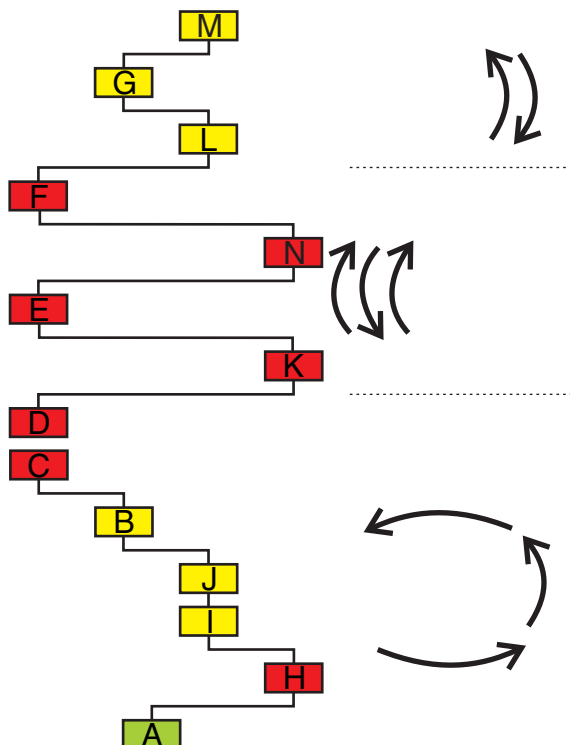


- N. flat, marginal retouch on the lower face near the tip, can be usewear (?)
- M, I. flat removals on the lower face near the tip, surface thinning,
- D. semi-flat, deep removals on the upper face near the tip, partly successful surface thinning
- C. semi-steep removals on the upper face, unsuccessful surface thinning, decortication
- L. flat removals on the lower face near the base, edge angle correction
- K. flat removals on the lower face near the base, edge correction
- F. flat, high hinged removals on the upper face, final trial to thin the upper face, unsuccessful
- E. semi-flat, hinged removals on the upper face, unsuccessful surface thinning,
- G, H. flat removals on the lower face, edge angle correction
- J. flat, broad removals on the lower face, surface formation, thinning
- B, A. semi-steep removals on the upper face, partly successful thinning, decortication

# Plate 55 Vedrovice V 73199

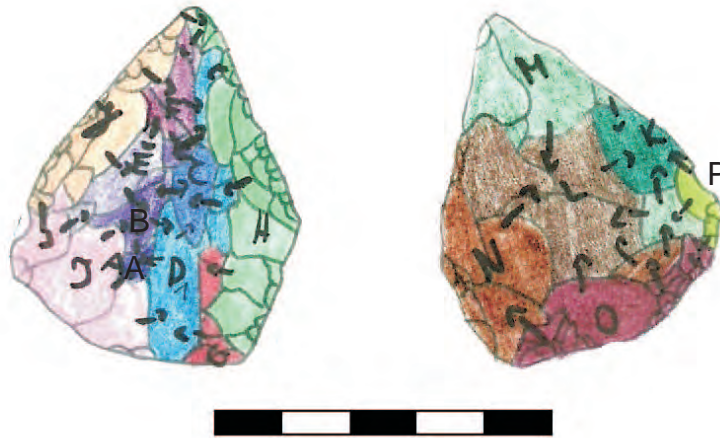


Shallow tool with exposed tip, knapped alternately, especially near the tip. Near-the-tip part was precisely thinned and knapped. Base was blunted at the beginning of manufacturing process. The knapper struggled with considerable tool width, which could not be limited due to unsuccessful thinning near the base (sequence C, B).

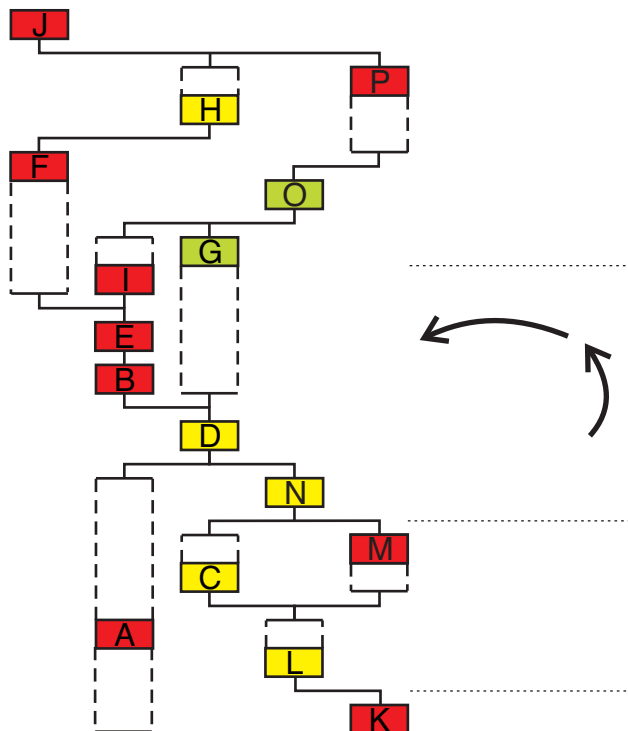


- M. flat removals on the lower face, edge thinning, resharpening (?)
- L. flat, far going removals on the lower face near the tip, edge thinning
- G. marginal retouch on the upper face near the base, edge correction
- F. flat, marginal retouch on the upper face near the tip, analogical to sequence M
- N- flat removals on the lower face, edge correction
- E. flat removals on the upper face near the tip, edge and near-the-tip part thinning
- K. flat removals on the lower face, surface thinning, shaping (?)
- D. semi-flat removals on the upper face, flat near the tip, surface thinning, shaping (?)
- C. semi-flat removals on the upper face, surface thinning, aimed at removing hinged scars of sequence B
- B. flat, partly hinged removals on the upper face, surface formation, thinning
- H, J, I. flat removals on the lower face, surface formation, thinning
- A. steep removals on the upper face at the base

# Plate 56 Vedrovice V 73200



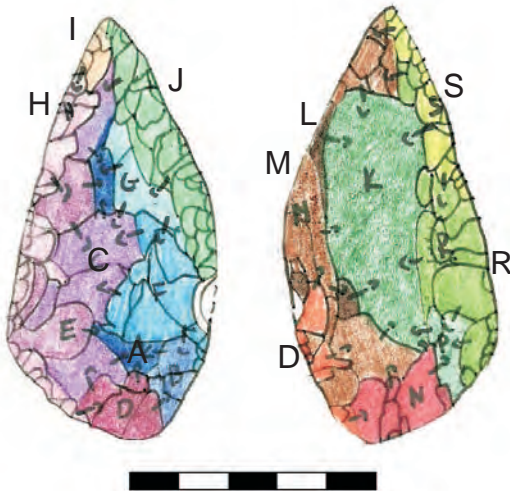
Plano-convex tool with exposed tip and rejuvenated, thinned base edge. Both edges were retouched and resharpener on the upper face. Cutting edge was retouched along its whole length and opposite edge only near the tip.



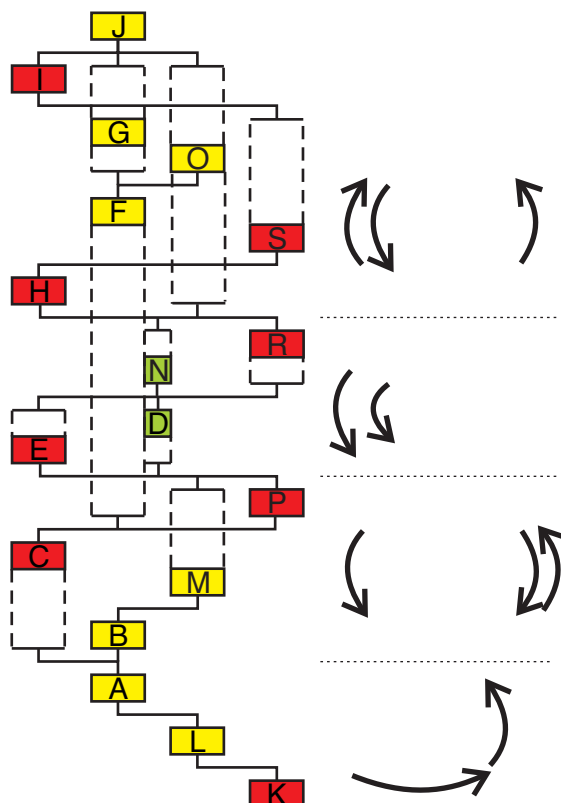
- H, J. semi-steep retouch on the upper face, more flat near the base
- P. flat, marginal removals on the lower face, edge correction
- F, D. semi-steep removals on the upper face near the tip, more flat near the base
- O. semi-flat removals on the lower face, base edge rejuvenation, thinning
- G. flat removals on the upper face, derived from the base, base edge angle correction
- N. flat removals on the lower face, edge angle correction, thinning
- I. semi-flat removals on the upper face near the base, edge rejuvenation
- E, B. semi-steep removals on the upper face, earlier stages of edge formation/rejuvenation (?)
- M. flat removals on the lower face near the tip, edge angle correction, surface thinning
- L. flat, broad removals on the lower face, surface formation, thinning
- K. ventral surface of a flake
- C. flat scar on the upper face, earlier stages of manufacturing process
- A. semi-flat scar on the upper face, earlier stages of manufacturing process



## Plate 57 Vedrovce V 117327



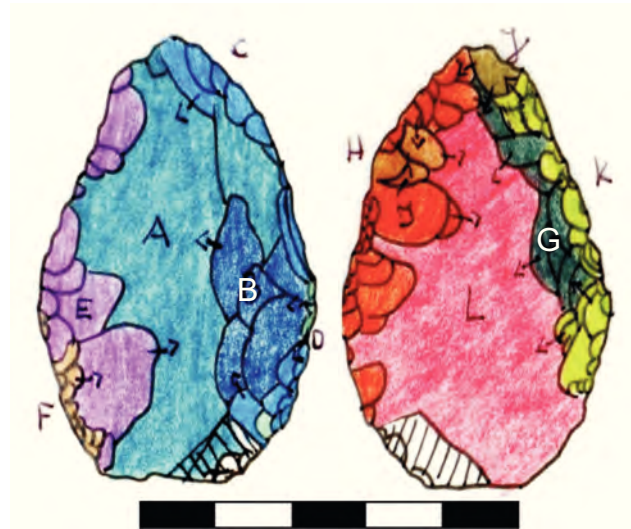
Plano-convex, bent, very thin, elongated tool with exposed tip and precisely worked base. Its both edges were precisely worked, but cutting edge is more concave, and distal posterior edge is more vertical. Both edges were rejuvenated; cutting edge was resharpened by series of semi-flat retouches derived on the upper face. Distal posterior edge was retouched alternately by series of flat retouches.



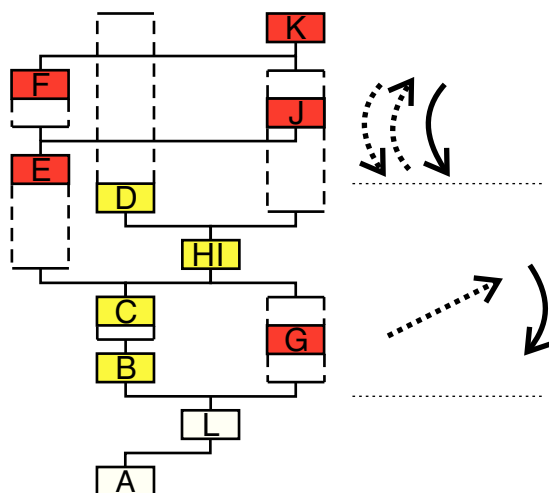
- J. semi-flat, marginal retouch on the upper face, edge resharpening
- I. semi-flat, marginal retouch on the upper face near the tip, edge resharpening, and flat, thinning removals
- G. semi-flat removals on the upper face, edge resharpening
- O. flat, marginal removals on the lower face, edge correction
- F. flat removals on the upper face, edge resharpening
- S. semi-flat, marginal removals on the lower face near the tip, edge correction
- R, P. flat removals on the lower face, edge thinning
- M. flat and semi-flat removals on the lower face, edge angle correction, thinning
- H. flat, irregular removals on the upper face, edge angle correction, thinning
- E. semi-flat removals on the upper face, edge thinning, edge angle correction
- N. flat removals on the lower face, derived from the base, surface thinning, base formation
- D. flat removals on the upper face, derived from the base, surface thinning, base formation
- C. flat removals on the upper face, surface formation, thinning
- B. flat removals on the upper face, earlier stage of edge sharpening
- A. flat scars on the upper face, earlier stages of manufacturing process
- L. flat and semi-flat, broad removals on the lower face, surface formation, thinning, edge angle correction
- K. single, flat, very broad, deep removal on the lower face, surface formation, thinning, can be also a ventral surface of a flake (?)



# Plate 58 Ehringsdorf 31/93

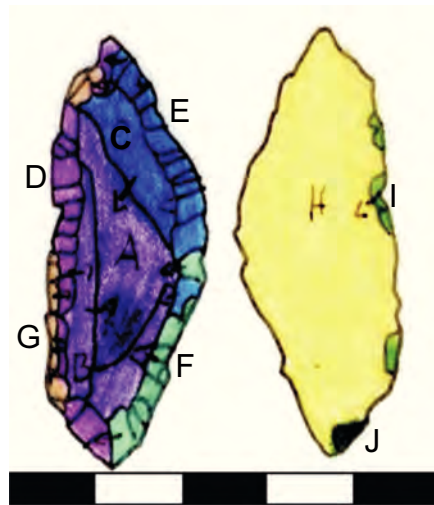


Tool made of flake with two retouched and resharpened edges and poorly exposed tip.

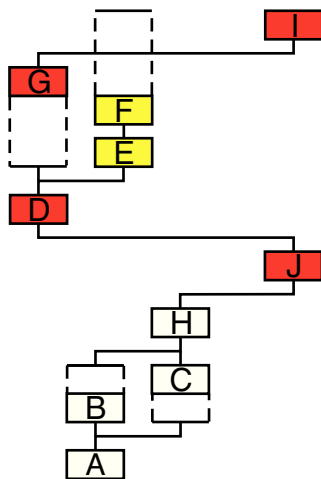


- K. semi-flat and flat, marginal removals on the lower face, edge resharpener
- F. marginal retouch on the upper face, edge resharpener
- G, I, H. flat removals on the lower face, edge angle correction, edge remodeling after hinged removals (sequence C)
- D. marginal retouch on the upper face, edge resharpener
- E. flat removals on the upper face, edge resharpener or edge angle correction
- J. single, flat removal on the lower face derived from the tip, tip thinning
- C. flat, partly hinged removals on the upper face, edge resharpener, thinning
- B. flat removals on the upper face, edge sharpening
- L. ventral surface of a flake with a big bulb in the proximal part of tool, the butt/striking platform was rejuvenated by small, parallel removals
- A. removals derived before obtaining

# Plate 59 Ehringsdorf 36/93

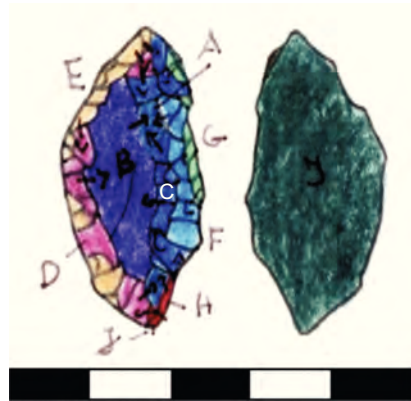


Plano-convex tool made on a flake with two convergent edges retouched and resharpened abruptly on the upper face, almost no removals on the lower face; exposed tip.

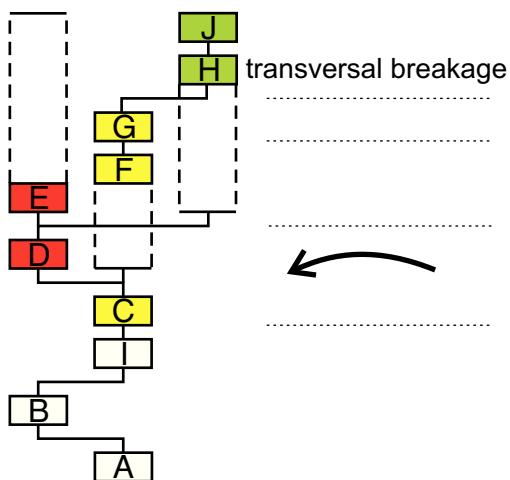


I, J. flat, marginal removals on the lower face, edge correction  
 G, F, D. steep, marginal retouch on the upper face, edge resharpening and usewear  
 E. semi-steep, marginal retouch on the upper face, edge resharpening  
 H. ventral surface of a flake  
 C, B, A. flat removals derived before obtaining the blank

## Plate 60 Ehringsdorf 37/93

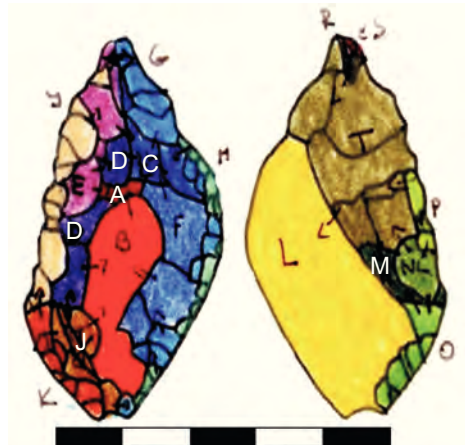


Plano-convex, unifacial tool with exposed, blunted tip and both edges retouched. One edge was resharpened.

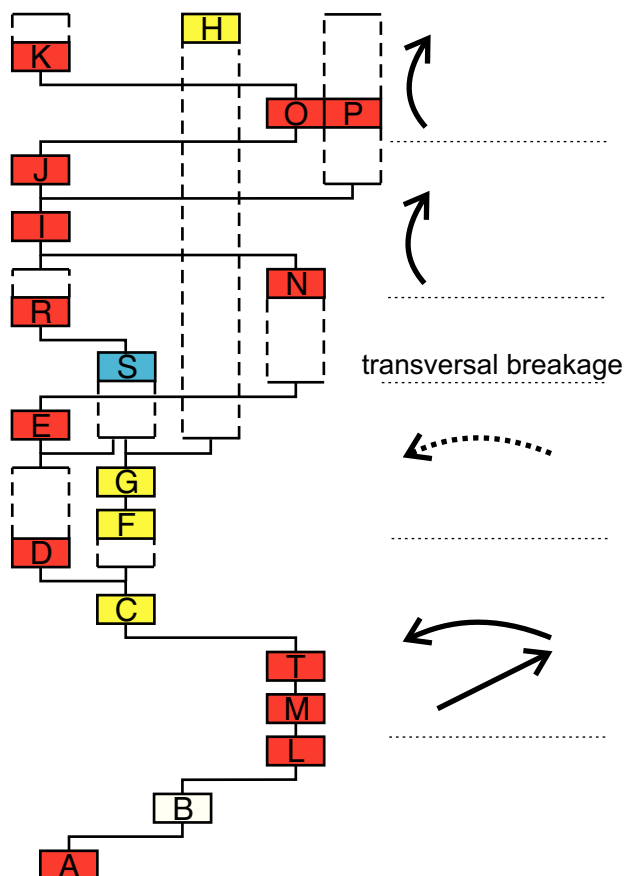


- H. transversal breakage near the base
- J. steep, marginal retouch, edge rejuvenation after breakage
- G, E. steep, marginal retouch on the upper face, edge resharpening
- F. semi-steep, marginal retouch on the upper face, edge resharpening
- C, D. semi-flat retouch on the upper face, edge sharpening
- A, B. flat removals derived before obtaining the flake
- I. ventral surface of a flake

# Plate 61 Ehringsdorf 38/93

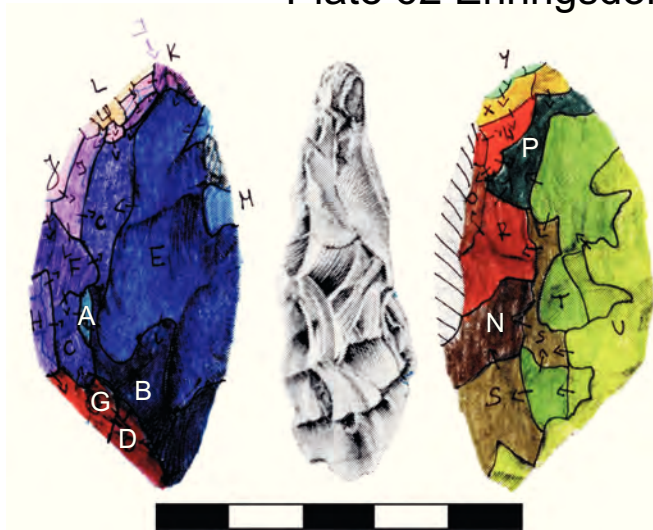


Plano-convex tool made on a flake with both edges retouched and resharpened several times, exposed tip broken and rejuvenated, orientation was changed at last stages of rejuvenation and near-the-base part was sharpened and resharpened afterwards. Lower face was used for edge angle correction, but only from edge II. Both edges are blunted.

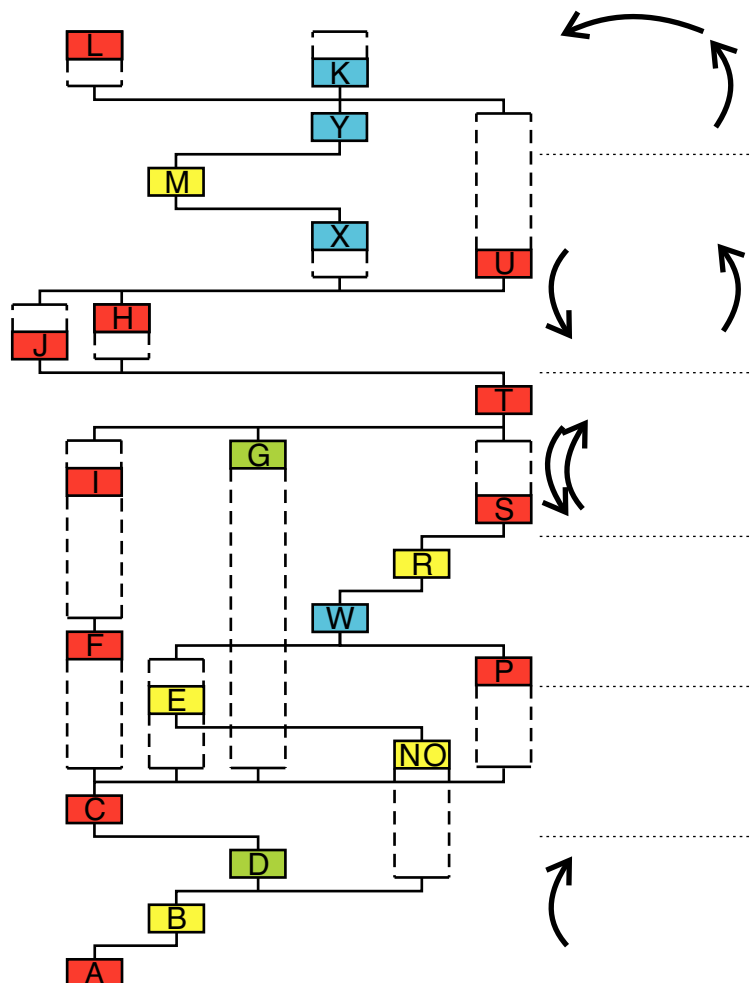


- K. flat, marginal retouch on the upper face, edge resharpening after orientation change
- O. semi-flat/semi-steep retouch on the lower face, edge angle correction after orientation change
- P, N. flat and semi-flat, small removals on the lower face, edge angle correction
- J. hinged removals on the upper face, edge thinning, sharpening after orientation change
- I. steep, irregular, marginal retouch, edge resharpening
- R. single, flat, deep removal, near-the-tip part thinning after tip breakage (sequence S)
- S. transversal breakage at the tip
- H. steep, marginal retouch on the upper face, edge resharpening, partly usewear
- E, G. steep retouch on the upper face, edge resharpening
- F, D. semi-flat removals on the upper face, edge resharpening
- M, T. flat removals on the lower face, edge angle correction, thinning
- C. steep removals on the upper face, edge formation/resharpening (/)
- B, A. flat removals, derived probably before obtaining the flake
- L. ventral surface of a flake

# Plate 62 Ehringsdorf 43/93



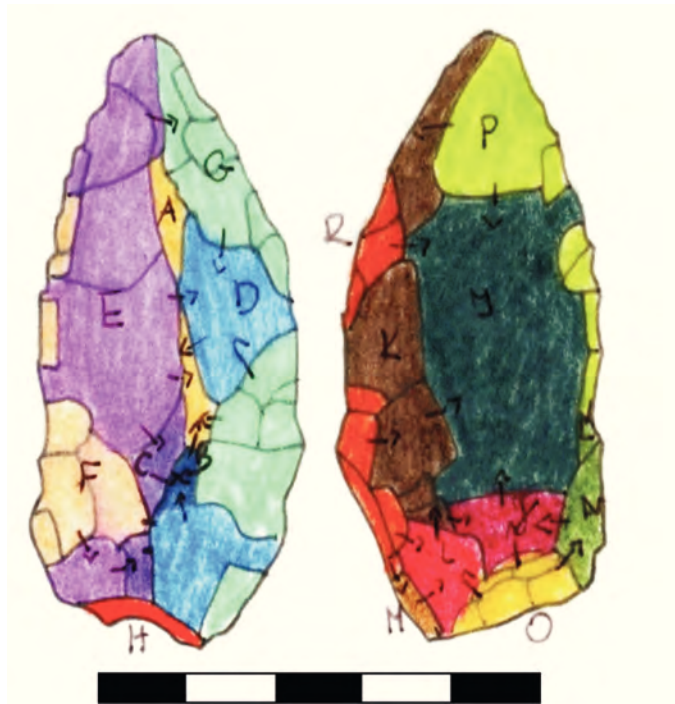
Plano-convex knife with subsequent rejuvenation of cutting edge and distal posterior edge. Tip is poorly exposed and last sequences of marginal retouches were also derived on the tip edge, lower face was used for edge angle correction and thinning, base was formed angularly by abrupt removals on the upper face.



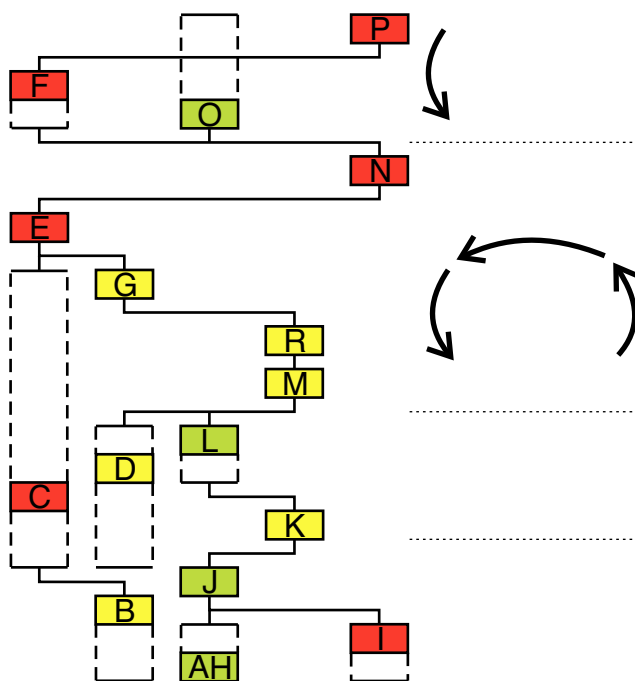
- L. semi-steep, marginal retouch on the upper face near the tip
- K. marginal retouch on the upper face near the tip
- Y. tip breakage and remodeling, marginal removals on the lower face of the tip
- M. flat removals on the upper face, cutting edge resharping
- X, W, O, R. flat removals on the lower face near the tip, edge/edge angle correction, thinning
- U, T, S. flat removals on the lower face, edge angle correction, thinning
- J. marginal, partly hinged removals on the upper face, edge rejuvenation
- I. semi-steep removals on the upper face, edge rejuvenation
- H. flat, marginal removals on the upper face, edge rejuvenation
- G, D. steep removals on the upper face at the base, base edge formation
- N, P. flat removals on the lower face, surface formation, thinning
- E, B. semi-steep, broad removals on the upper face, cutting edge rejuvenation
- C. semi-steep removals on the upper face, distal posterior edge formation
- A. flat scar from earlier stages of manufacturing process



## Plate 63 Ehringsdorf 46/93

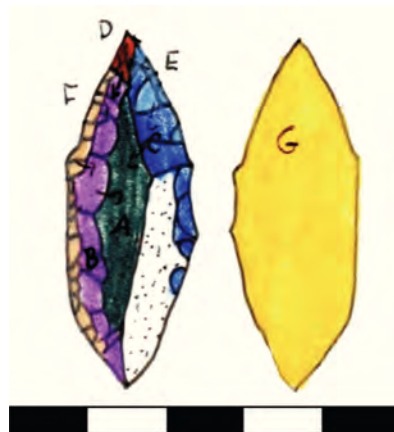


Plano-convex tool, probably made on a flake with both edges retouched and resharpened. Exposed tip is located out of axis; abrupt base was formed by transversal breakage or natural surface. Lower face was used for edge angle correction and thinning.

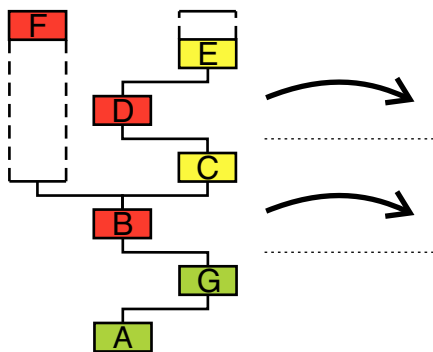


- P, R. flat removals on the lower face, edge angle correction
- F, G. semi-flat retouch on the upper face, edge angle resharpening
- O. flat removals on the lower face derived from the base, base edge correction
- N, M. flat, partly hinged removals on the lower face near the base, edge angle correction
- L. single, flat, hinged removal on the lower face, surface thinning
- D, E, C. semi-steep removals on the upper face, edge sharpening
- B, A. semi-flat scars of broad removals on the upper face, earlier stages of manufacturing process
- K. flat removals on the lower face, edge angle correction
- J. flat removals on the lower face derived from the base, surface thinning
- I. flat, broad removals on the lower face, surface formation, thinning
- H. natural surface or transversal breakage at the base

## Plate 64 Ehringsdorf 47/93

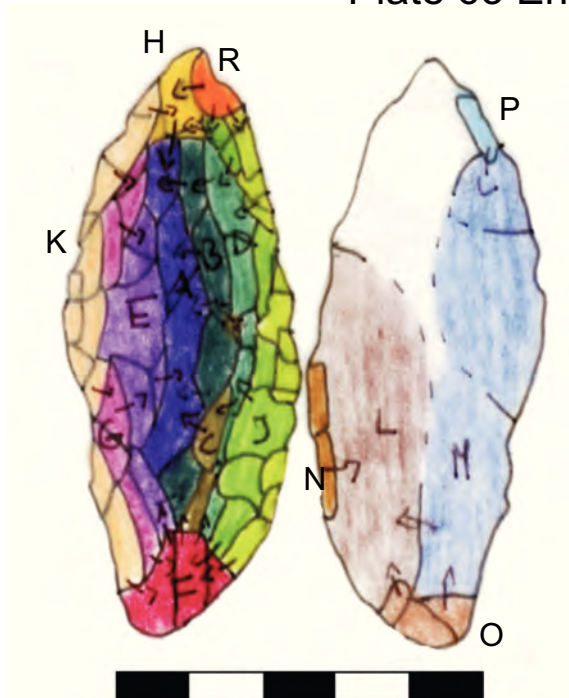


Unifacial, plano-convex, symmetrical tool made of flake with steep, marginal retouch on both edges, one of edges retouched and worked only in near-the-tip part, the rest remains cortical. Exposed tip and base angle. Probably both edges were resharpened several times, but very precisely.

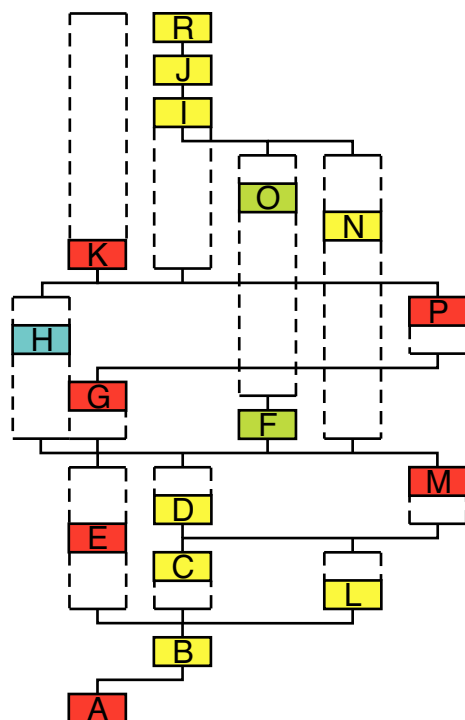


- F. steep, marginal retouch on the upper face, probably a few stages of edge resharpening
- E. steep retouch on the upper face, near the tip, edge/tip resharpening
- D. semi-steep removals on the upper face near the tip, tip exposure
- B. semi-steep removals, edge formation/resharpening (?)
- C. steep removals on the upper face, edge formation/resharpening (?)
- A. flat removals on the upper face, probably derived before obtaining the blank
- G. ventral surface of a flake

# Plate 65 Ehringsdorf 48/93

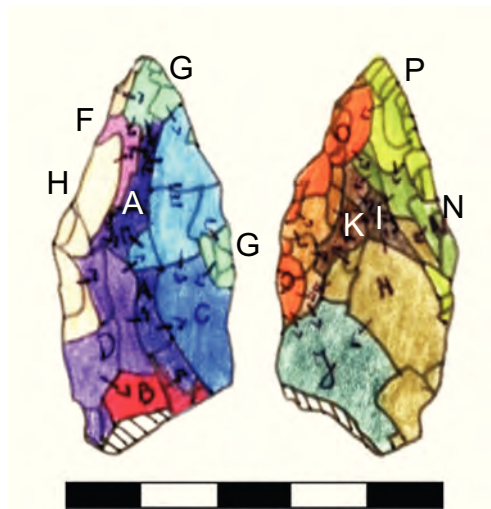


Plano-convex tool with exposed tip and both edges retouched and subsequently resharpened on the upper face, lower face was used for edge angle correction. Perhaps orientation was changed during rejuvenation. One edge was used first (edge II), then the other (edge I) was retouched and resharpened, mainly afterwards.

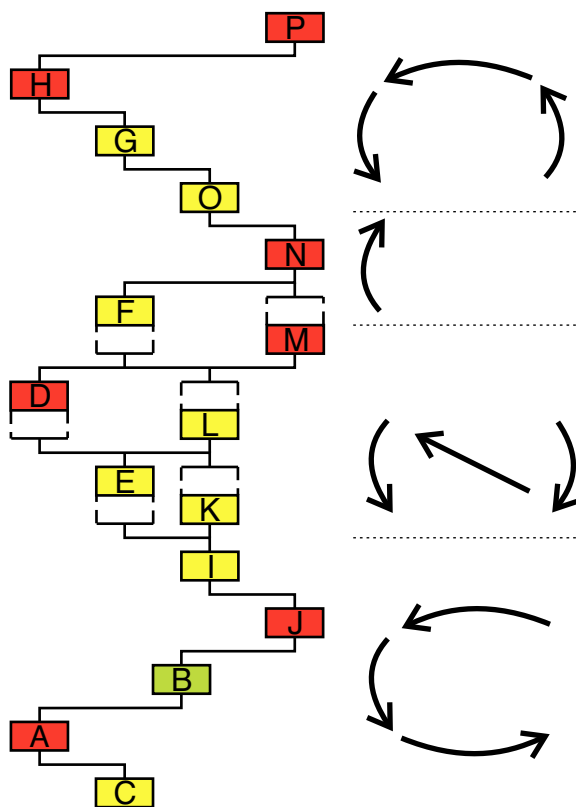


- R. single, semi-steep removal on the upper face near the tip, tip exposure, thinning
- J, I. semi-steep, partly hinged, marginal retouch on the upper face, edge resharpening
- O, N, P. flat removals on the lower face, edge angle correction
- K. semi-flat, partly hinged, marginal retouch on the upper face, edge resharpening
- G, E. semi-flat/semi-steep, partly hinged removals on the upper face, edge resharpening
- F. semi-steep removals on the upper face near the base, thinning, could be tip sharpening before orientation change (?)
- M, L. flat, broad removals on the lower face, thinning, flattening, edge angle correction
- D, C. semi-steep removals on the upper face, edge resharpening
- A, B. semi-flat, broad removals on the upper face, earlier phases of manufacturing process

## Plate 66 Ehringsdorf 50/93

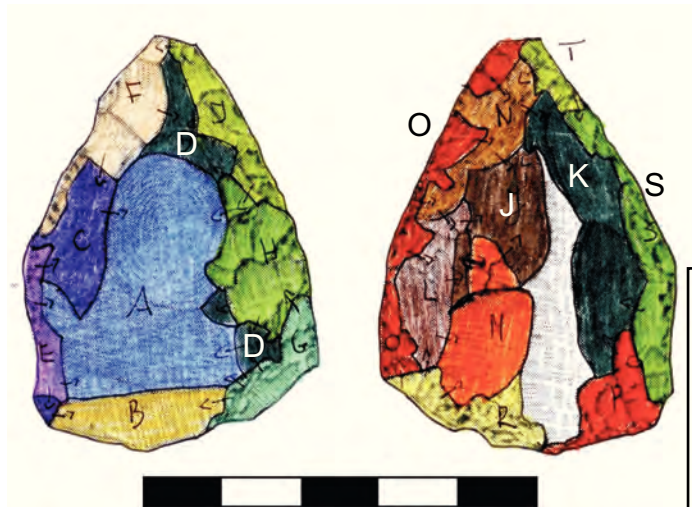


Plano-convex tool with both edges retouched and resharpened several times, exposed tip and cortical base. Lower face was used for edge angle correction.

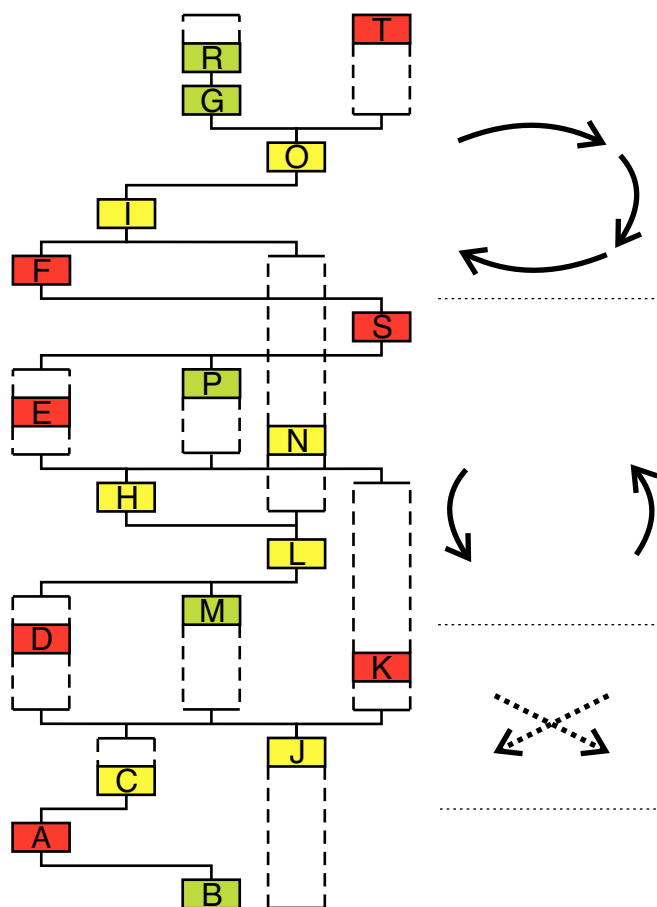


- P, O, L, K, N, I. flat removals on the lower face, edge angle correction
- H. semi-flat, partly hinged removals on the upper face, edge resharpening, rejuvenation
- G. semi-flat removals on the upper face, edge resharpening
- F, E. semi-steep/steep removals on the upper face, edge resharpening
- D. semi-steep, partly hinged removals on the upper face, edge thinning
- C. steep removals on the upper face derived from the base, derived before obtaining the flake (?)
- A. flat removals on the upper face, derived before obtaining the flake (?)
- B. semi-flat removals on the upper face at the base, derived before obtaining the flake (?)
- M. semi-flat removals on the lower face, surface formation, edge angle correction
- J. flat, broad removal on the lower face near the base, surface formation

# Plate 67 Ehringsdorf 51/93



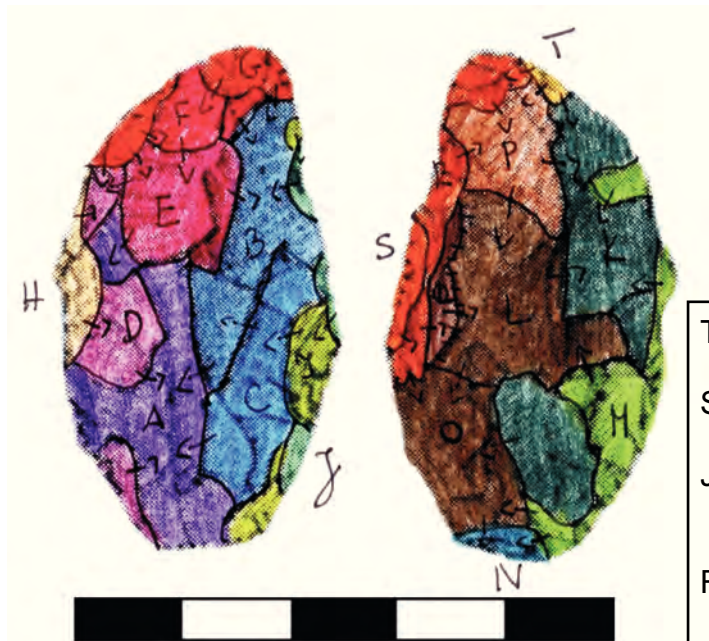
Triangular, plano-convex tool with both edges retouched alternately, base thinned and formed precisely, tip was broken.



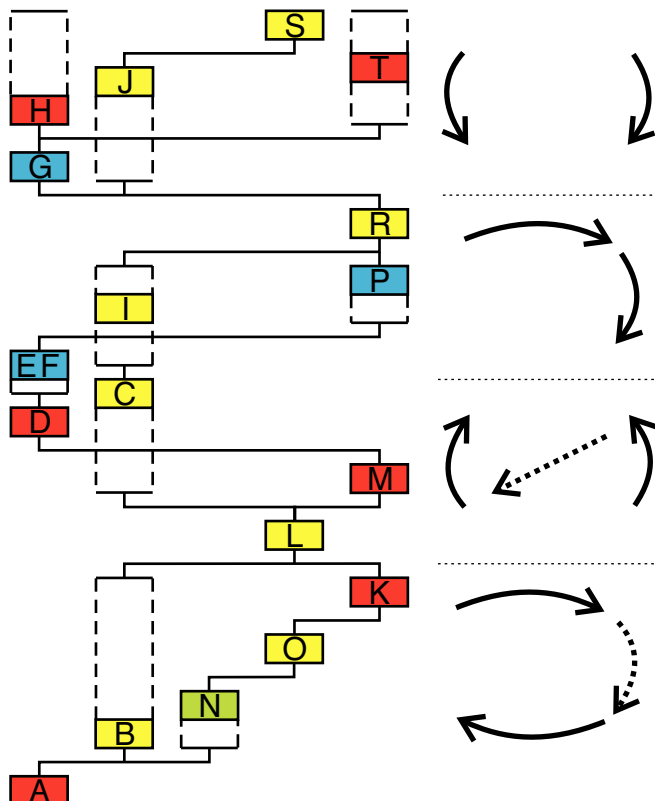
- R. single, steep removal on the lower face derived from the base, base formation/rejuvenation
- M. flat, long removals on the lower face derived from the base, surface thinning
- G. semi-steep removals on the upper face near the base, base edge rejuvenation
- O. flat and semi-flat removals on the lower face, edge angle correction
- I, H. semi-flat, marginal retouch on the upper face, edge resharpening
- E, F. semi-flat removals on the upper face, edge resharpening, edge angle correction (?)
- T, S. semi-flat, marginal retouch on the lower face, edge resharpening
- N, L. flat removals on the lower face, edge angle correction/edge thinning
- D, C. semi-flat removals on the upper face, edge sharpening
- K, J. flat, broad removals on the lower face, surface formation, thinning
- A. flat removals derived before obtaining the blank
- B. semi-steep scar on the upper face at the base, derived before obtaining the flake
- M. semi-flat removals on the lower face, surface formation, edge angle correction
- J. flat, broad removal on the lower face near the base, surface formation



# Plate 68 Ehringsdorf 52/93

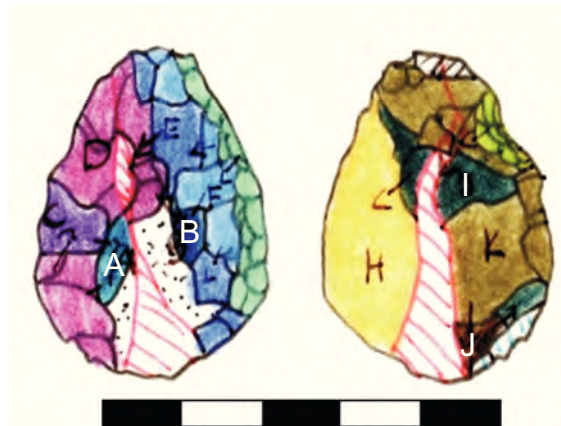


Knife with single cutting edge, multiple sequences of rejuvenation derived on cutting edge and on distal posterior edge near the tip; unexposed tip.

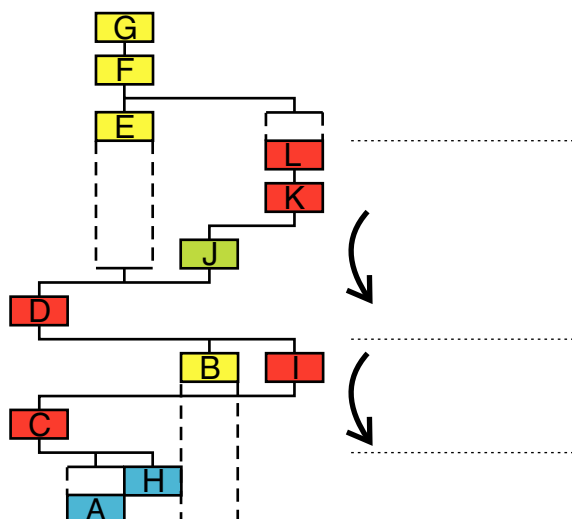


- T. single, marginal truncation on the lower face
- S. semi-flat, hinged removals on the lower face, edge correction
- J, I. semi-flat marginal removals on the upper face, cutting edge resharpening
- R. flat removals on the lower face, edge angle correction
- H. semi-steep, hinged removals on the upper face, edge resharpening/rejuvenation
- M. semi-flat removals on the lower face, edge correction
- G. semi-flat, marginal removals on the upper face near the tip, edge resharpening
- F, E. semi-flat removals on the upper face near the tip, edge thinning, rejuvenation
- P. semi-flat removals on the lower face near the tip, edge angle correction
- C, D. semi-flat removals on the upper face, edge resharpening
- B. semi-flat and semi-steep removals on the upper face, edge formation, resharpening (?)
- L. flat, broad removals on the lower face, surface formation, thinning
- O, K. semi-flat, broad removals on the lower face, surface formation, thinning
- N. semi-steep removal on the lower face near the base, earlier stage of manufacturing process
- A. single, flat, broad removals on the upper face, earlier stage of manufacturing process

## Plate 69 Ehringsdorf 53/93

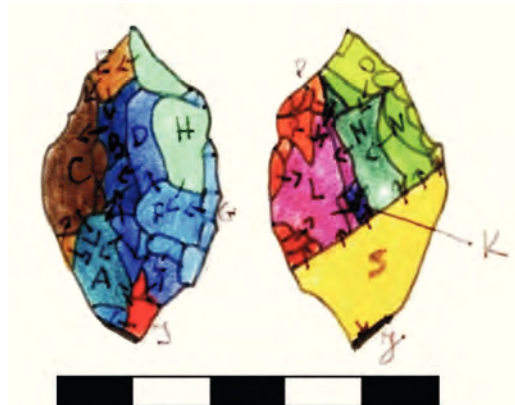


Tool made on a flake with one edge retouched and subsequently resharpened, the other edge was thinned but has no retouch; unexposed tip, lower face was used for edge angle correction and thinning.

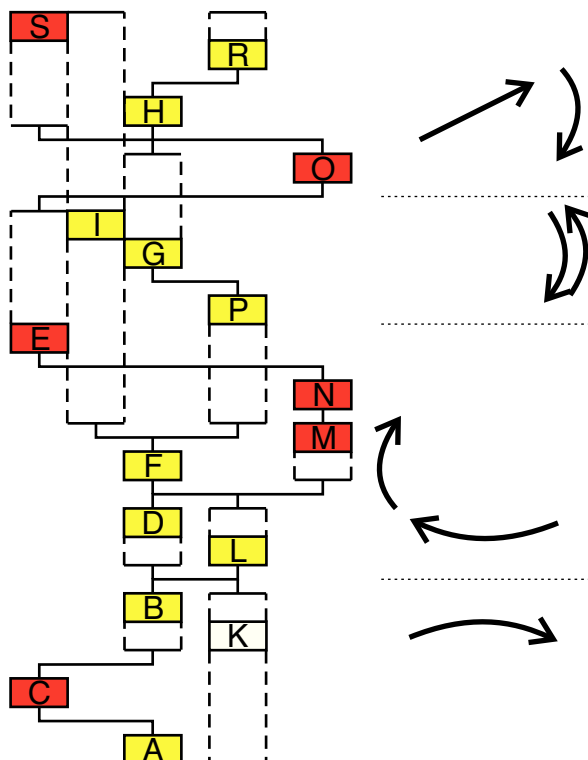


- G. semi-flat, partly hinged, marginal retouch on the upper face, edge resharpening
- F, E. semi-steep, partly hinged retouch on the upper face, edge resharpening
- B, A. flat scar, earlier stages of edge/surface formation
- D, C. semi-steep removals on the upper face, thinning, edge formation
- L. fine, marginal retouch, created a notch on the lower face, can be usewear
- K, J. flat removals on the lower face, edge angle correction, thinning
- I. flat removals on the lower face, edge angle correction, thinning, bulb removing
- H. ventral surface of a flake

# Plate 70 Ehringsdorf 54/93

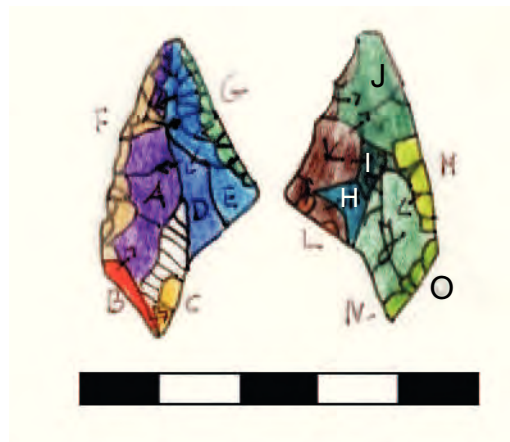


Tool with possibly postdepositional removal (sequence S) which damaged 1/3 of lower surface. Tip is exposed, near-the-tip part retouched alternately. H and E sequences expose the tip, they could be derived after sequence S, if it is not postdepositional, and they could be aimed at changing orientation and remodeling the base into the tip. The tool is highly exhausted; both edges were rejuvenated multiple times.

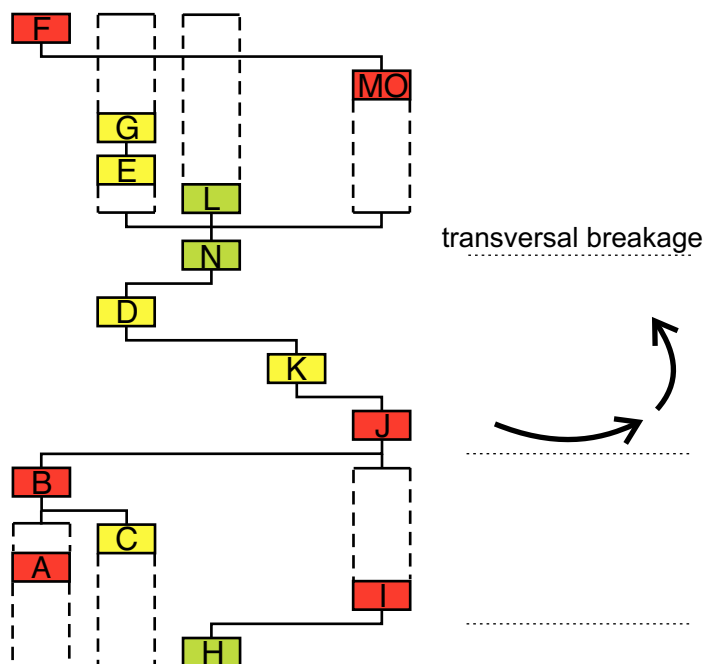


- S. flat overpassed removal reaching the opposite edge, probably postdepositional
- R. single, flat removal on the lower face, edge correction
- G. marginal retouch on the upper face, edge sharpening
- P. flat removals on the lower face, edge angle correction
- H, E. flat and semi-steep, hinged removals on the upper face near the tip, edge rejuvenation, thinning
- O, N, P. marginal retouch on the lower face, edge sharpening or thinning/edge angle correction
- I. single, flat removal on the upper face derived from the base, earlier stages of manufacturing process
- M, L. flat removals on the lower face, edge angle correction, thinning
- F, D. semi-flat removals on the upper face, edge sharpening
- C. single, semi-steep removal on the upper face, probably derived before obtaining the blank
- K. ventral surface of a flake (?)
- B. single, flat, broad removal, probably derived before obtaining the blank
- A. single, steep removal, probably derived before obtaining the blank

# Plate 71 Ehringsdorf 55/93

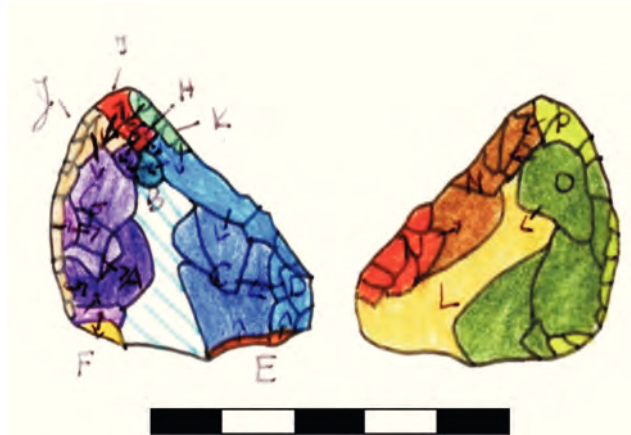


Small, heavily exhausted tool with both edges retouched and resharpened several times, exposed tip and transversally broken base.

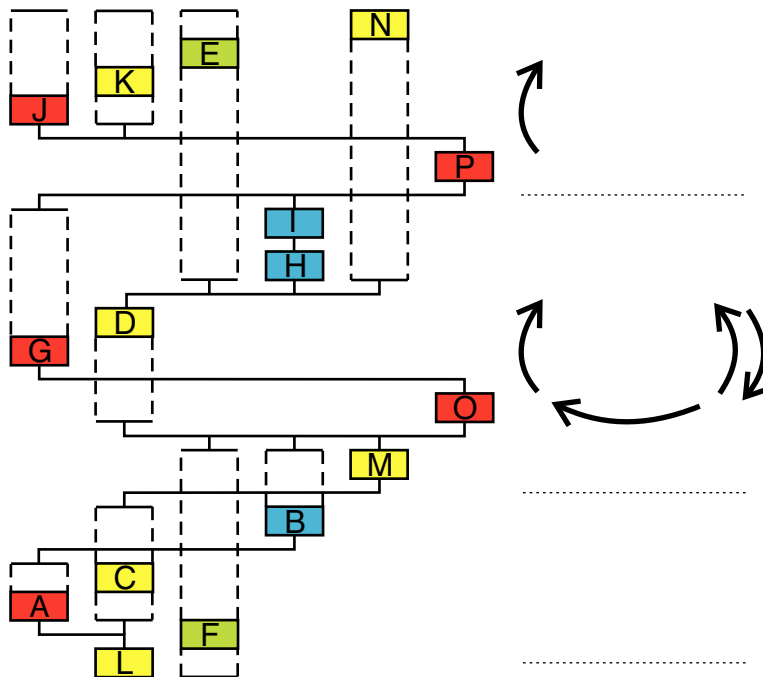


- F, G. semi-steep, marginal retouch, edge resharpening
- M, O, L. flat, small removals on the lower face, edge correction
- E, A. semi-steep removals on the upper face, edge resharpening
- D. semi-flat removals on the upper face, edge sharpening
- C. flat removals, edge, surface correction
- K, I. flat removals on the lower face, edge angle correction, thinning
- J. flat removals on the lower face, hinge in the middle part, edge angle correction, thinning
- N. transversal breakage, impact point in the middle of the upper surface
- H. ventral surface of a flake (?)
- B. steep removal at the base, blunting, back formation

## Plate 72 Ehringsdorf 56/93



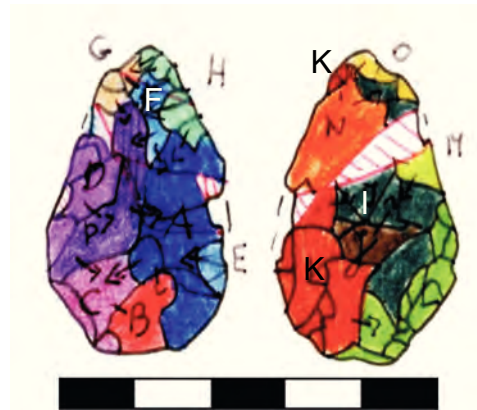
Plano-convex tool made on a flake with one edge convex and one concave, poorly exposed tip and blunted base. Both edges extensively reshaped on the upper face, lower face was used for edge angle correction. The tool could have its orientation changed.



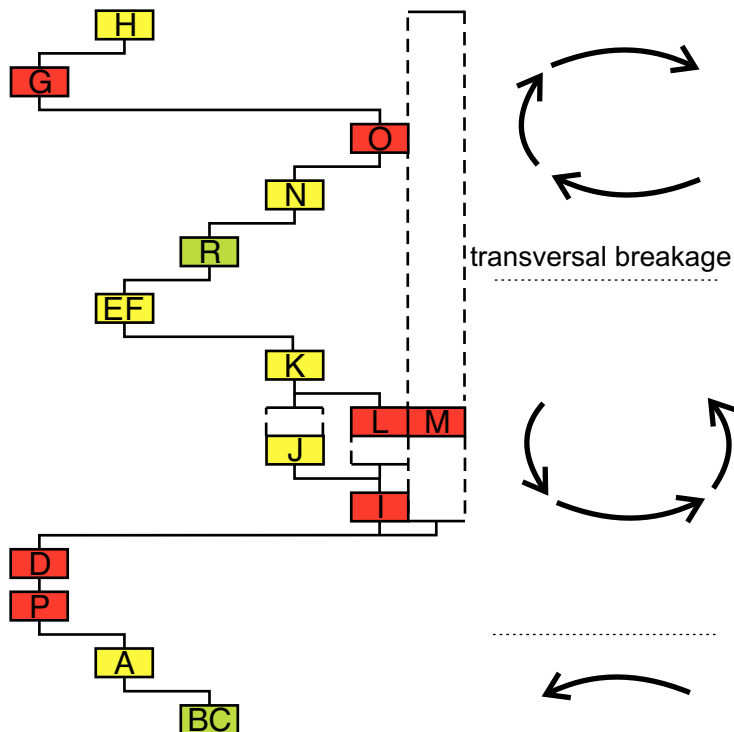
- E. steep, marginal removals on the upper face, base blunting
- N. semi-flat, deep removals on the lower face, edge correction
- K. semi-flat, marginal retouch, edge sharpening
- J. flat, marginal removals on the upper face, edge sharpening
- P. semi-flat removals on the lower face, edge angle correction
- I, H, B. flat removals on the upper face near the tip, edge sharpening, thinning
- G, D. flat and semi-flat removals on the upper face, edge sharpening
- O, M. flat removals on the lower face, edge angle correction
- C, A. flat/semi-flat, partly hinged removals on the upper face, edge sharpening, formation
- F. steep removal at the base, base blunting
- L. ventral surface of a flake



# Plate 73 Ehringsdorf 57/93



Exhausted tool, broken in the middle of rejuvenation process. After breakage, the tip was still resharpened on both edges. Both edges were retouched and resharpened.



H, G. semi-steep and steep, marginal retouch on the upper face, edge resharpening

O, N. flat, marginal removals on the lower face, edge angle correction

R. transversal breakage which breaks the tool into 3 pieces

E, F. semi-flat, marginal removals on the upper face, edge resharpening

C, D, P, B. semi-steep/semi-flat removals on the upper face, edge resharpening

A. semi-steep/semi-flat removals on the upper face, edge sharpening or surface formation

M. single, flat removal on the lower face, edge angle correction

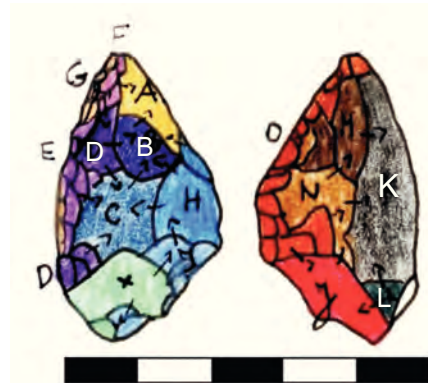
K. flat, partly hinged removals on the lower face, thinning, edge angle correction

L. flat removals on the lower face, semi-steep at the base, edge angle correction, base formation

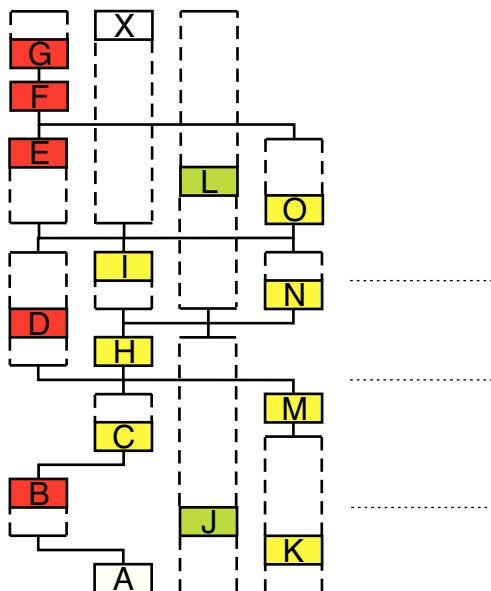
J. flat removals on the lower face, surface thinning

I. flat, partly very high (>5mm) hinged removals on the lower face, surface thinning

## Plate 74 Ehringsdorf 58/93

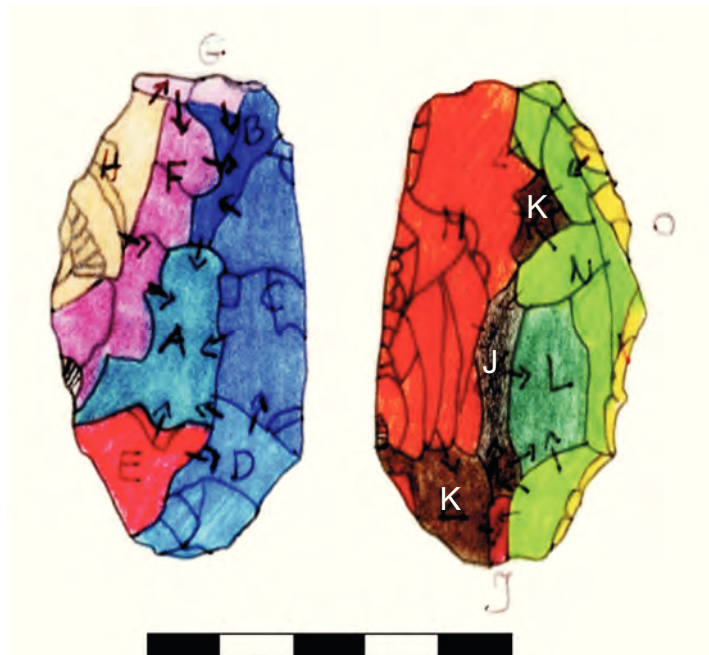


Heavily exhausted tool, probably made on a flake with exposed tip and alternate retouch of both edges, base was worked abruptly, both edges were resharpened several times

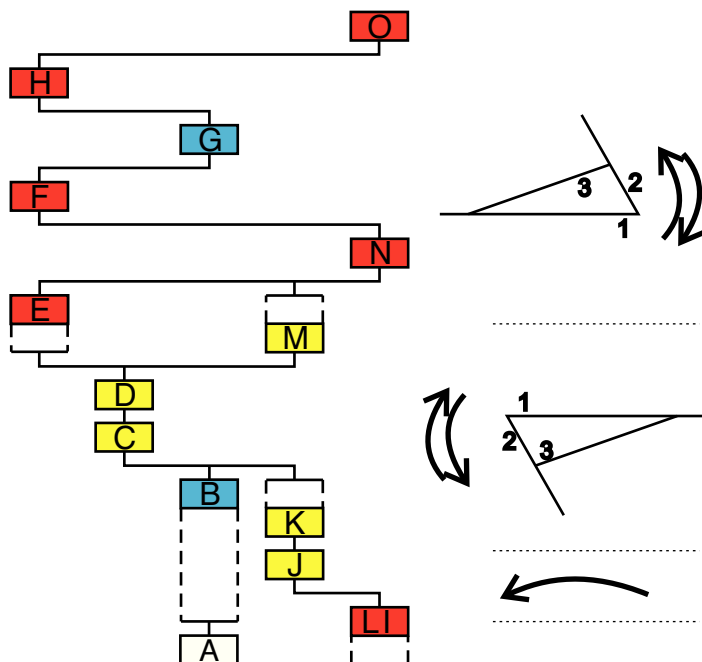


- X. postdepositional breakage
- G. steep, blunting, marginal retouch on the upper face, several stages of edge resharpening
- F, E. semi-flat, marginal retouch on the upper face, edge resharpening
- D. semi-steep removals on the upper face, edge sharpening/formation (?)
- I. steep, marginal retouch on the upper face near the base, edge formation, partly blunting
- O. marginal retouch on the lower face, edge resharpening
- N, M. semi-flat removals on the lower face, edge angle correction, thinning
- K. single, flat removal, reaching the opposite edge, surface formation
- L. single, flat removal on the lower face, surface formation
- J. single, semi-steep removal, earlier phases of manufacturing process
- H. semi-steep removals on the upper face, edge rejuvenation
- C, B. flat removal on the upper face, surface thinning
- A. ventral surface of a flake (?)

# Plate 75 Ehringsdorf 60/93

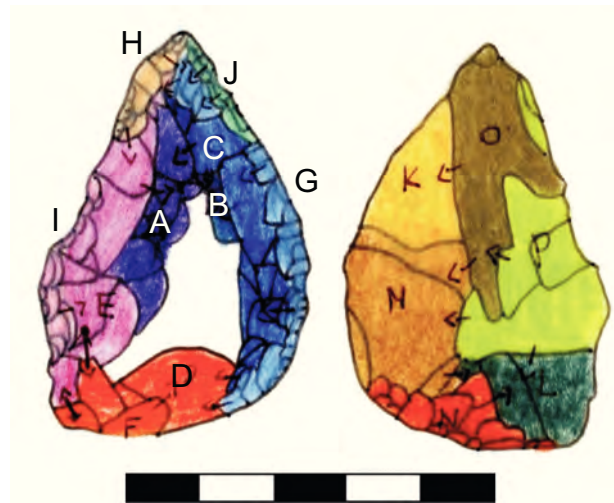


Unfinished tool made on a flake with blunted tip, unsuccessfully thinned, worked mainly near the tip.

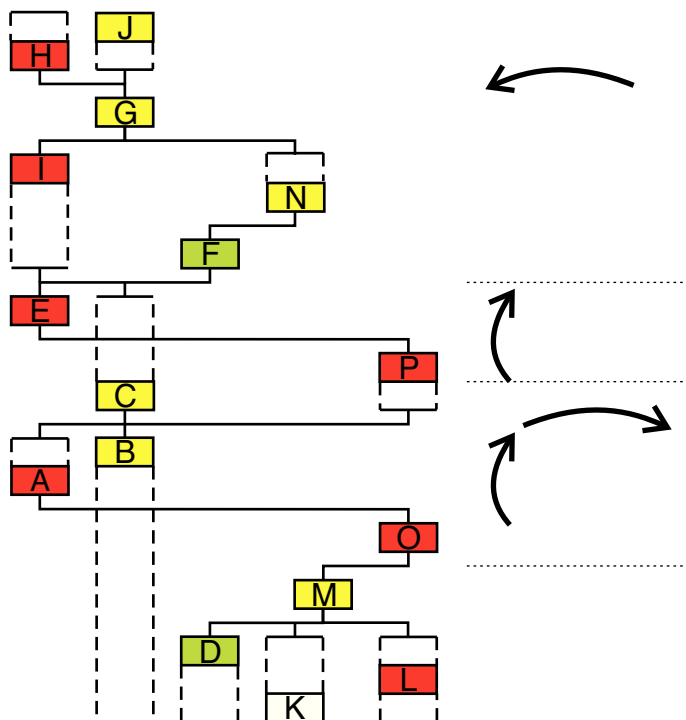


- O. marginal, irregular retouch on the lower face
- H. flat, hinged removals on the upper face, unsuccessful thinning near the tip
- G. semi-steep removals at the tip, created a separate tip edge
- F. semi-flat removals on the upper face, thinning near the tip
- N. semi-flat/semi-steep, partly hinged removals on the lower face, edge/surface formation
- M. flat, broad and smaller, marginal removals on the lower face, edge thinning, analogical to sequence F, edge formation
- E. semi-flat removals near the base, thinning
- D. semi-steep removals near the base on the upper face, working edge formation (?)
- C. semi-steep removals on the upper face along the edge, edge formation
- B. flat removal on the upper face derived from the tip, aimed at removing the flake bulb
- A. ventral surface of a flake
- K, J, I. semi-flat removals on the lower face, surface formation or derived before obtaining the blank
- L. semi-steep, broad removal on the lower face, surface formation or derived before obtaining the blank

## Plate 76 Ehringsdorf 61/93



Plano-convex knife made on a flake with one concave and one convex edge, and exposed tip. Both edges were retouched and resharpened subsequently; lower face was used for thinning and edge angle correction.



J. steep, marginal retouch on the upper face near the tip, edge resharpening

H, G, I. semi-flat, marginal retouch on the upper face, edge resharpening

E, C. semi-steep removals on the upper face, edge rejuvenation, resharpening

F. flat removals on the upper face derived from the base, base edge formation

N. semi-flat, marginal retouch on the lower face at the base, base edge formation

D. single, semi-flat removal on the upper face derived from the base, base formation

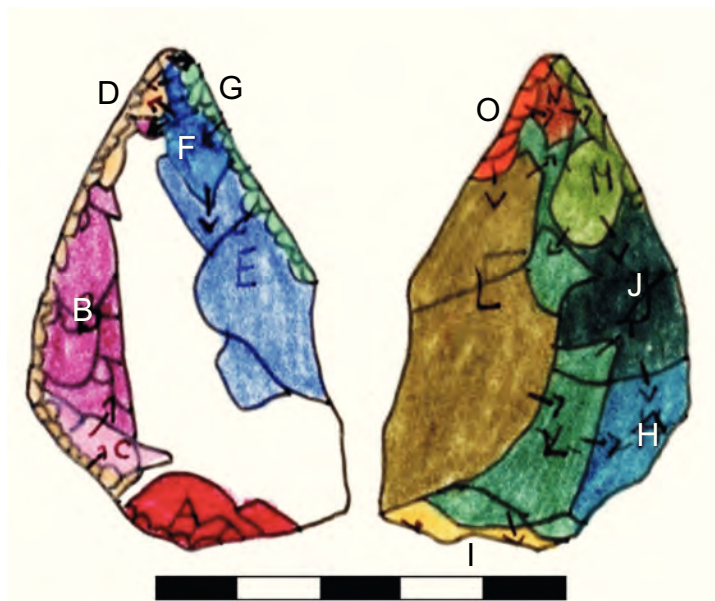
B, A. semi-flat/semi-steep removals on the upper face, edge formation, sharpening (?)

O, P, M. flat, broad removals on the lower face, edge angle correction, thinning

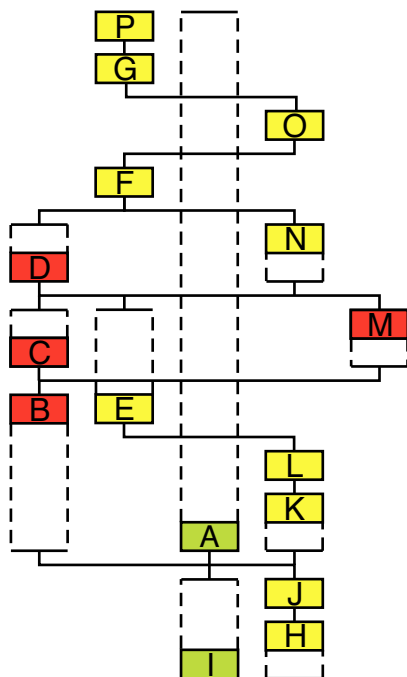
L. semi-flat, broad removals on the lower face, edge angle correction, thinning, bulb removal

K. ventral surface of a flake (?)

# Plate 77 Ehringsdorf 62/93



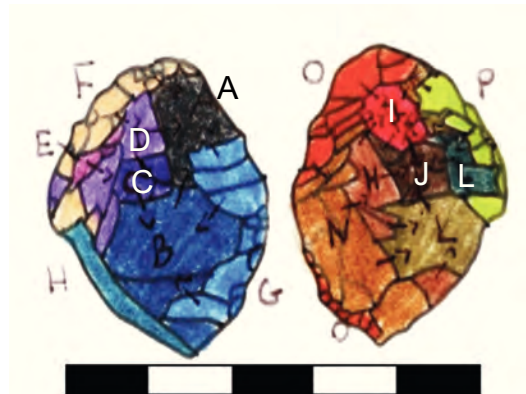
Plano-convex knife made on a flake with one concave and one convex edge, and exposed tip. Both edges were retouched and resharpened subsequently; lower face was used for thinning and edge angle correction.



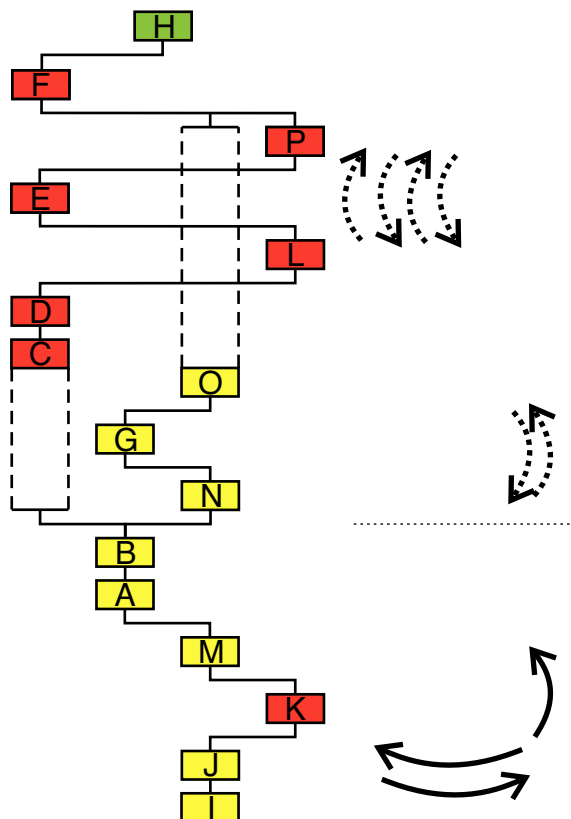
- G, D, C. flat, marginal retouch on the upper face, edge resharpening
- F. flat removals on the upper face near the tip, thinning, edge resharpening
- O, M, N. flat removals on the lower face, edge/edge angle correction
- B, E. semi-steep/semi-flat removals on the upper face, edge sharpening
- A. marginal retouch on the upper face at the base, base edge formation/sharpening (?)
- K, L. flat, broad removals on the lower face, edge angle correction, thinning, surface formation
- I. steep removals at the base, base formation
- J. ventral surface of a flake (?)
- H. steep removal on the lower face, created a back, perhaps a flake butt
- P. transversal breakage blunting the edge near the base



# Plate 78 Ehringsdorf 63/93

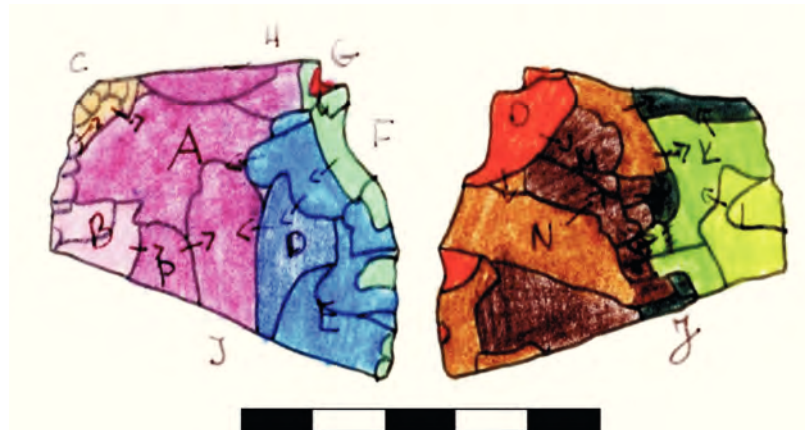


Tool with both edges worked separately, unexposed tip, broken postdepositionally near the base.

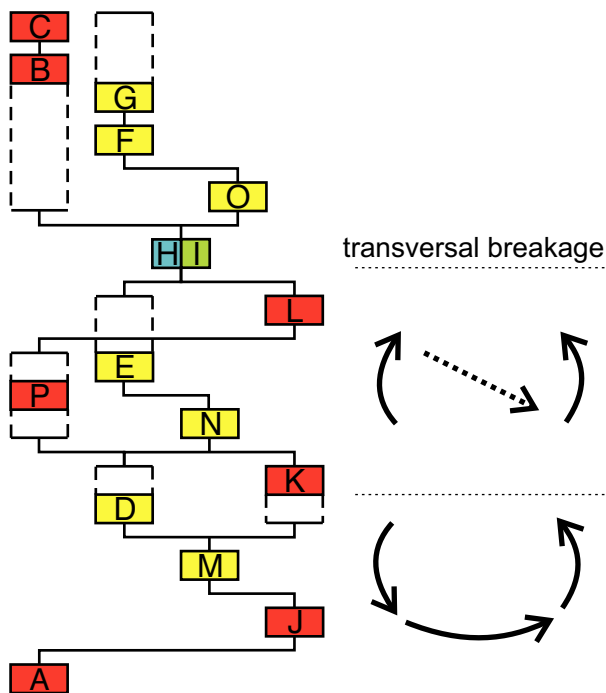


- F. flat, hinged, marginal retouch on the upper face, edge sharpening
- E. single, flat, hinged removal on the upper face, edge sharpening
- D, C. flat removals on the upper face, edge sharpening
- A. semi-steep removals on the upper face near the tip, earlier stage of manufacturing process
- B. semi-flat, broad removals on the upper face, surface formation, thinning
- G. semi-flat retouch on the upper face, edge sharpening
- O, P. flat removals on the lower face, edge angle correction
- N, M, L. flat/semi-flat removals on the lower face, edge angle correction
- K, J. flat removals on the lower face, analogous to sequence B, surface formation, thinning
- I. flat scar, probably ventral surface of a blank
- H. postdepositional breakage

# Plate 79 Ehringsdorf 64/93

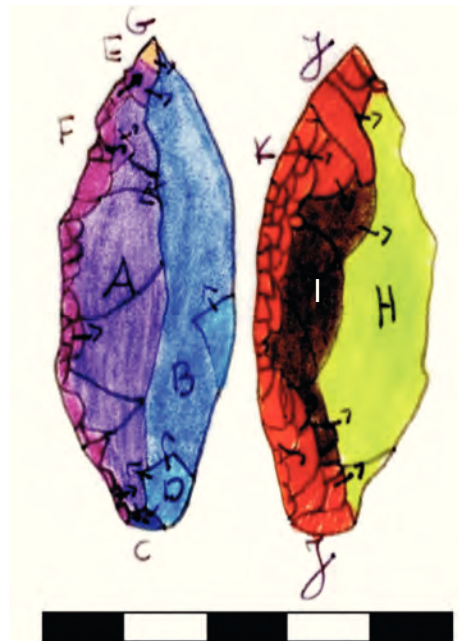


Flat, bifacial tool with transversal breakages on both ends. Double breakage scar on one end, and breakage impact point in the middle of surface on the other end probably point to the intentional character of both breakages.

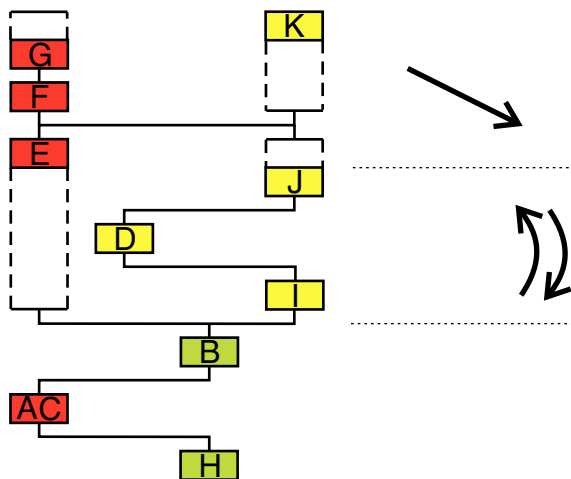


- C, B. semi-flat, marginal retouch, edge correction after breakage
- G. steep removals derived from breakage scar and along the edge, aimed at blunting the edge
- F. flat, marginal removals, edge correction after breakage, created a notch near the breakage
- O. flat, partly hinged removals on the lower face, edge angle correction
- H. transversal breakage, impact point in the middle of upper face
- I. transversal breakage, two breakage scars visible on the surface, impact point in the middle of upper face
- L. flat removals on the lower face, edge/edge angle correction
- K, E, P. flat removals, edge formation, thinning
- M, N, J, D, A. flat, broad removals, surface formation, thinning

# Plate 80 Ehringsdorf 77/93

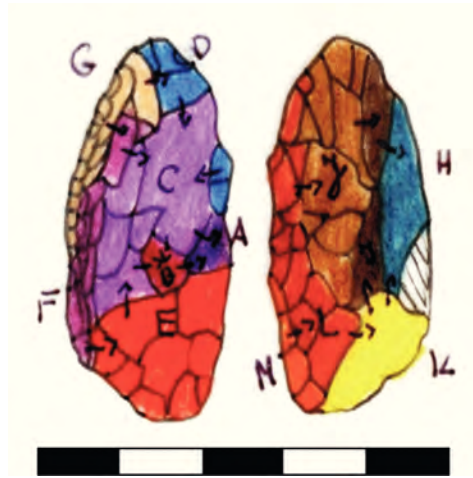


Symmetrical tool made on a flake with large butt (half of the upper face-sequence A and C, are the surface of butt), retouched alternately on both edges; exposed tip.

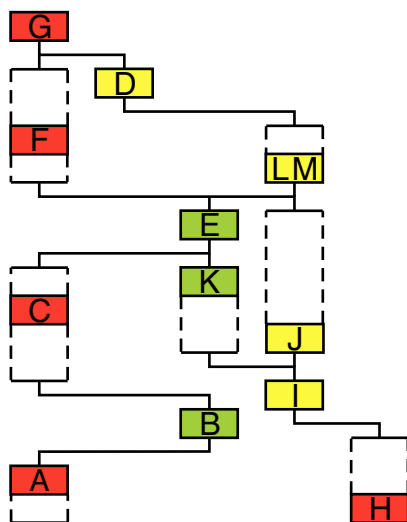


- K. flat, marginal retouch on the lower face, partly hinged near the base, a few subsequent resharpening sequences
- J. flat removals on the lower face, edge resharpening
- I. semi-flat removals on the lower face, edge formation, thinning
- G, E. single, semi-steep removals on the upper face near the tip, resharpening
- F. steep, marginal retouch on the upper face, edge sharpening/resharpening (?)
- D. flat removals on the upper face, edge angle correction
- B. ventral surface of a flake with a bulb in the middle of the upper face
- C, A. semi-steep removals, derived before obtaining the flake, striking platform formation
- H. flat removal derived before obtaining the flake

## Plate 81 Ehringsdorf 79/93

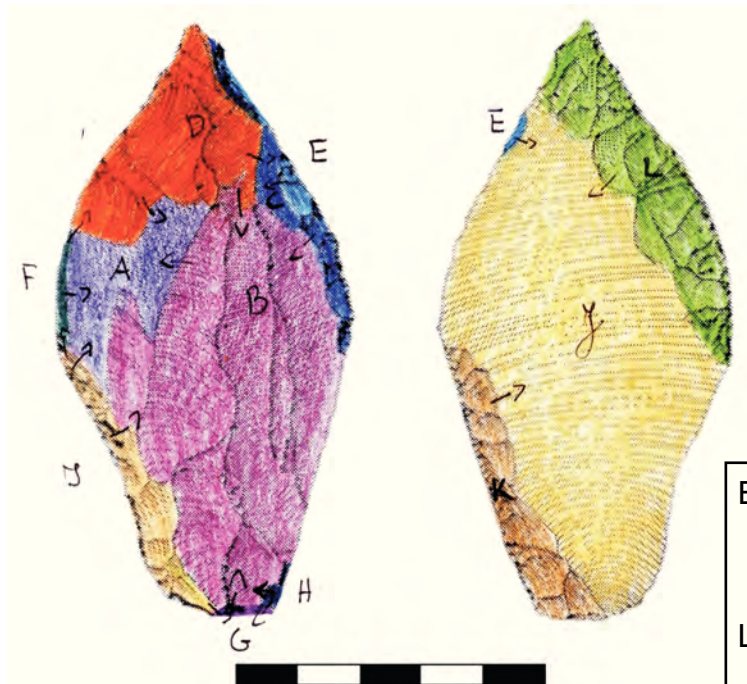


Tool with subsequent resharpening of edges. Both edges retouched alternately, one edge with semi-flat retouch on the upper face and the other with flat retouch on the lower face; unexposed, concave tip.

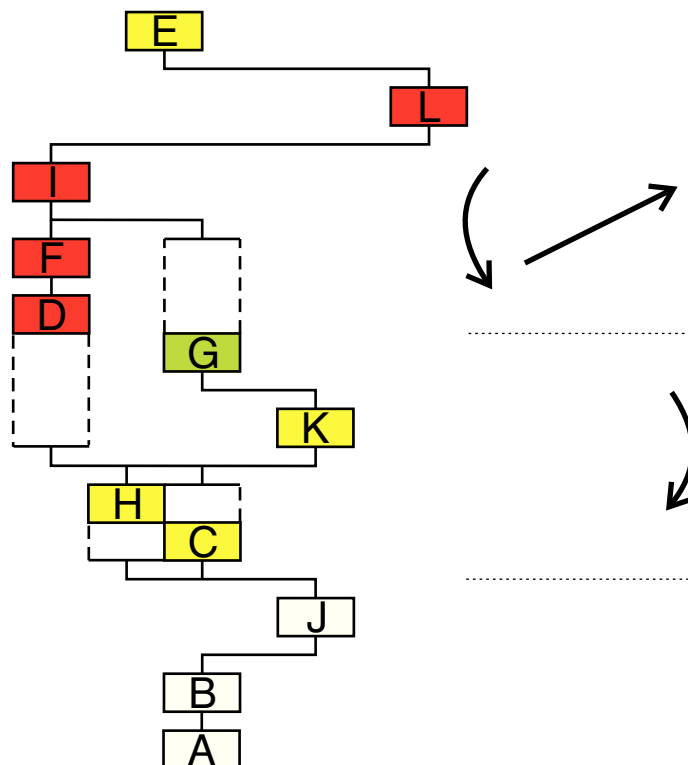


- G, F. flat, hinged, marginal retouch, probably a few stages of edge resharpening on the upper face
- D. flat removals on the upper face near the tip, near-the-tip thinning
- M, J. semi-flat removals on the lower face, edge resharpening
- L. semi-flat, partly hinged removals on the lower face, edge resharpening
- I. flat, broad removals on the lower face, surface thinning
- K. flat removals on the lower face, surface thinning near the base
- E. semi-flat removals on the upper face, base formation
- A, B. flat scars on the upper face, earlier phases of manufacturing process
- C. flat removals on the upper face, surface thinning, edge resharpening
- H. steep removals on the lower face, earlier stage of manufacturing process

## Plate 82 Ehringsdorf 283/93



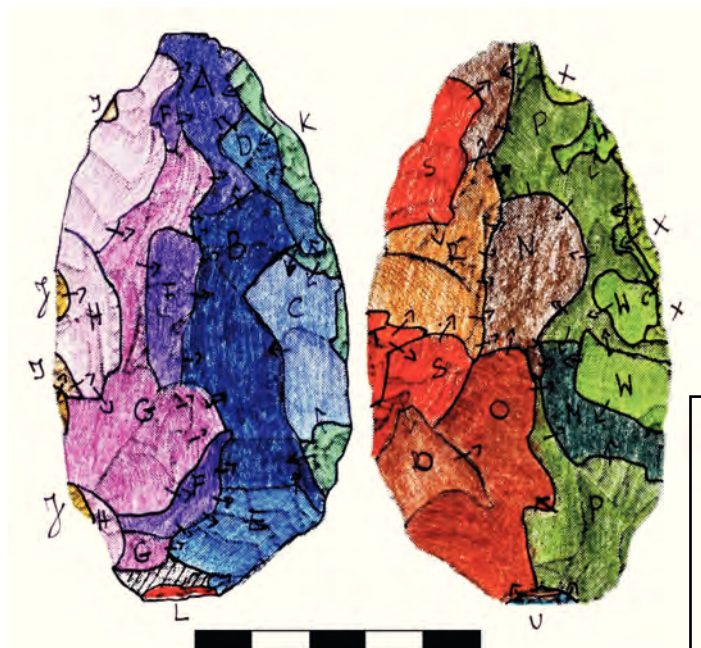
Plano-convex tool made on a flake, with exposed tip, resharpened single edge, traces of shaping and thinning.



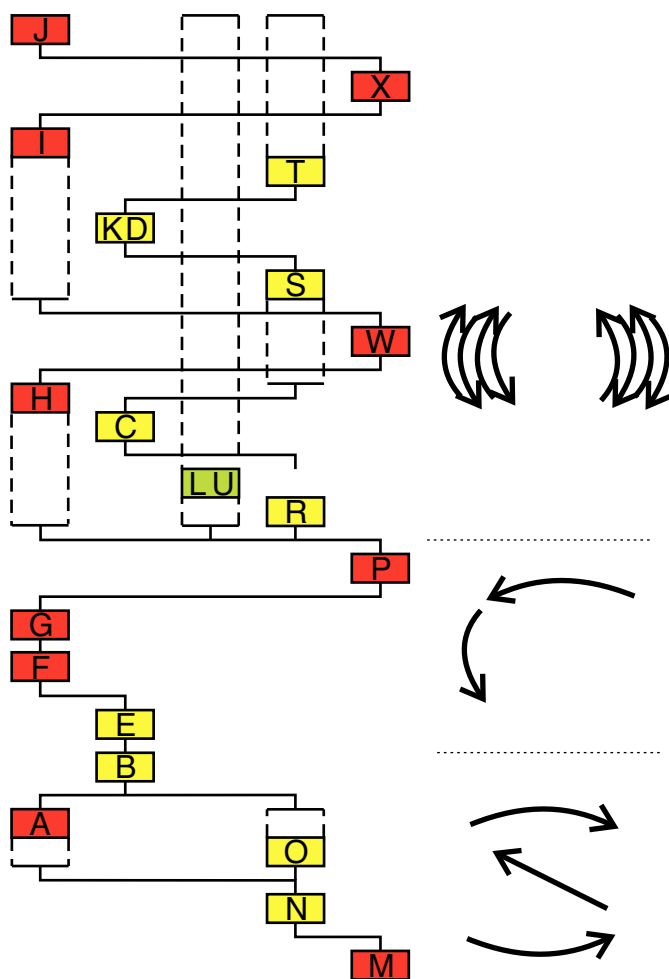
- E. steep, hinged, marginal retouch on the upper face, edge resharpening, damaged the edge
- L. semi-flat removals on the lower face, edge angle correction, shaping
- I. semi-steep, marginal retouch on the upper face near the base, edge sharpening, shaping
- G. steep removals at the base, base formation, blunting
- F. single, flat removal on the upper face, edge angle correction before sequence L
- D. semi-flat, long removals on the upper face, shaping, edge formation, thinning
- K. semi-steep retouch on the lower face near the base, edge shaping, sharpening, thinning the butt
- H. flat removals on the upper face, edge angle correction before sequence K
- C. semi-steep removals on the upper face, edge sharpening
- B. flat, long removals on the upper face derived parallel to vertical axis, derived before obtaining the flake
- A. flat, broad scars of removals derived before obtaining the flake
- J. ventral surface of a blank



# Plate 83 Ehringsdorf 284/93

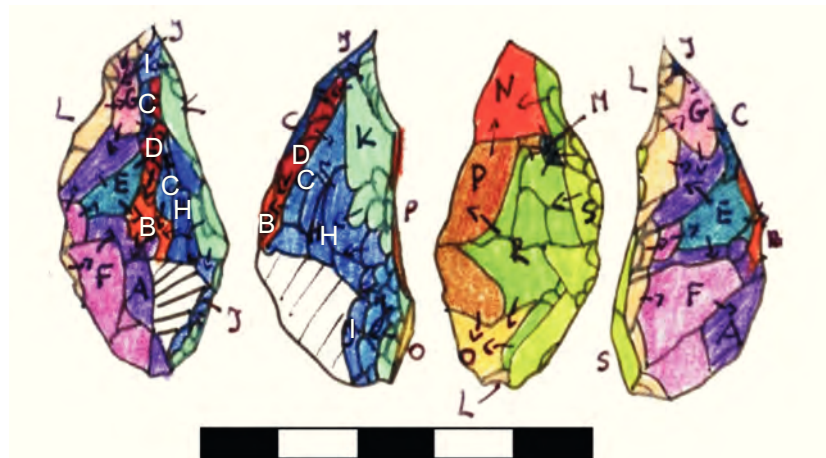


Big, plano-convex, bifacial tool with concave lower face, both edges resharpened several times, no traces of shaping and unexposed tip.

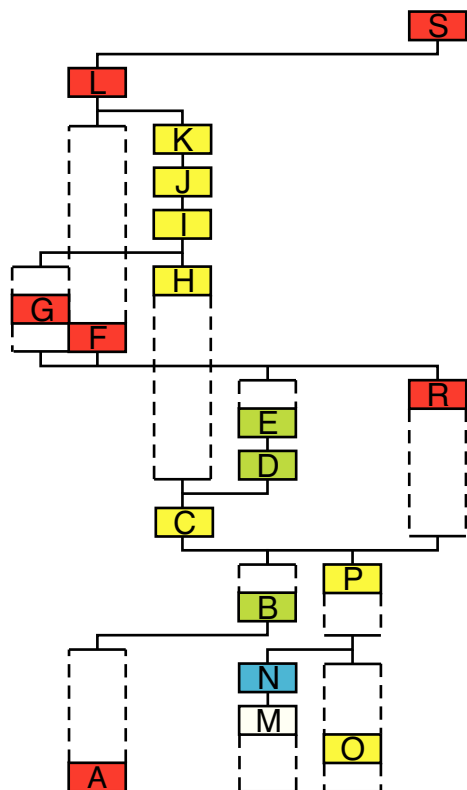


- J, I. small, marginal retouch on the upper face
- L. small, marginal retouch on the upper face at the base
- U. small, marginal retouch on the lower face at the base
- K. semi-steep, marginal retouch on the upper face, edge resharpening
- T, X. flat, marginal retouch, edge angle correction
- H. flat, hinged removals, edge sharpening, thinning, analogical to sequence S
- S. flat removals on the lower face, analogical to sequence H, thinning, edge angle correction
- W. flat removals on the lower face, edge angle correction
- D, F. flat/semi-flat removals on the upper face near the tip, edge resharpening
- E. semi-steep, long removals on the upper face near the base, edge formation
- R, O, N, M. flat removals on the lower face, surface formation, flattening, thinning
- P. semi-flat removals on the lower face near the base, surface formation, thinning, flattening
- C. semi-steep removals on the upper face, edge formation
- A, B. flat, broad removals on the upper face, surface formation
- G. semi-flat and semi-steep, hinged removals on the upper face, edge formation

## Plate 84 Ehringsdorf 287/93

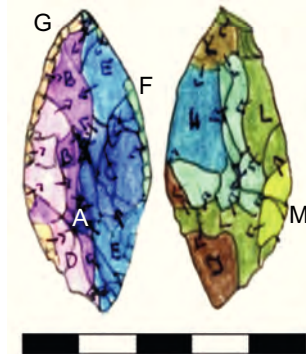


Big, plano-convex, bifacial tool with concave lower face, both edges resharpened several times, no traces of shaping and unexposed tip.

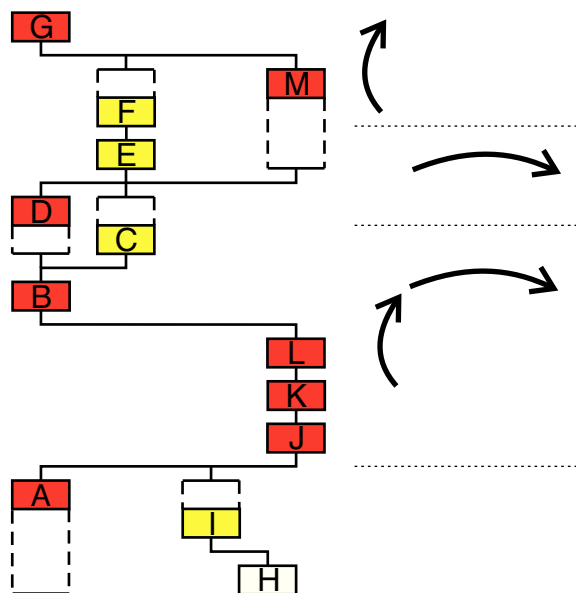


- J, I. small, marginal retouch on the upper face
- L. small, marginal retouch on the upper face at the base
- U. small, marginal retouch on the lower face at the base
- K. semi-steep, marginal retouch on the upper face, edge resharpening
- T, X. flat, marginal retouch, edge angle correction
- H. flat, hinged removals, edge sharpening, thinning, analogical to sequence S
- S. flat removals on the lower face, analogical to sequence H, thinning, edge angle correction
- W. flat removals on the lower face, edge angle correction
- D, F. flat/semi-flat removals on the upper face near the tip, edge resharpening
- E. semi-steep, long removals on the upper face near the base, edge formation
- R, O, N, M. flat removals on the lower face, surface formation, flattening, thinning
- P. semi-flat removals on the lower face near the base, surface formation, thinning, flattening
- C. semi-steep removals on the upper face, edge formation
- A, B. flat, broad removals on the upper face, surface formation
- G. semi-flat and semi-steep, hinged removals on the upper face, edge formation

## Plate 85 Ehringsdorf 315/93

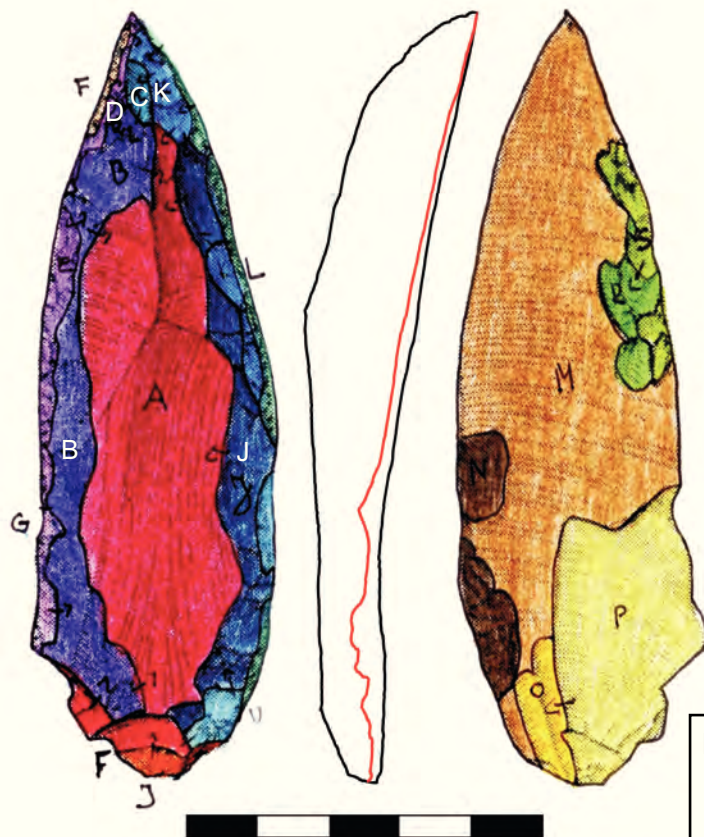


Plano-convex tool with both ends exposed, both edges are retouched abruptly and were resharpened several times; lower face was used for edge angle correcting sequences.

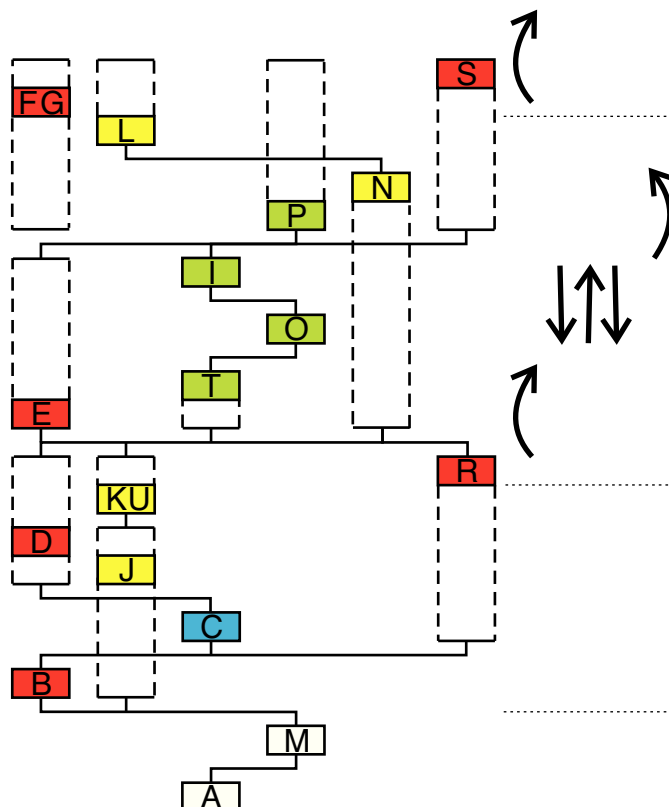


G, F. steep, hinged, marginal retouch, edge resharpening  
 M, K. flat removals on the lower face, edge angle correction  
 D. semi-steep and steep, partly hinged removals on the upper face, edge resharpening  
 E, B, C. semi-steep and steep removals on the upper face, edge resharpening  
 A. semi-flat removals on the upper face, edge sharpening (?)  
 L, J, I. flat removals on the lower face, edge angle correction, thinning  
 H. ventral surface of a flake

# Plate 86 Ehringsdorf 316/93

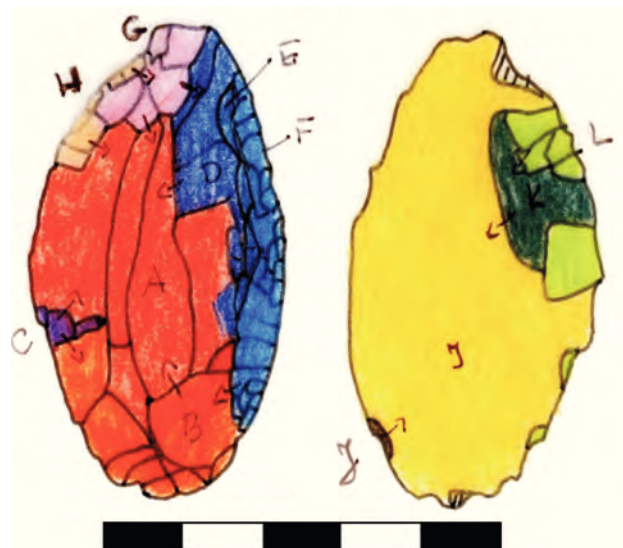


Plano-convex tool made on a bent flake/blade with exposed tip and multiple resharpening phases on both edges, near-the-tip part was very precisely worked, lower face was used for edge angle correction, base was thinned. Sequences were not aimed at removing the blank's bend, resharpening sequences even deepen the bend.

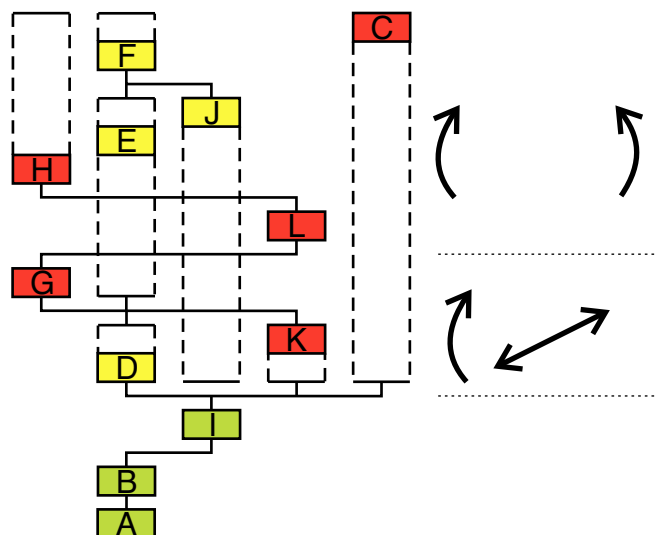


- F, L. steep, partly hinged, marginal retouch on the upper face near the tip, edge resharpening and probably usewear
- K, E, D. steep and semi-steep, partly hinged, marginal retouch on the upper face, probably a few stages of edge resharpening
- G, U. semi-flat and semi-steep, marginal retouch, edge resharpening
- J, B. semi-flat/semi-steep retouch on the upper face, edge sharpening
- S, R, N. flat, deep removals on the lower face, edge/edge angle correction, flattening
- C. single, semi-flat removal on the upper face, near-the-tip part thinning
- I. flat removals on the upper face derived from the base, base formation
- T. semi-flat, very high (>8mm) hinged removal, unsuccessful thinning of the near-the-base part
- O, P. flat, long removals on the lower face derived from the base, aimed at thinning and bulb removing
- A. semi-flat, broad scars of removals derived before obtaining the blank
- M. ventral surface of a blank

# Plate 87 Ehringsdorf 1463/93



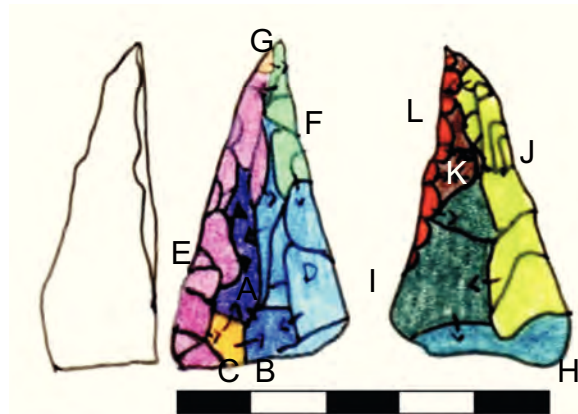
Plano-convex tool made on a striking platform rejuvenating the flake.  
Unexposed tip, both edges retouched and resharpened, edge I resharpened on its whole length, edge II only near the tip.



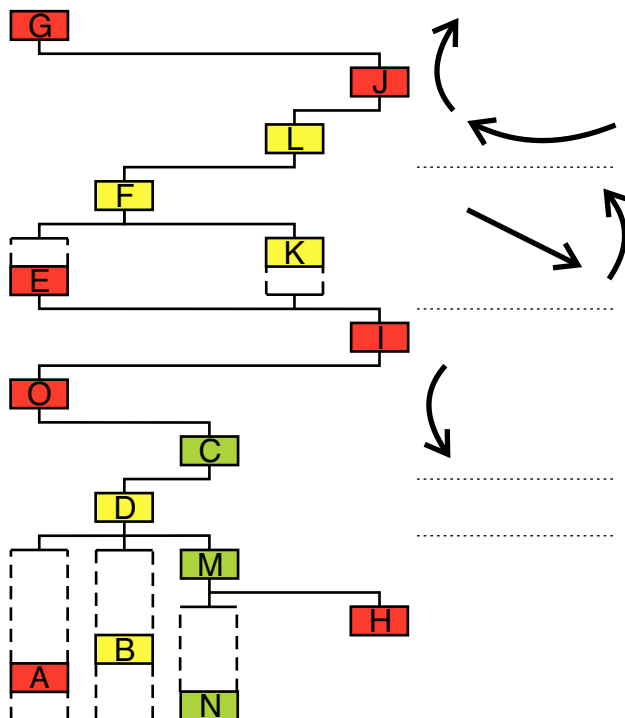
- F, H. semi-flat, hinged, marginal retouch on the upper face, edge resharpening
- J, L, K. flat removals on the lower face, edge angle correction
- G, E. semi-flat retouch on the upper face, edge resharpening
- C. semi-steep, small removals on the upper face, edge correction
- D. semi-steep/semi-flat removals on the upper face, edge sharpening
- B. flat, long removals, aimed at core edge angle correction, derived before obtaining the flake
- A. flat, long removals derived before obtaining the flake
- I. ventral surface of a flake



## Plate 88 Ehringsdorf 1648/93

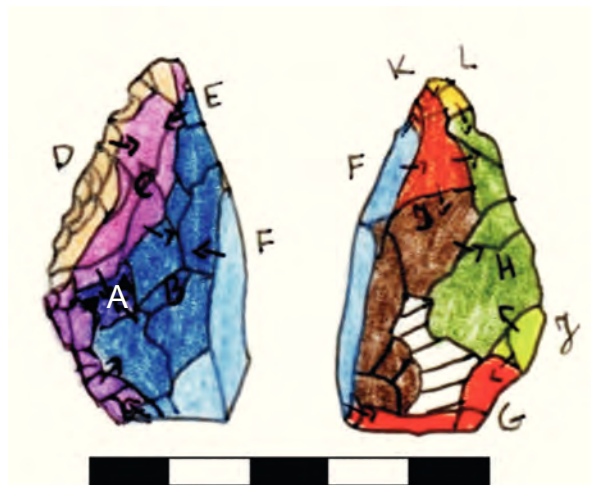


Triangular, plano-convex knife made of flake, with two steeply retouched edges converging at an extremely exposed tip. Lower surface was used for edge angle corrections only, subsequent resharpening sequences were derived on the upper face.

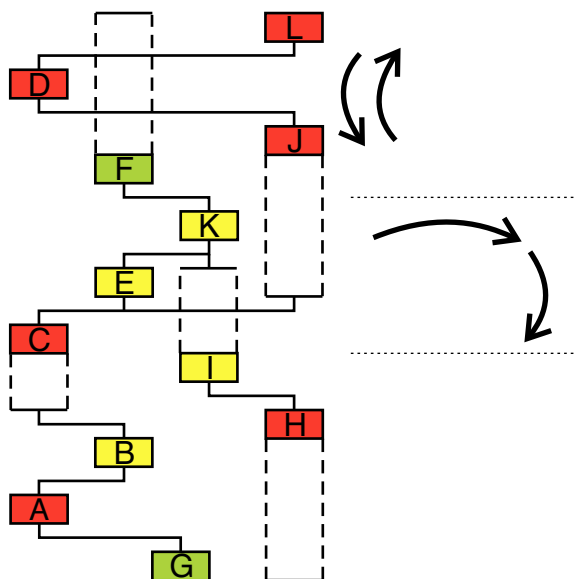


- G. flat, marginal removal on the upper face, edge correction
- J, K. flat, deep removals on the lower face, edge angle correction, thinning
- L. marginal retouch on the lower face, edge correction
- F, E. semi-steep, marginal retouch on the upper face near the tip, edge resharpening
- I. flat, far going, reaching the opposite edge removals on the lower face, edge angle correction from distal posterior edge
- O, D. semi-steep removals on the upper face, edge resharpening
- C. flat removal on the upper face derived from the base, surface correction
- M. steep, blunting removals at the base, base formation
- B, A. semi-steep removals on the upper face, earlier phases of edge rejuvenation (?) or derived before obtaining the blank
- H. ventral surface of a flake
- N. natural surface at the base

# Plate 89 Ehringsdorf 2242/93

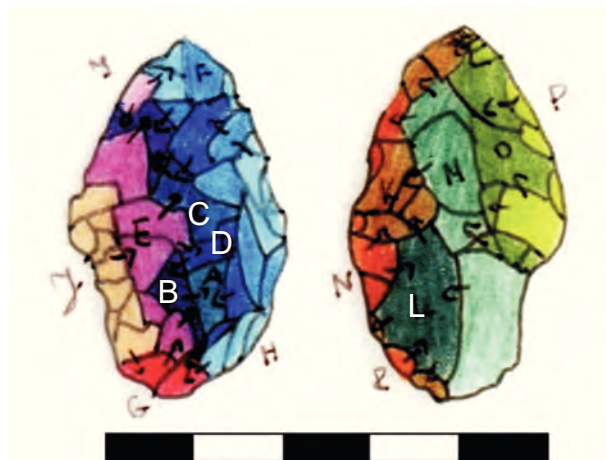


Tool with abrupt back and single cutting edge located on the left side of the upper face. Subsequently rejuvenated by edge angle correcting removals on the lower face and resharpening retouch on the upper face.

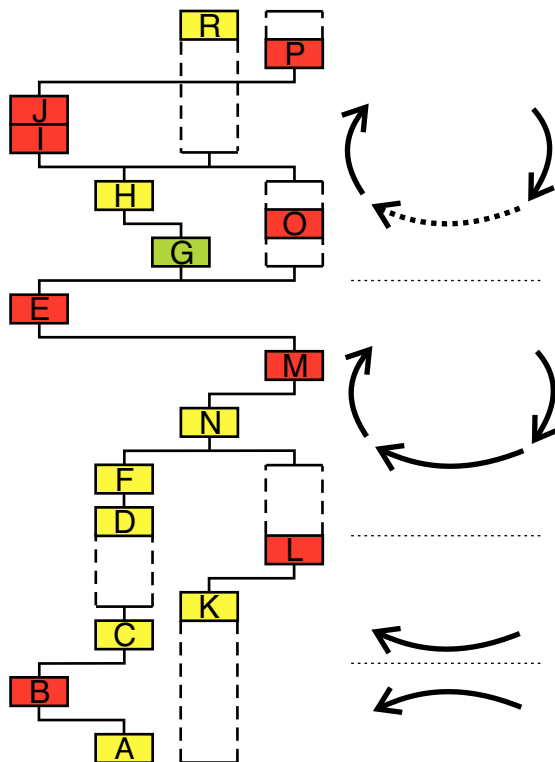


- L. flat, small removals on the lower face near the tip, tip sharpening
- D. semi-flat, marginal retouch on the upper face, cutting edge resharpening
- J. semi-flat, marginal removals on the upper face, edge and edge angle correction
- F. long removals derived from the base, created an orthogonal back surface
- K. flat removals on the lower face near the tip, derived angularly from distal posterior edge, near-the-tip part thinning
- E. flat removal on the upper face near the tip, edge correction
- C. overlapping removals, probably from several stages of cutting edge resharpening on the upper face
- I. flat removals on the lower face, surface formation, earlier stages of remodeling (?)
- B, A. flat removal on the upper face, surface formation, earlier stages of remodeling (?)
- H. flat removals on the lower face, cutting edge angle correction
- G. steep removals on the lower face near the base, base formation

# Plate 90 Ehringsdorf 2304/93

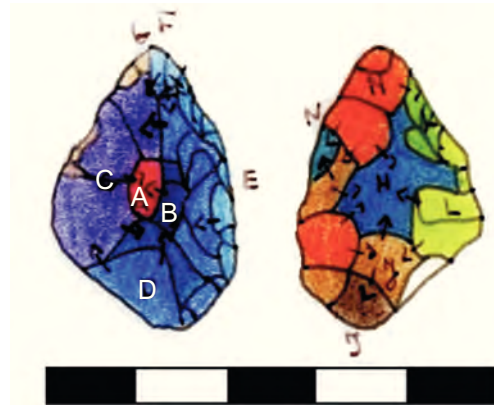


Plano-convex, highly exhausted tool with subsequent rejuvenation on both edges, perhaps it had its orientation changed.

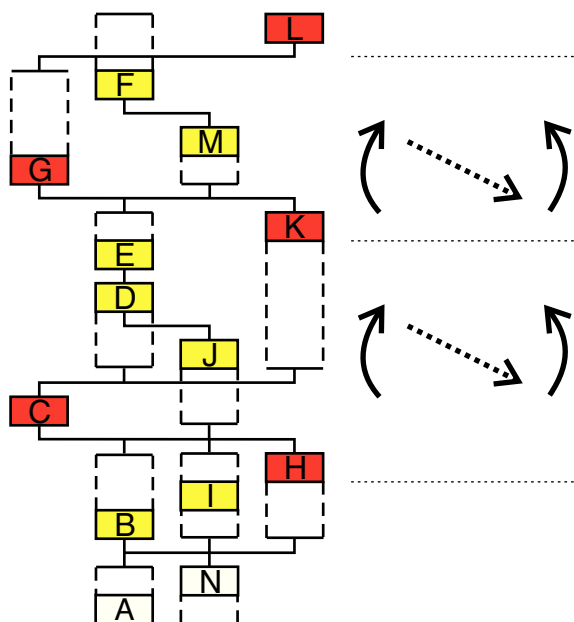


- R. semi-flat, small, marginal removals on the lower face, edge correction
- P. semi-flat, marginal removals on the lower face, edge/edge angle correction
- J. semi-steep/steep, marginal retouch on the upper face, edge resharpener
- I. single flat, marginal removal on the upper face, edge resharpener
- H, F, D, C, B. semi-flat, partly hinged, marginal removals, edge resharpener
- G. semi-steep removals at the base, edge rejuvenation
- O, K. semi-flat removals on the lower face, edge angle correction, thinning
- M, L, N. flat and semi-flat, broad removals on the lower face, edge angle correction, thinning
- E. semi-flat removals on the upper face, edge resharpener
- A. semi-flat scar, earlier phase of the manufacturing process

# Plate 91 Ehringsdorf 5875/93

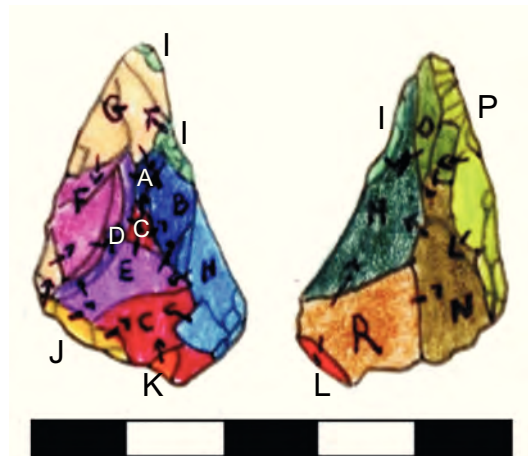


Plano-convex, heavily exhausted tool with subsequent rejuvenation of cutting edge and near-the-tip part. Lower face was used for edge angle correction, resharpening retouches were derived on the upper face.

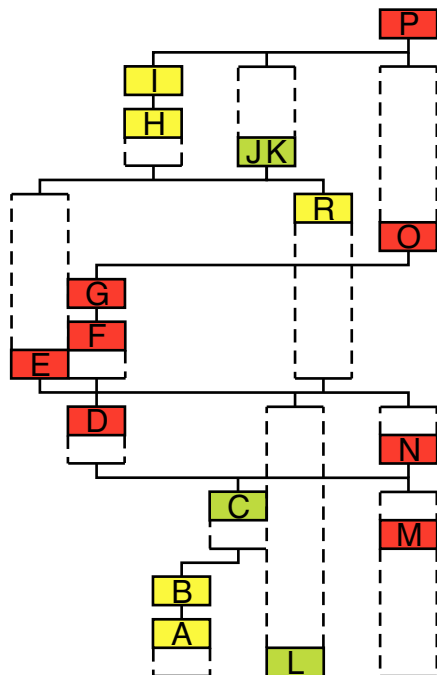


- F. semi-flat/semi-steep, marginal retouch on the upper face near the tip, edge resharpening
- G. steep, marginal retouch on the upper face near the tip, edge resharpening
- M, J, K. flat removal on the lower face, edge angle correction
- L. semi-flat removals on the lower face, edge angle correction
- E. steep/semi-steep, hinged removals on the upper face, edge resharpening
- C. semi-steep removals on the upper face, edge resharpening
- D. semi-flat/semi-steep removals on the upper face, edge resharpening
- B. semi-flat removals on the upper face, edge resharpening
- I. single, semi-flat removal on the lower face, edge angle correction
- H, N. single, semi-flat, broad removal on the lower face, earlier stages of manufacturing process
- A. single, flat removal on the upper face, earlier stages of manufacturing process

# Plate 92 Ehringsdorf 5883/93



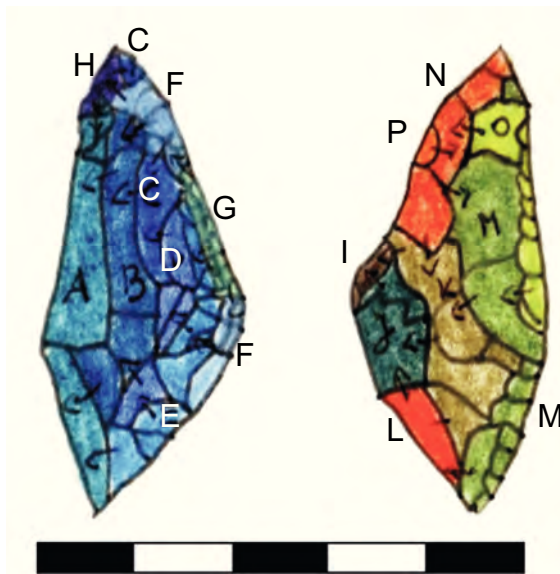
Heavily exhausted tool with multiple resharpening sequences on both edges, exposed tip and edges retouched alternately.



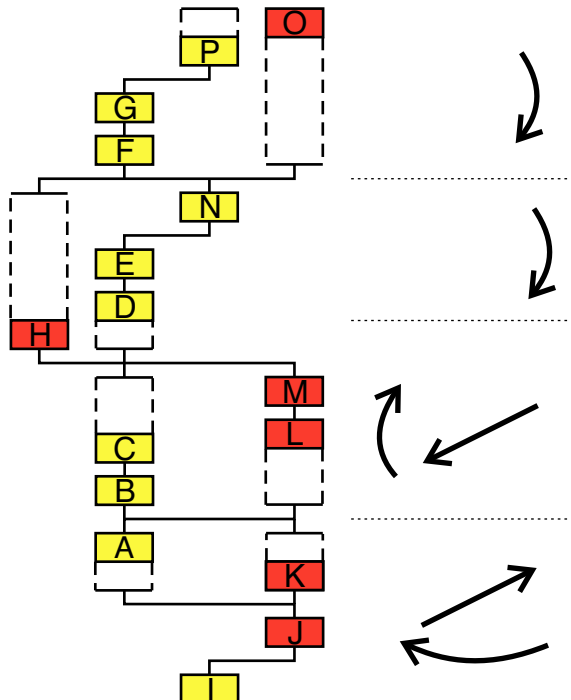
- P. semi-steep, marginal retouch on the lower face, edge resharpening
- O. semi-steep/semi-flat removals on the lower face near the tip, edge resharpening
- N. semi-flat removals on the lower face, edge resharpening
- M. flat removals reaching the opposite edge, thinning
- G, F, E. flat removals on the upper face, thinning, edge angle correction
- R. flat removals on the lower face, surface rejuvenation, thinning
- I. hinged, marginal removals on the upper face, edge resharpening
- H. semi-flat removals on the upper face, edge resharpening
- B. steep, hinged removals on the upper face, edge resharpening
- J, K. marginal retouch at the base
- C. semi-flat removals on the upper face near the base, thinning
- A, D. flat scars, earlier stages of rejuvenation
- L. transversal breakage at the base



## Plate 93 Ehringsdorf 7932/93

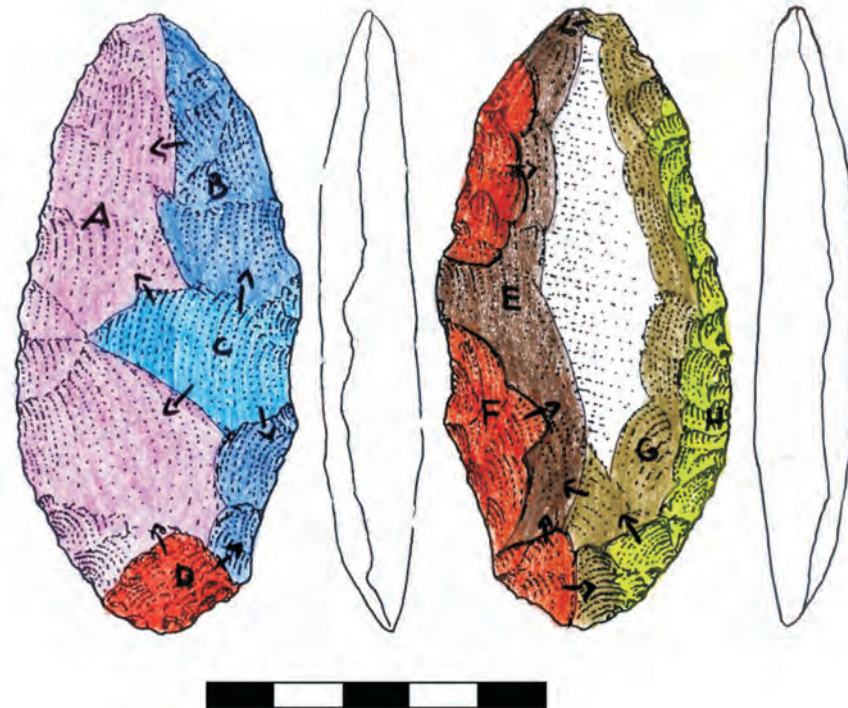


Highly exhausted knife with cutting edge vertical and blunted, or even concave in cross-section. Exposed tip; cutting edge bears traces of multiple resharpening sequences. Lower face was used for edge angle correction and thinning.

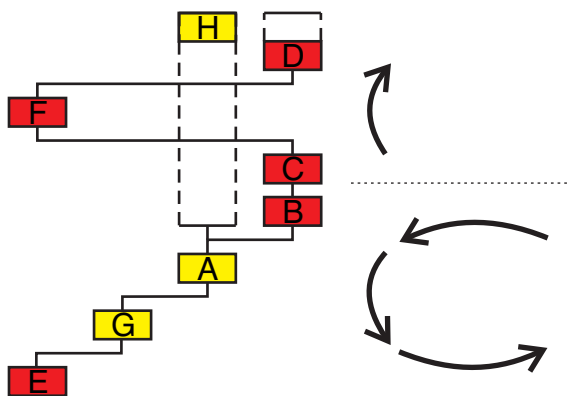


- P. single small, marginal removal, edge correction
- O. flat, marginal retouch on the lower face, edge correction, resharpening and usewear
- G. few phases of steep, blunting marginal retouches on the upper face, cutting edge resharpening
- F. semi-flat, marginal retouch on the upper face, cutting edge resharpening
- E, D. steep, hinged removals on the upper face, cutting edge resharpening
- C. semi-steep removals on the upper face, cutting edge resharpening
- N, I. flat removals on the lower face, edge angle correction
- H. small, marginal removals on the upper face near the tip, tip exposure, edge resharpening
- M, K, J. flat and semi-flat removals on the lower face, edge angle correction, thinning
- L. steep removal on the upper face, base formation
- B. flat removals on the upper face, earlier cutting edge formation/resharpening (?)
- A. flat, broad removals reaching the opposite edge, earlier stages of thinning or edge formation

# Plate 94 Lenderscheid V11\_3

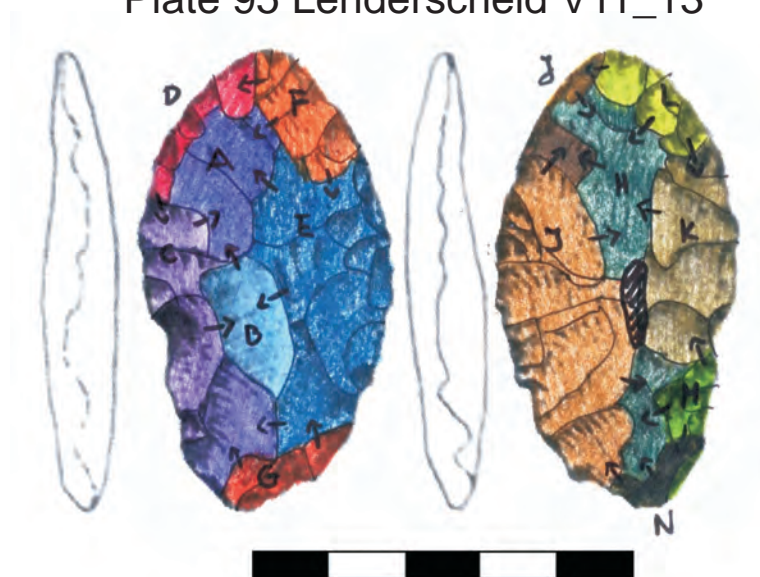


Plano-convex tool, partly cortical on the upper face with one edge sharpened and retouched (edge II) and unexposed tip. Several edge forming sequences were also derived from the tip and removed the tip.

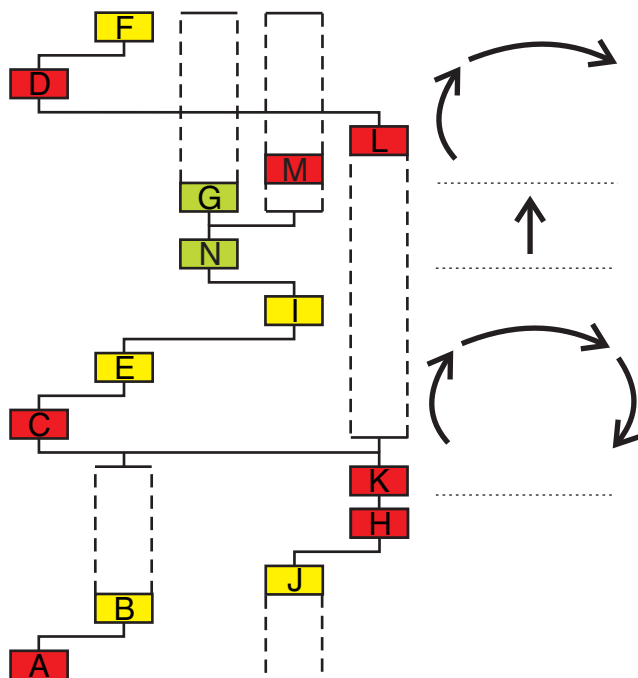


- H. semi-steep, partly hinged, marginal retouch on the upper face, edge sharpening
- F. semi-steep and semi-flat removals on the upper face, edge formation
- D. flat removals on the lower face at the base, base formation or orientation change and base sharpening
- C, B, A. flat, broad removals on the lower face, surface formation, thinning, flattening
- E, G. flat and semi-flat removals on the upper face, decortication, edge formation, thinning

# Plate 95 Lenderscheid V11\_13

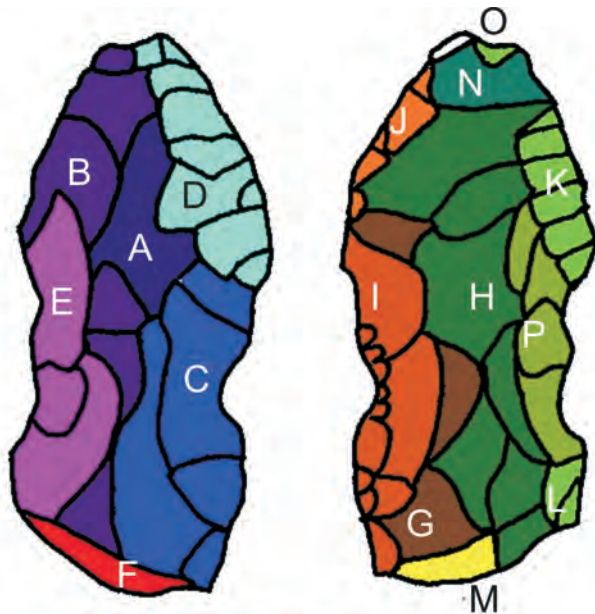


Tool with unexposed tip, blunted back and base. Cutting edge was resharpened several times.



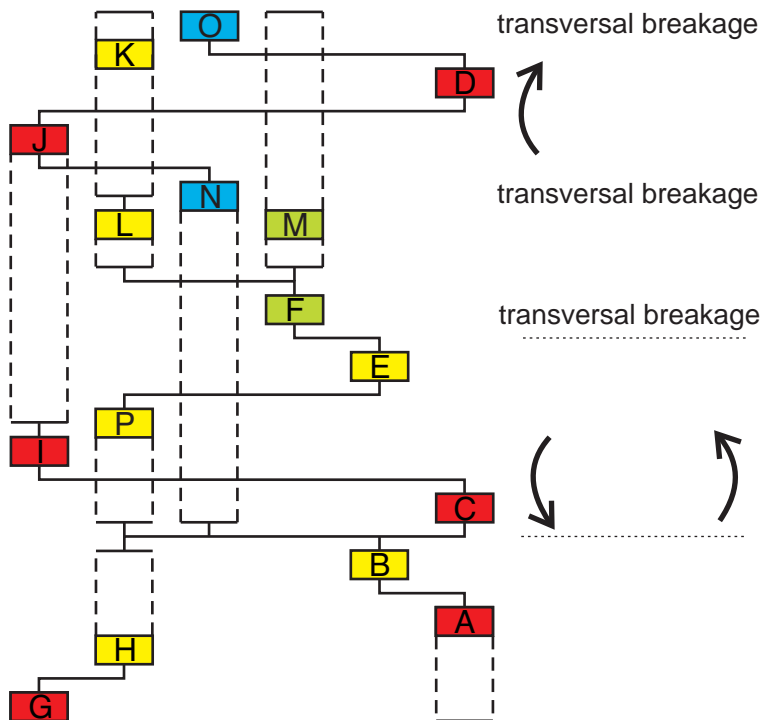
- F. flat, regular, marginal retouch on the upper face near the tip, edge resharpening
- D. flat, irregular, marginal retouch on the upper face, edge resharpening
- L. flat removals on the lower face near the tip, edge angle correction
- M. steep, hinged removals on the lower face near the base, edge blunting
- G. steep removals on the upper face near the base, base formation, edge blunting
- N. semi-steep removals on the lower face at the base, base formation, edge blunting
- I. flat removals on the lower face, edge thinning, resharpening
- E. flat removals on the upper face, edge formation/rejuvenation (?)
- C. semi-steep removals on the upper face, back formation/rejuvenation (?), edge blunting
- K. flat removals on the lower face, edge angle formation
- H. flat, broad removals on the lower face, surface formation
- J. steep removals on the lower face near the tip, earlier stages of manufacturing process
- A, B. flat removals on the upper face, earlier stages of manufacturing process, surface formation (?)

# Plate 96 Lenderscheid V11\_54



V11\_54

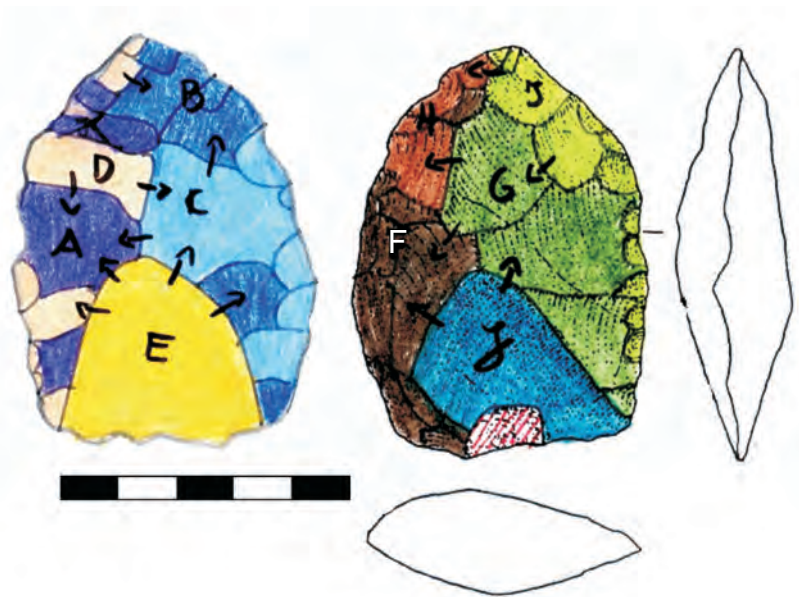
Plano-convex, bent tool with two notches created alternately, which were probably aimed at leading the line of transversal breakage. Breakage went out of notches. Tip was broken and edges were rejuvenated after breakage.



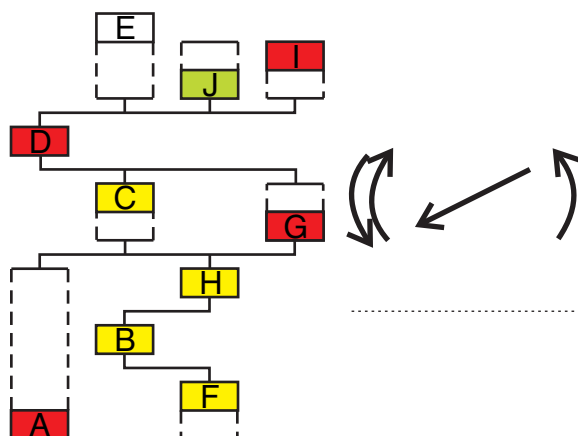
- O. small truncation at the tip
- D. flat, regular removals on the lower face, edge sharpening, rejuvenation after breakage (sequence N)
- J. marginal removals on the upper face near the tip, edge angle correction before sequence D
- N. transversal breakage at the tip
- K. marginal retouch on the upper face near the tip, edge reshaping
- L. steep retouch on the upper face, edge correction near breakage
- M. flat, small removals on the upper face derived from the transversal breakage
- F. transversal breakage
- E, I. semi-steep removals on the lower face, created a notch
- P, C. semi-flat removals, edge angle formation before sequence E
- B, A. flat removals on the lower face, surface and edge formation
- H, G. flat removals on the upper face, surface formation



# Plate 97 Lenderscheid V11\_55



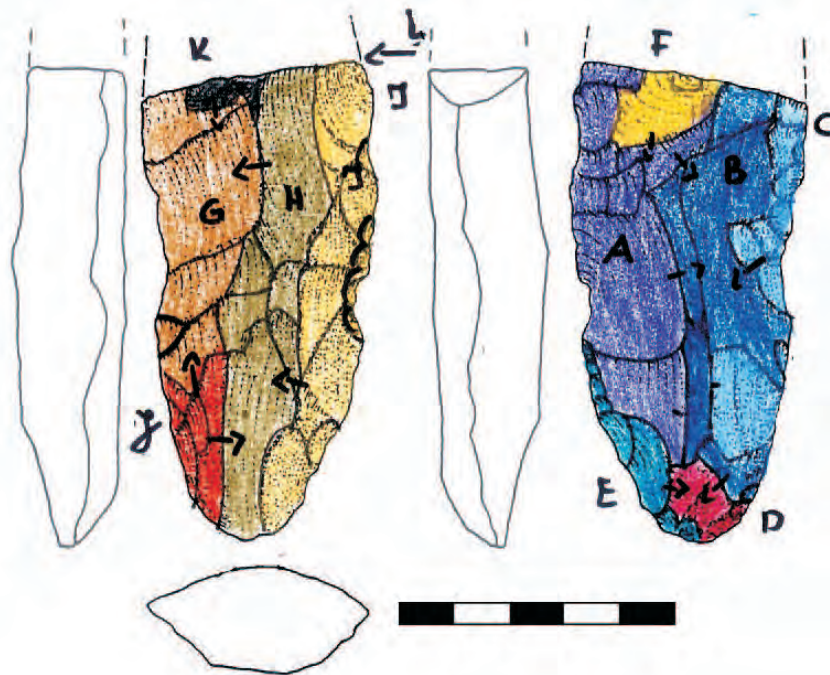
Tool with unexposed tip and single cutting edge. Opposite edge was more precisely worked and retouched.



- E. postdepositional, flat scar removing a great part of the upper face near the base
- I. semi-flat, marginal retouch on the lower face near the tip, edge sharpening
- J. flat, broad removal derived from the base, surface thinning
- D. semi-flat removals on the upper face, edge angle correction
- C. semi-flat removals on the upper face, edge sharpening
- G. flat, broad removals on the lower face, edge formation
- H. semi-steep removals on the lower face near the tip, edge formation
- B. semi-flat removals on the upper face, edge formation
- F. semi-flat removals on the lower face, surface formation, thinning
- A. flat removals on the upper face, surface/edge formation

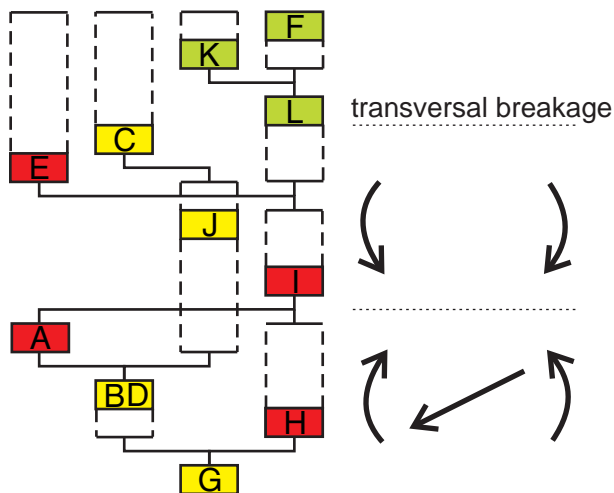


# Plate 98 Lenderscheid V11\_56

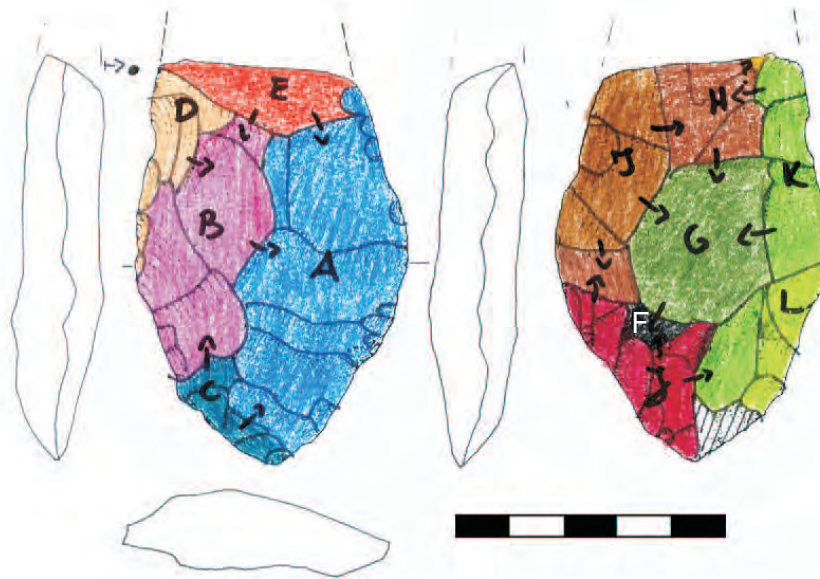


Plano-convex, bent tool with transversal breakage in its half and blunted base. Notches along edges could be aimed at leading the line of breakage, but are not regular. The tool was probably unfinished—no traces of intensive edge sharpening sequences.

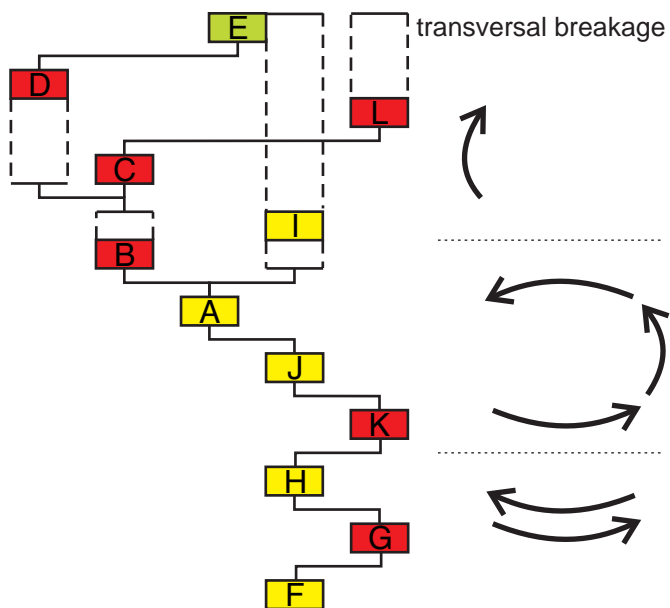
- F. single, flat removal on the lower face, derived from the breakage scar, surface correction
- K. flat, marginal removals on the lower face derived from the breakage scar
- L. transversal breakage
- C. irregular, hinged, marginal retouch on the lower face, edge reshaping
- E. steep, marginal retouch on the lower face near the base, edge blunting, base formation
- J. steep, hinged removals on the upper face near the base, analogical to sequence E, edge blunting, base formation
- I. hinged removals on the upper face, unsuccessful edge thinning
- A, B. flat, broad removals on the lower face, surface thinning
- D. single, semi-steep removal on the lower face, derived from the base, surface thinning
- H. semi-flat, broad removals on the upper face, surface formation, thinning
- G. semi-steep removals on the upper face, surface formation



# Plate 99 Lenderscheid V11\_57

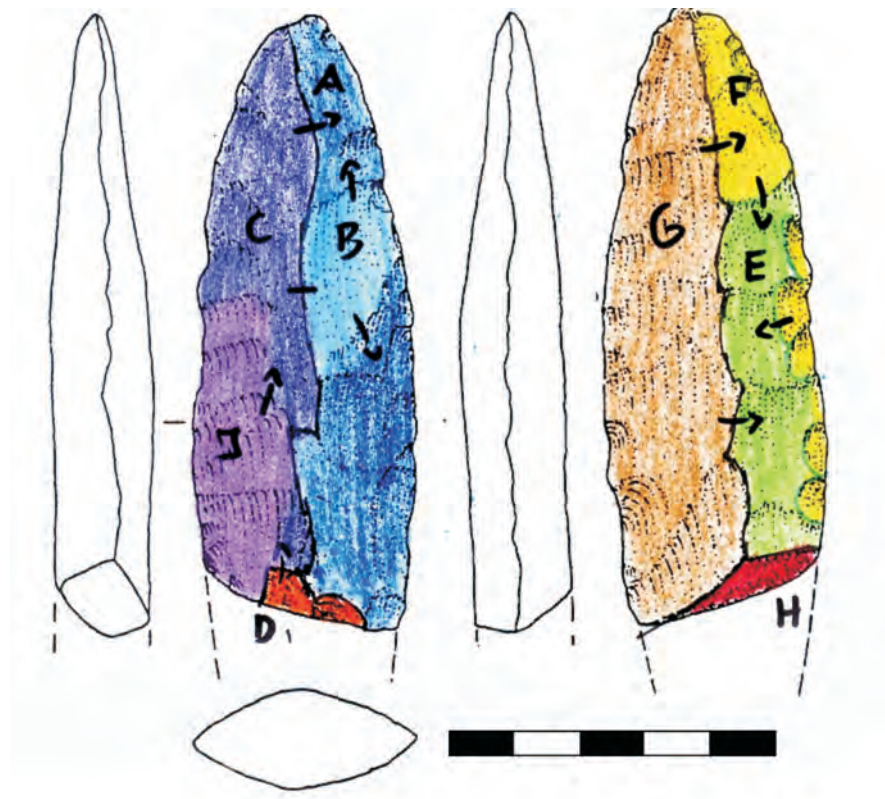


Plano-convex tool with transversal breakage in its half. Alternate notches could be aimed at leading the breakage line. Tip/base were exposed and formed by separate, semi-steep series of removals.

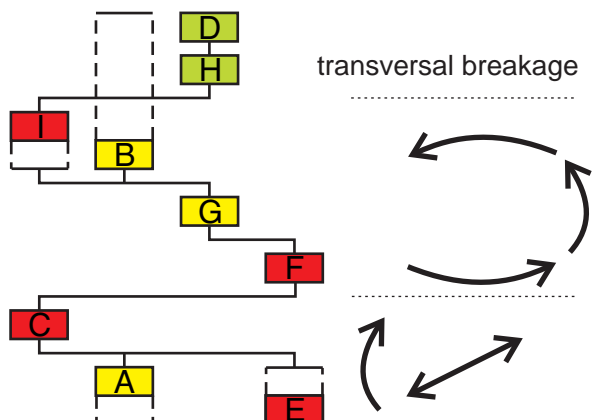


- E. transversal breakage, probably caused by one of the D sequence removals
- D. semi-flat removals on the upper face, created a notch
- L. semi-steep/semi-flat removals on the lower face, tip/base formation
- C. flat removals on the upper face near the base/tip, edge angle correction
- B. flat, broad removals on the upper face, surface formation, thinning
- A. semi-flat, long removals on the upper face, surface and edge formation
- I. semi-flat removals on the lower face near breakage, created a notch
- J. semi-steep removals on the lower face, base/tip formation
- K. flat, hinged removals on the lower face, edge thinning
- G, F. single, flat scar of a broad removal, earlier stages of manufacturing process
- H. flat removals on the lower face, earlier phases of manufacturing process

# Plate 100 Lenderscheid V11\_58

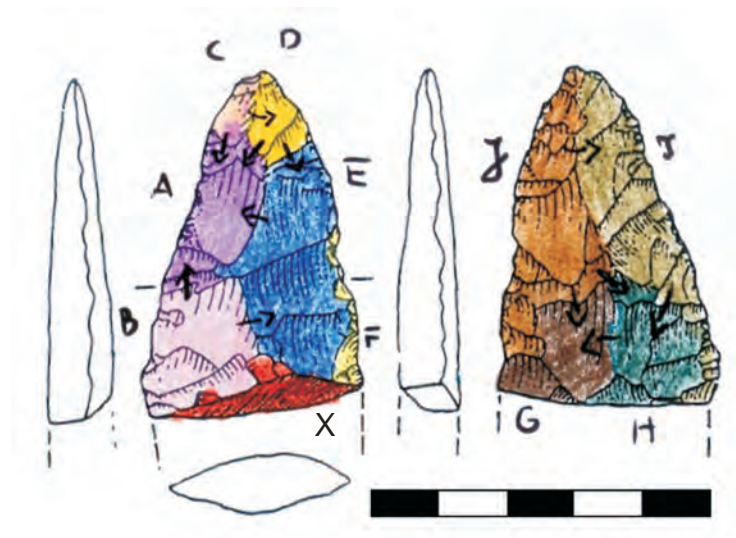


Nearly symmetrical, biconvex tool with broken base. Both edges were treated alike. Edge II was retouched (sequence F) and more precisely worked. Semi-steep removals near the tip removed the tip and moved it out of vertical axis. The tool was probably used/remodeled after breakage (sequence D).

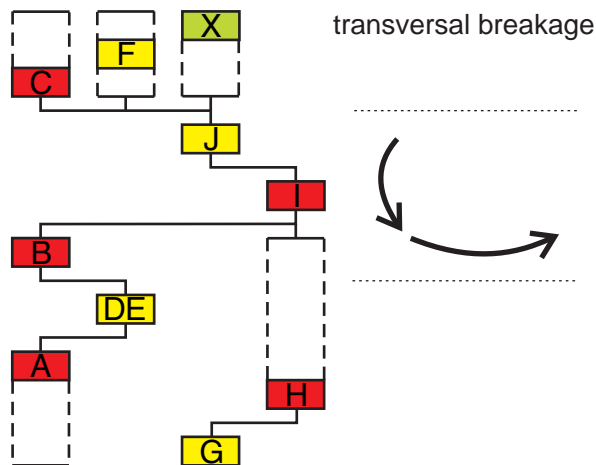


- D. flat, small removals derived from the breakage scar
- H. transversal breakage at the base
- I. semi-flat, regular removals, edge formation, thinning
- B. flat removals, edge thinning
- G. semi-flat removals, edge formation
- F. irregular, marginal retouch along the edge, edge formation, sharpening
- E. semi-steep removals, edge formation
- C. flat removals, surface/edge formation
- A. semi-flat removals, edge formation

# Plate 101 Lenderscheid V11\_59



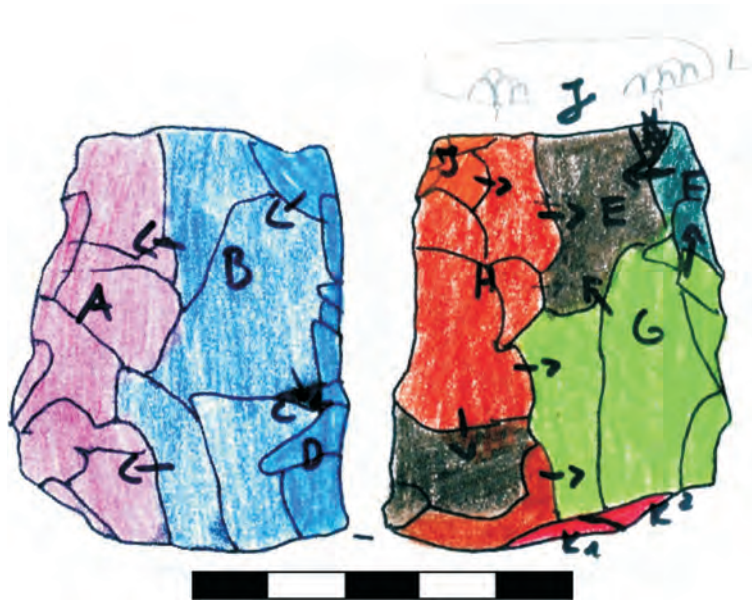
Tip of broken tool with both edges retouched/resharpened and exposed tip.



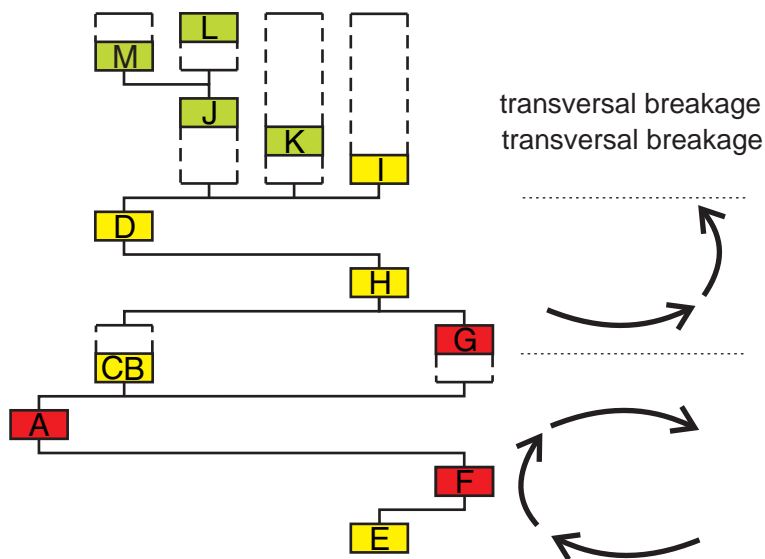
- X. transversal breakage
- F. steep, marginal retouch on the lower face, probably usewear or edge blunting
- C. single, small removals on the lower face near the tip, edge thinning
- J, I. flat, deep removals on the upper face, edge thinning, sharpening
- B. flat removals on the lower face near breakage, surface thinning
- D, E. semi-flat removals on the lower face, surface formation/rejuvenation
- A. flat removals on the lower face, edge formation, thinning
- G, H. flat removals on the upper face, surface/edge formation (?), thinning



# Plate 102 Lenderscheid V59-5



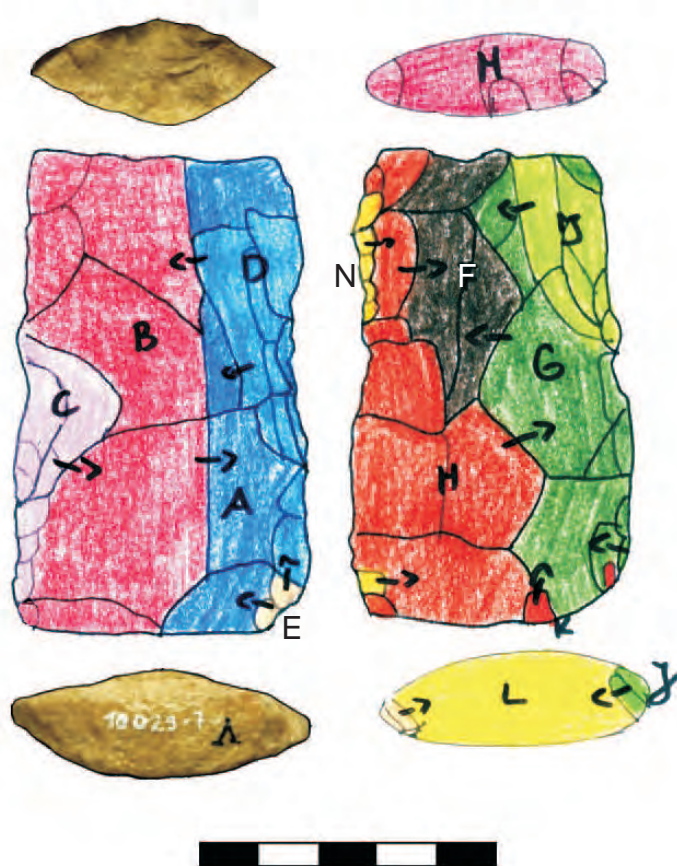
Biconvex, rectangular segment with both ends formed by transversal breakages. Both edges have straight profiles and were retouched. Edge I was more precisely, marginally retouched.



- L. flat, marginal retouch derived on the breakage scar
- J, K1, K2. transversal breakage
- I. steep, marginal removals on the lower face, edge blunting near breakage
- D. hinged, marginal retouch on the upper face, edge sharpening
- B. flat removals on the upper face, edge sharpening/formation
- A. flat removals on the upper face, edge formation, thinning
- H. semi-flat removals on the lower face, edge thinning, edge angle formation
- E. flat, broad removals on the lower face, surface formation, thinning
- G. semi-flat removals on the lower face, edge formation
- E. F semi-steep/semi-flat removals on the lower face, surface formation
- C. flat scar on the upper face, remains of earlier stages of manufacturing process.

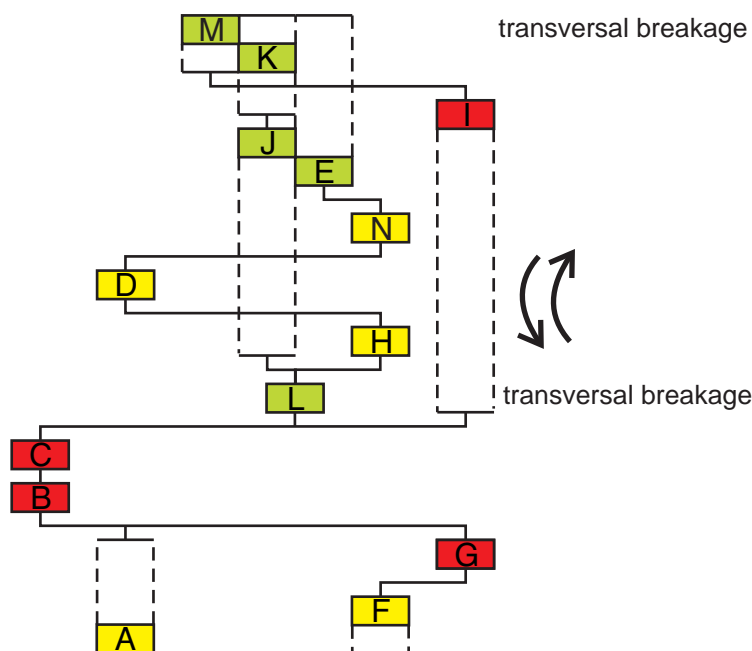


# Plate 103 Lenderscheid V10029-7

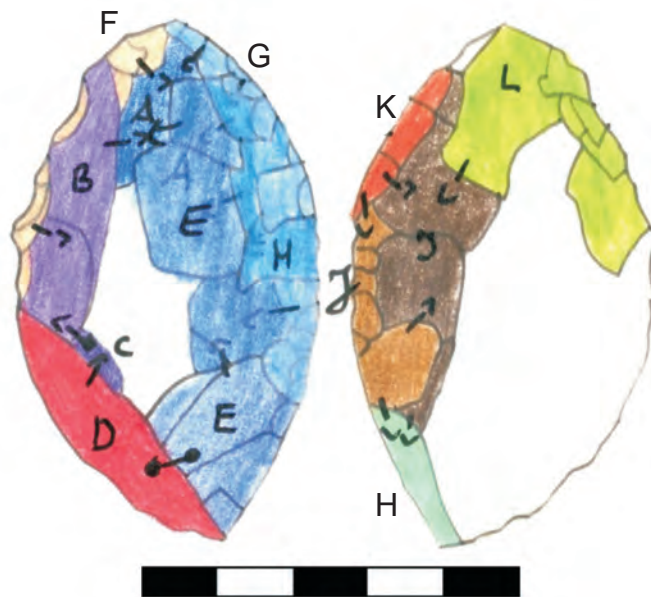


Biconvex, rectangular segment with both ends formed by transversal breakages. Both edges have straight profiles and were retouched.

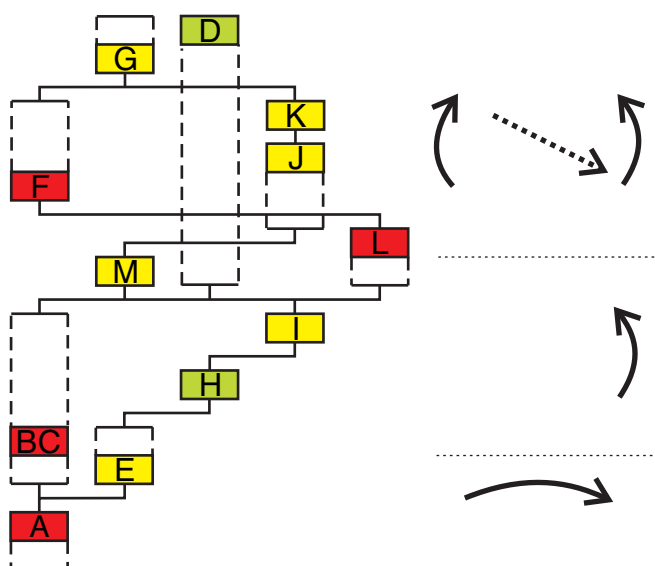
- K. small removals on the lower face derived from the breakage scar
- E, J. steep retouch in the angle between the breakage and the edge, edge remodeling
- I. flat, hinged removals on the lower face, edge thinning
- M. flat removals derived on the breakage scar, breakage scar flattening
- C. flat, marginal retouch on the upper face, edge sharpening
- D. hinged removals on the upper face, unsuccessful edge thinning or edge rejuvenation
- N. marginal retouch on the lower face, edge correction
- H, G, F. flat removals on the lower face, surface formation, thinning
- B. flat, broad removals on the upper face, surface formation, thinning
- A. semi-flat removals on the upper face, surface formation
- L. transversal breakage



## Plate 104 Kösten Kös1



Plano-convex knife with no exposed tip and back/base formed with single, steep, blunting removal. Distal posterior edge was less precisely worked. Cutting edge was resharpened several times.

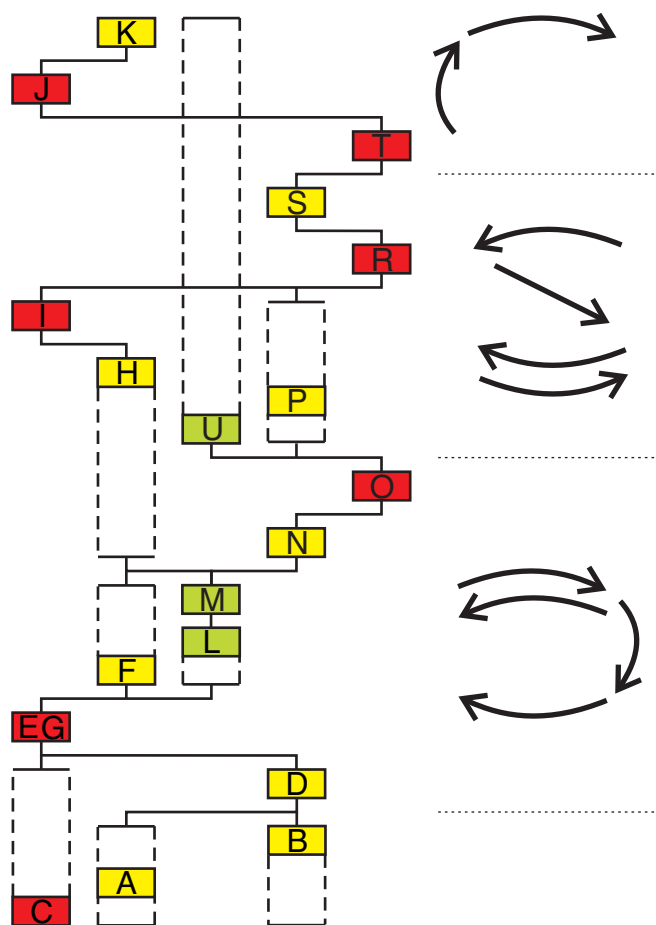


- D. steep, angular removal created a back
- G, M. semi-flat, marginal retouch, edge resharpening
- K, J. flat removals on the lower face, edge angle correction
- E. semi-flat removals on the upper face, edge sharpening
- I, L. flat removals on the lower face, edge angle correction, edge formation, thinning
- F. steep, irregular, marginal retouch on the upper face, more flat near the tip, distal posterior edge correction
- B. semi-steep/semi-flat removals on the upper face, distal posterior edge formation
- H. steep removal derived from the base, base formation, edge blunting near the base
- A. flat, broad removals on the upper face near the tip, earlier stage of manufacturing process, thinning, and surface formation

## Plate 105 Kösten Kös2

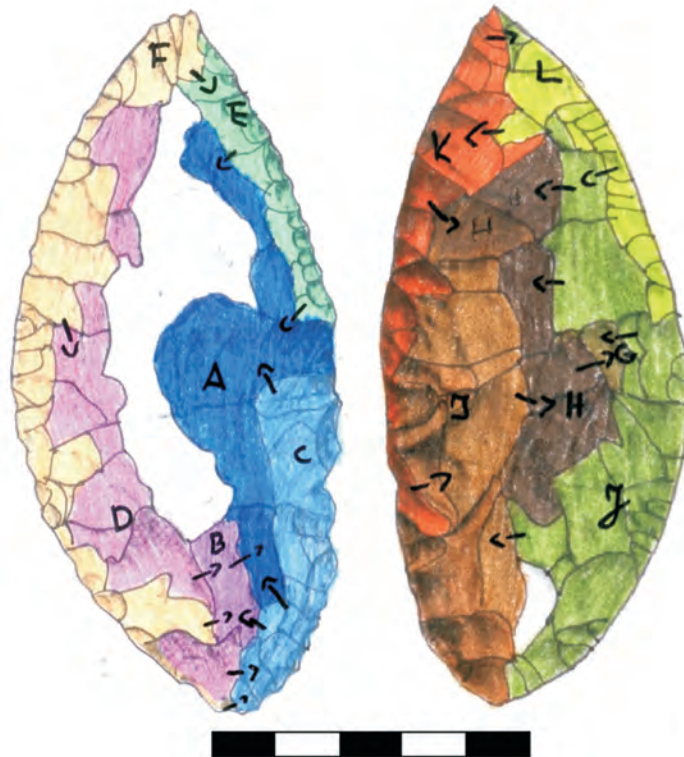


Symmetrical tool with exposed tip and blunted base, one of edges is more straight than the other.

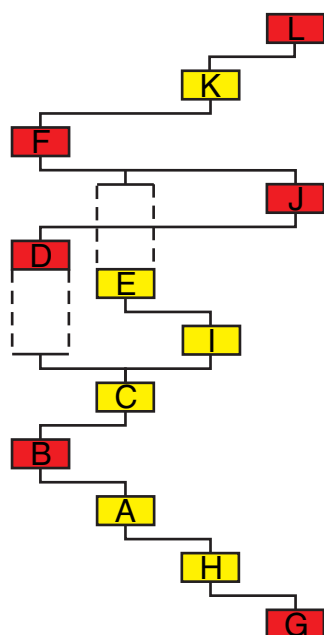


- K. steep, very fine, marginal retouch on the upper face near the tip, edge resharpening
- J. semi-flat retouch on the upper face near the tip, near-the-tip part sharpening
- T. semi-steep, marginal removals on the lower face near the tip, near-the-tip part thinning
- R, S. semi-flat/semi-steep removals on the lower face, edge thinning and sharpening
- H, I. semi-flat removals on the upper face, edge angle correction, sharpening/resharpening (?)
- P, N, O. flat removals on the lower face, edge/surface formation
- G, F. flat removals on the upper face, edge formation/sharpening
- E, D. flat and semi-flat, partly hinged, broad removals on the upper face, surface formation
- B, C. steep removals on the upper face near the base, base formation
- L. flat, hinged removal on the upper face derived from the base, surface formation
- U. flat, hinged removal on the lower face derived from the base, surface formation
- M. steep removals on the lower face, base formation
- A. semi-flat scar on the upper face, earlier stage of manufacturing process

# Plate 106 Kösten Kös3



Plano-convex tool with both ends exposed, both edges retouched and remains of cortex on both faces. The tool was made on a flat plaquette. Edges near the tip are more carefully worked, they also bear traces of usewear.



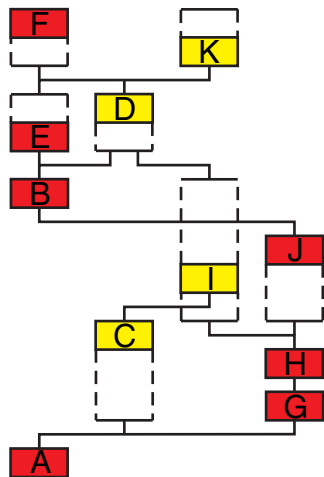
- L, K. semi-steep, marginal retouch on the lower face near the tip, edge sharpening
- F, E. semi-flat, marginal retouch on the upper face, edge sharpening/resharpening (?), thinning removals at the tip
- J, I. semi-flat removals on the lower face, edge thinning/formation
- D. semi-flat removals on the upper face, edge formation/sharpening
- C. semi-flat, marginal removals near the base, edge sharpening
- B, A. semi-flat and flat, broad removals on the upper face, decortication, surface formation
- G, H. flat removals on the lower face, surface formation, thinning, decortication



## Plate 107 Kösten Kös4



Plano-convex, highly exhausted knife with exposed tip and single cutting edge blunted by subsequent rejuvenation sequences derived on the upper face. Back and base blunted, near-the-tip part subsequently and alternately thinned.



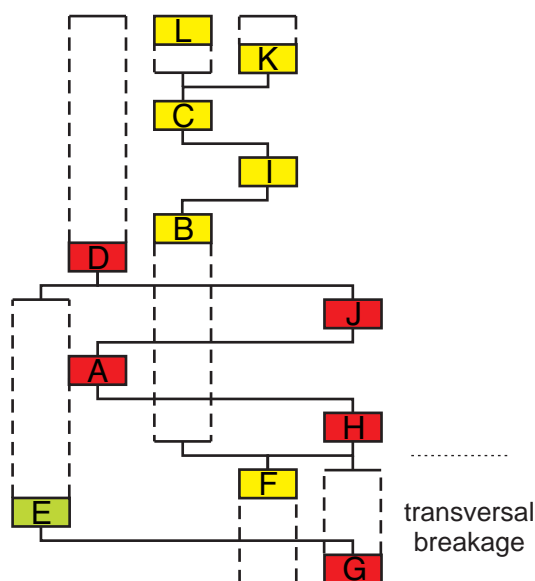
- K. semi-flat/semi-steep, marginal retouch on the lower face, cutting edge rejuvenation near the tip, analogical to sequence F
- F. semi-flat, partly hinged retouch on the upper face near the tip, edge rejuvenation, analogical to K
- D. semi-steep removals along the edge on the upper face, edge rejuvenation
- E. semi-flat, broad removals on the upper face and hinged, small, marginal removals near the base, edge rejuvenation/thinning
- B. steep removals on the upper face near the base, base/back formation
- A. remains of earlier phases of manufacturing process
- C. semi-steep removals on the upper face, cutting edge resharpening
- I. semi-flat removals on the lower face, edge angle correction
- J. semi-flat removals on the lower face, edge rejuvenation
- H. semi-steep removals on the lower face, edge angle correction
- G. semi-flat removals on the lower face, surface formation



## Plate 108 Kösten Kös5

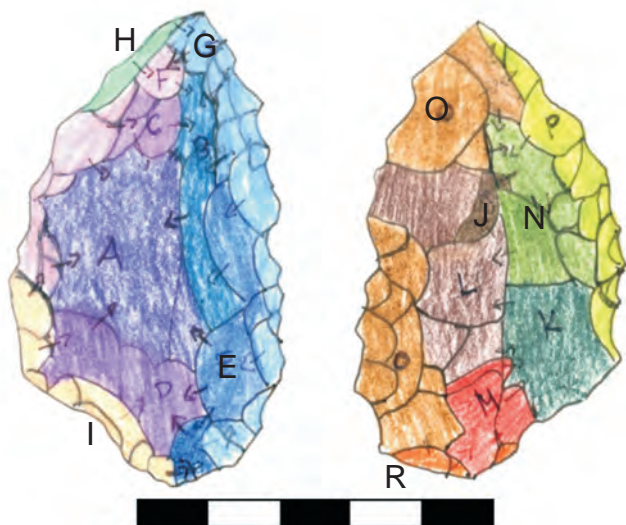


Knife with base formed by transversal breakage. Transversal surface located also at the tip, was not removed during sharpening and resharpening stages. Cutting edge is more straight in profile and more carefully worked than the opposite edge.

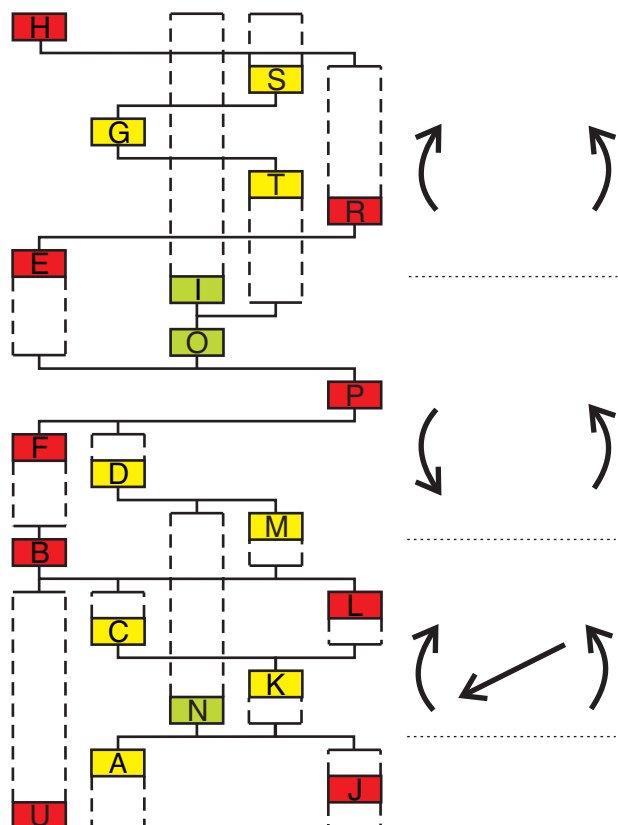


- K. marginal retouch on the lower face of the cutting edge, edge correction
- L. hinged truncation on the upper face near the tip, cutting edge destroying removal
- C, B. removals on the upper face, cutting edge resharpening
- I. flat removals on the lower face and high, hinged removal near the tip, edge angle correction
- F. semi-flat removals on the lower face, edge angle correction, edge formation
- J, H. semi-flat removals on the lower face, edge angle correction
- D. marginal retouch on the upper face, distal posterior edge rejuvenation
- A. semi-flat, broad removals on the upper face, surface formation, thinning
- E. transversal breakage angular to the main axis
- G. flat and semi-steep removals from earlier phases of manufacturing process

## Plate 109 Kösten Kös6

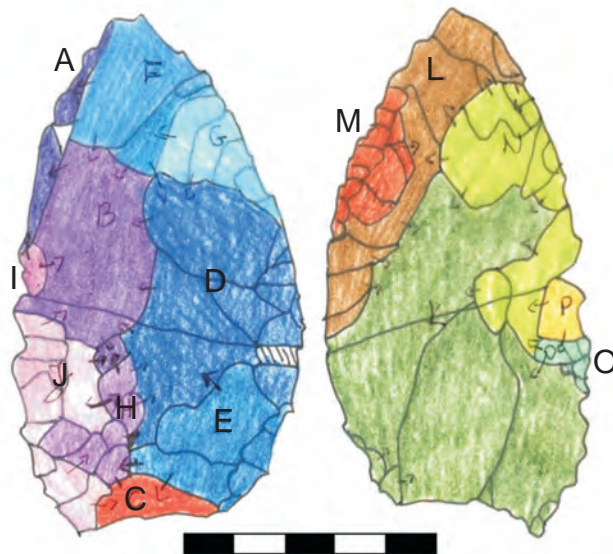


Knife with short distal posterior edge, base formed with notches on both sides and long, vertical cutting edge, thinned near the tip. Cutting edge and near-the-tip part were subsequently resharpened.

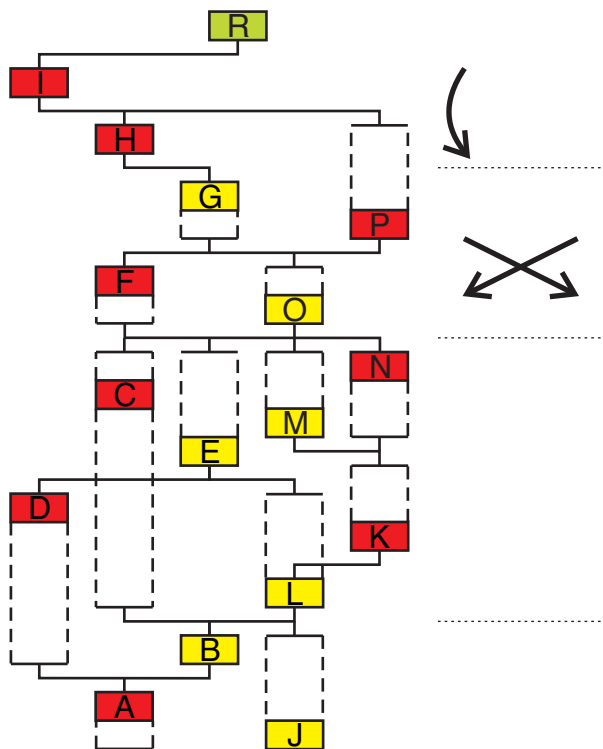


- H. semi-flat, marginal retouch, cutting edge resharpening
- S. semi-flat, marginal retouch on the lower face, edge resharpening
- G. marginal retouch on the upper face, distal posterior edge correction
- R. small removals on the lower face, cutting edge correction
- T. semi-flat removals near the tip and more steep near the base on the lower face, edge angle correction, thinning
- E. flat removals on the upper face near the tip, surface thinning near the tip and distal posterior edge correction
- M. flat removals on the lower face near the tip, surface thinning near the tip and distal posterior edge correction
- I. semi-flat, marginal removals on the upper face, base formation
- O. semi-flat, marginal removals on the lower face, base formation
- N. steep removals on the lower face, edge formation, created a notch near the base
- P. deep removals on the lower face near the base, created a notch near the base
- F. semi-flat removals on the upper face near the base, edge angle correction before deriving sequence P
- D. semi-flat and semi-steep removals on the upper face, back edge correction
- B, U. semi-flat/semi-steep removals on the upper face, surface thinning/formation
- C. semi-steep, broad removals on the upper face, surface formation
- A. semi-flat removals on the upper face, surface formation
- L. flat and semi-flat removals on the lower face, edge angle formation
- K, J. semi-flat removals on the lower face, surface formation

## Plate 110 Kösten Kös7



Knife with distal posterior edge blunted by burin spall-like removals derived from the tip (sequence H). Base and back edge were blunted by abrupt removals. Cutting edge was resharpened several times on the upper face, with edge angle correction on the lower face.

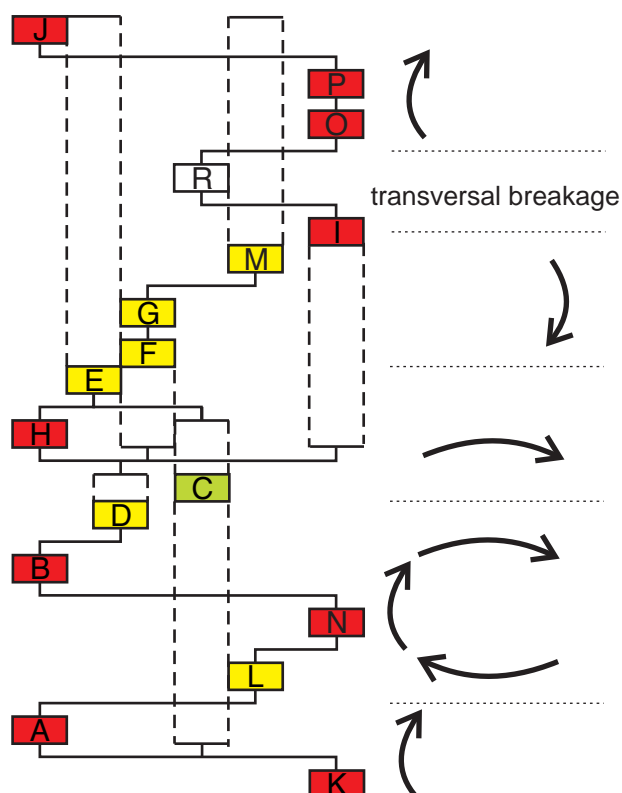


- R. small truncations on the lower face near the base, perhaps postdepositional
- I. steep, blunting retouch on the upper face near the base and on the back edge, edge formation
- H. removal derived from the tip angularly to the edge, distal posterior edge formation
- G. steep, denticulated retouch on the upper face, cutting edge sharpening
- P, O. flat removals on the lower face, edge angle correction
- F. partly hinged removals on the upper face, distal posterior edge correction
- N, K, L, J. flat removals on the lower face, thinning, surface formation
- M. flat removals on the lower face near the base, thinning, base formation
- C. flat and semi-flat removals on the upper face, distal posterior edge formation
- E. semi-flat removals on the upper face, cutting edge resharpening
- D, A. flat removals on the upper face near the base, surface formation
- B. semi-flat removals on the upper face, edge formation or sharpening

## Plate 111 Kösten Kös8



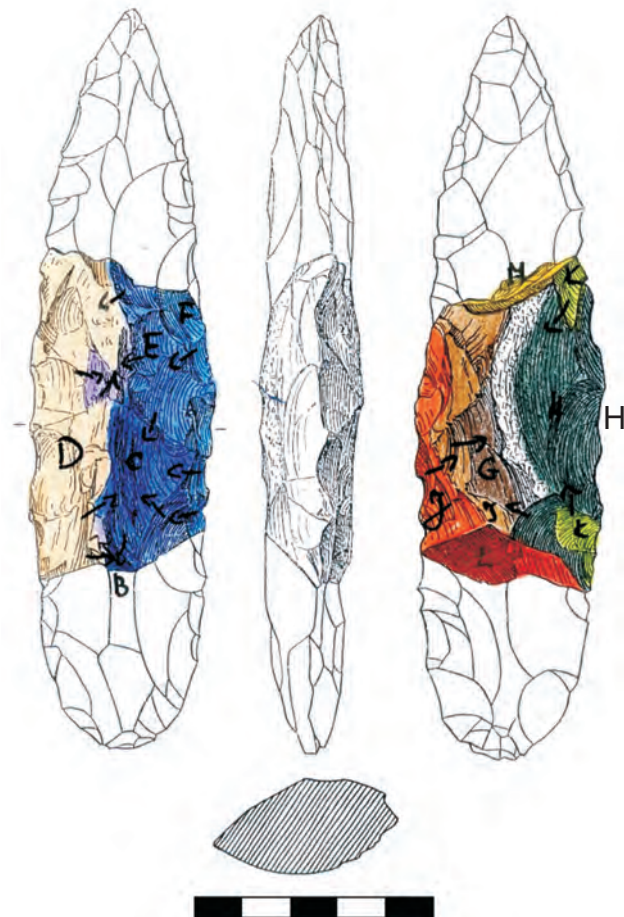
Plano-convex tool with unworked tip and back edge near the tip. Cutting edge is convex, carefully thinned and worked on both sides. Back edge and base are blunted. The tool was broken in a half and back edge was reshaped afterwards.



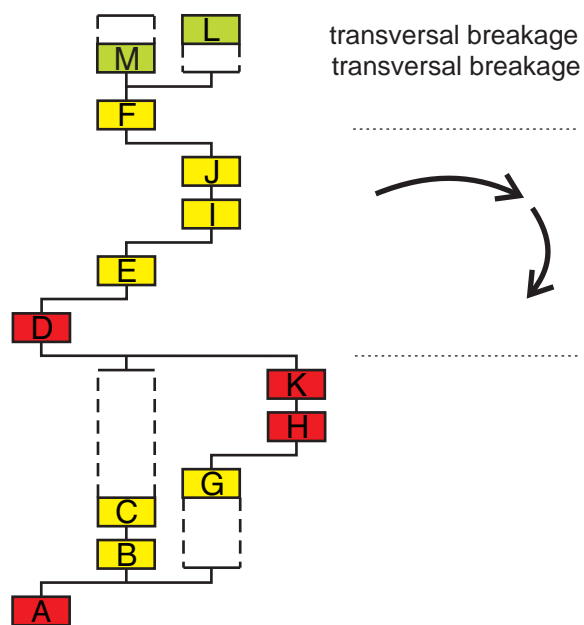
- J. semi-steep, irregular, partly hinged retouch on the upper face, edge sharpening/remodeling after breakage (sequence R)
- P. removal near breakage angle, aimed at removing the angle
- O. small removals on the lower face, edge angle correction
- R. transversal breakage caused by percussion of sequence I
- I. deep removal on the upper face, caused the transversal breakage (sequence R)
- M. flat, hinged retouch on the lower face, edge correction, thinning
- G, F. flat, long removals on the upper face, edge sharpening
- E. semi-flat removals on the upper face near the base, edge sharpening
- H. semi-steep removals on the upper face near the base, edge formation, thinning
- L, N. flat removals on the lower face, edge angle correction, thinning
- K. flat, broad removals on the lower face, surface formation
- D, B. semi-flat, broad removals on the upper face, surface formation, thinning
- C. single, steep removal on the upper face at the base, base formation
- A. single, steep removal on the upper face near the tip, back edge formation



## Plate 112 Kösten P48



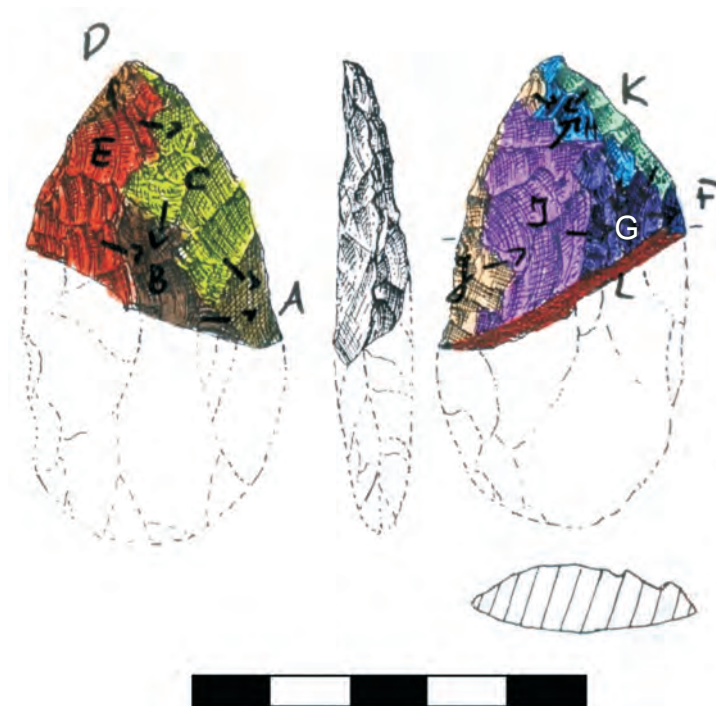
Middle part of bifacial, biconvex tool, with both ends broken transversally. Both edges were formed irregularly, edge I was formed more precisely and bears traces of rejuvenation.



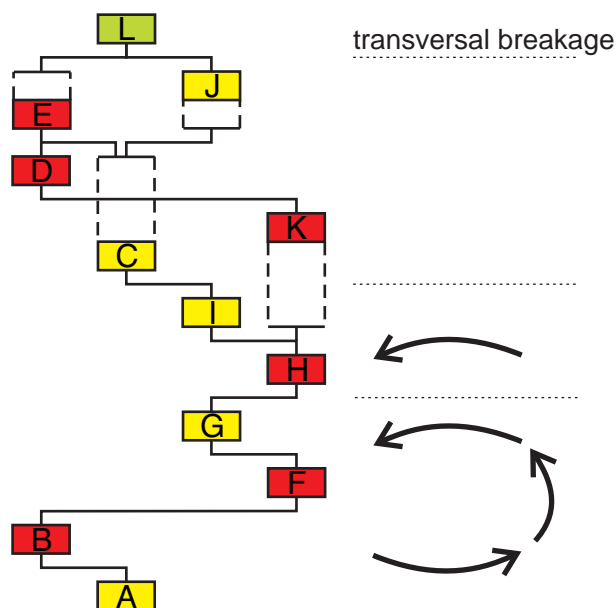
- M, L. transversal breakage
- F. semi-flat, hinged removals, edge resharpening
- J. semi-flat, hinged removals, edge resharpening
- I. semi-flat, hinged removals, edge thinning
- E. semi-steep removals, edge thinning
- G, H. semi-flat removals, surface formation, thinning
- K. small, marginal removals, edge/edge angle correction
- D. semi-steep, deep, irregular removals, edge formation/rejuvenation (?)
- C. semi-flat removals, surface formation
- B, A. semi-flat removals, earlier phases of manufacturing process, surface formation (?)



# Plate 113 Kösten P74

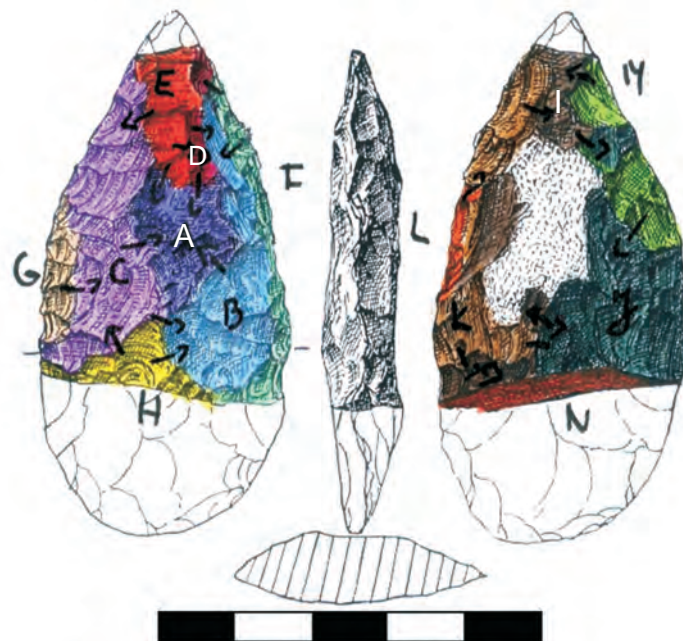


Tip of broken tool with convex lower face which was unsuccessfully thinned. Cutting edge was probably changed during rejuvenation, first it was edge II, then edge I.

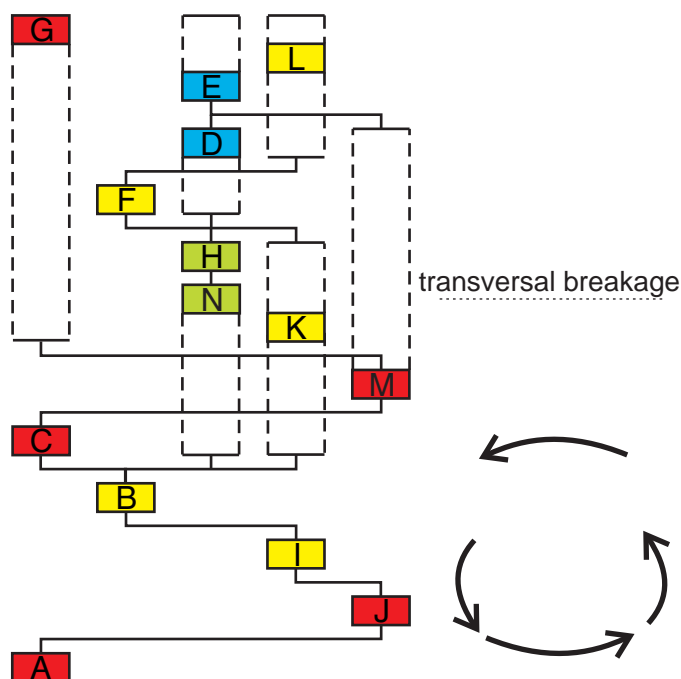


- J. marginal retouch on the lower face, probably partly usewear
- E. flat removals on the upper face, edge angle correction
- D. small, marginal retouch on the upper face, edge resharpening
- K, H, F. semi-flat, marginal retouch, edge resharpening
- I. flat removals on the lower face, edge angle correction, thinning
- G. flat, partly hinged removals on the lower face, edge angle correction, thinning; the tool had been thicker before
- C. semi-flat removals on the upper face, edge angle correction
- A. single, semi-flat removal on the upper face, earlier stages of manufacturing process
- B. flat, broad removals on the upper face, earlier stages of manufacturing process
- L. transversal breakage, impact point on edge II

# Plate 114 Kösten P74a

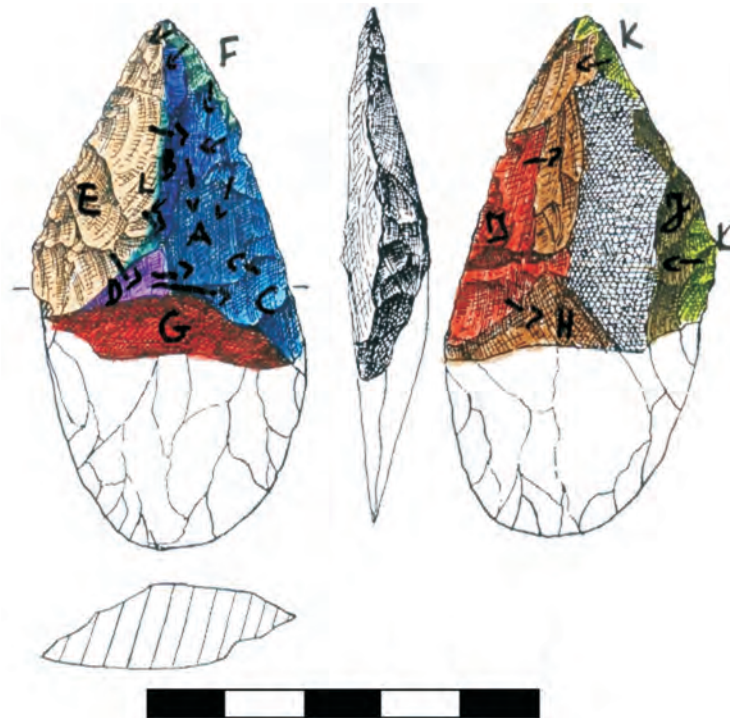


Tip of broken tool with convex lower face which was unsuccessfully thinned. Cutting edge was probably changed during rejuvenation, first it was edge II, then edge I.

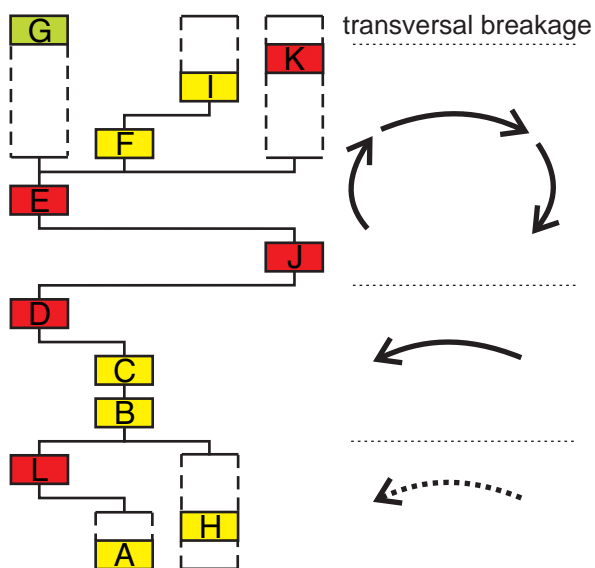


- J. marginal retouch on the lower face, probably partly usewear
- E. flat removals on the upper face, edge angle correction
- D. small, marginal retouch on the upper face, edge resharpening
- K, H, F. semi-flat, marginal retouch, edge resharpening
- I. flat removals on the lower face, edge angle correction, thinning
- G. flat, partly hinged removals on the lower face, edge angle correction, thinning; the tool had been thicker before
- C. semi-flat removals on the upper face, edge angle correction
- A. single, semi-flat removal on the upper face, earlier stages of manufacturing process
- B. flat, broad removals on the upper face, earlier stages of manufacturing process
- L. transversal breakage, impact point on edge II

# Plate 115 Kösten P75

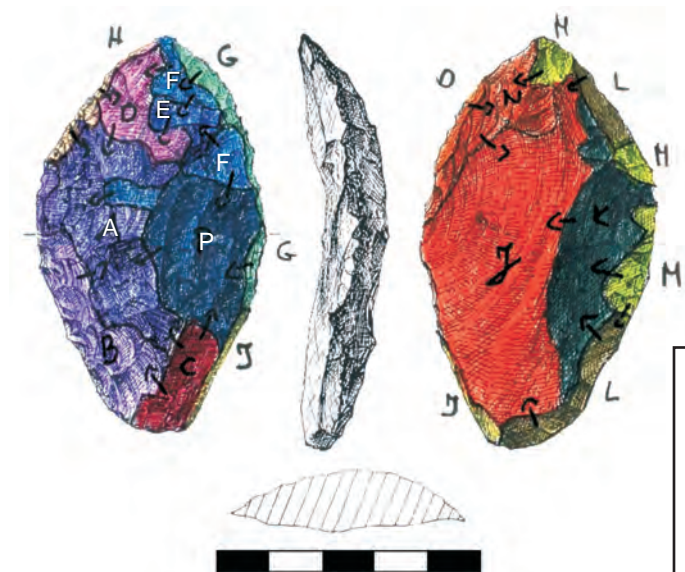


Tip of broken tool with cutting edge resharpened several times near the tip. The second edge was worked only after retouching the first one.

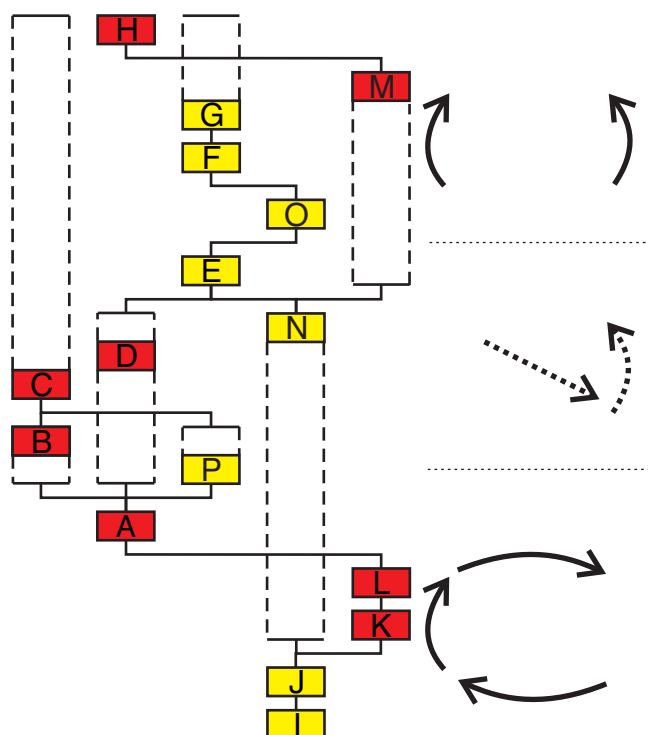


- G. transversal breakage, impact point in the middle of the upper face (?)
- K. marginal retouch on the lower face
- I. semi-flat removals on the lower face, edge angle correction
- F. semi-flat, marginal retouch on the upper face near the tip, edge resharpening
- C. semi-flat, marginal retouch on the upper face, edge sharpening
- E, D. semi-flat removals on the upper face, edge formation
- J. flat removals on the lower face, edge formation
- B. flat removals on the upper face derived from the tip, thinning
- A. semi-flat removals on the upper face, surface formation or previous edge sharpening
- H. flat removals on the lower face, edge formation
- L. flat scars, previous stages of manufacturing process

## Plate 116 Kösten Pa1302



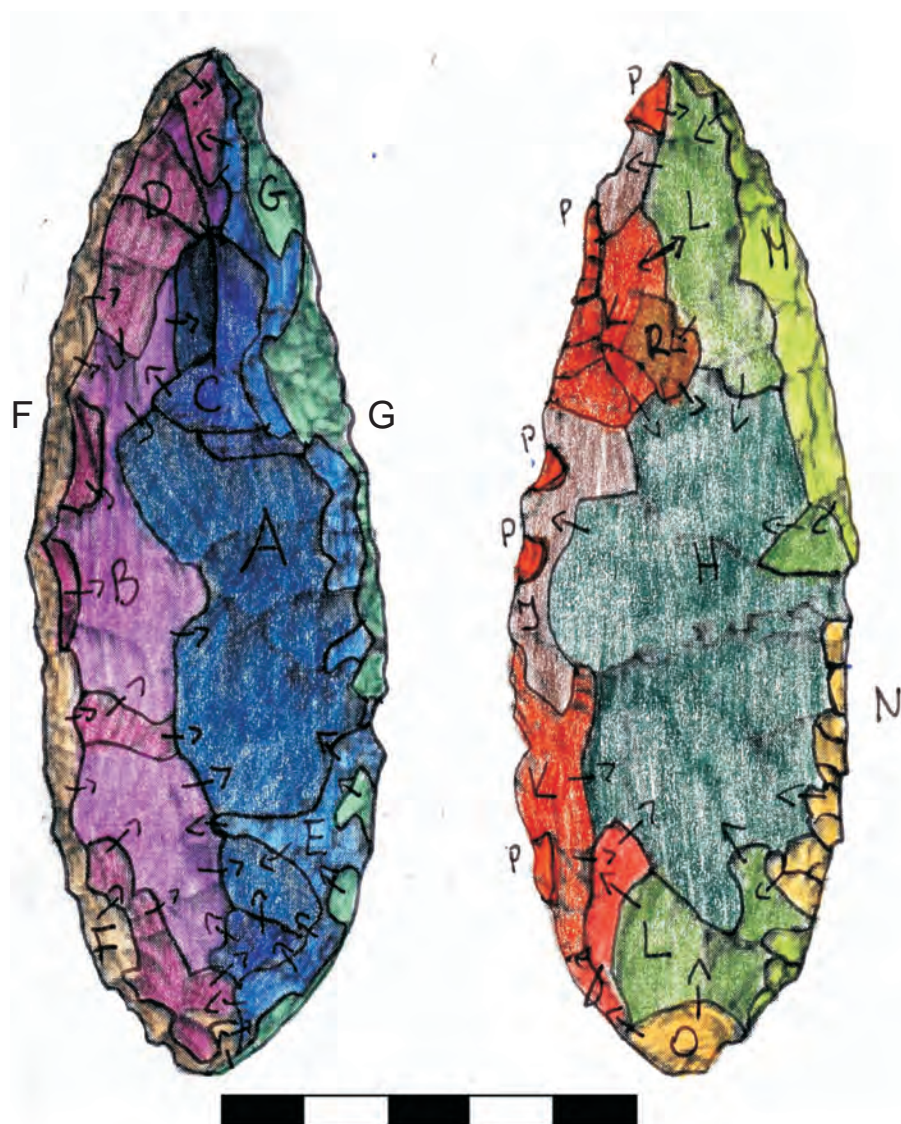
Plano-convex tool probably made on a bent flake, retouched on both edges on the upper face. Lower face was used for edge angle correction, thinning and flattening the tool. Tip is poorly exposed. One of edges was blunted near the base by orthogonal, natural surface which was left unworked. Edge I is more straight in profile and was more carefully worked than edge II.



- H. flat, very fine, marginal retouch on the upper face, edge reshaping
- G. semi-steep, marginal retouch, more steep near the base, edge reshaping
- M. flat removals on the lower face, edge angle correction
- O. flat removals on the lower face near the tip, edge angle correction
- F, E. semi-steep removals on the upper face near the tip, near-the-tip part formation
- D. semi-flat removals on the upper face near the tip, near-the-tip part formation
- N. flat, hinged removals on the lower face near the tip, surface thinning, edge angle correction
- L. semi-steep removals on the lower face, edge formation, edge blunting near the base
- B. semi-steep retouch on the upper face, edge formation, sharpening
- C. flat, long removals on the upper face near the base, surface thinning
- K. flat removals on the lower face, edge/surface thinning
- P, A. semi-flat, broad removals on the upper face, surface formation
- I. abrupt, orthogonal natural surface created a back near the base
- J. flat, broad, very deep removal on the lower face, created the whole surface, makes the tool concave on the lower face.



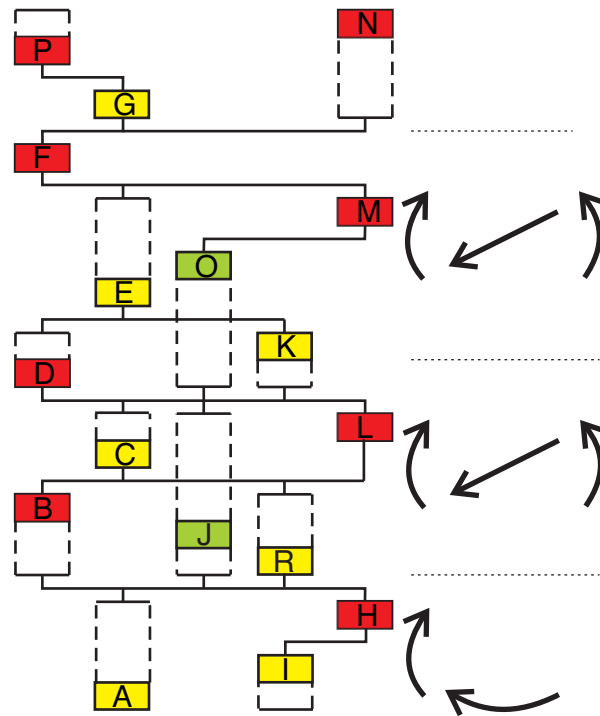
Plate 117 Mauern 1951\_602



Plano-convex, big, symmetrical, elongated, tool with exposed tip. Both edges were retouched and resharpened several times on the upper face, lower face was used only for edge angle correction.

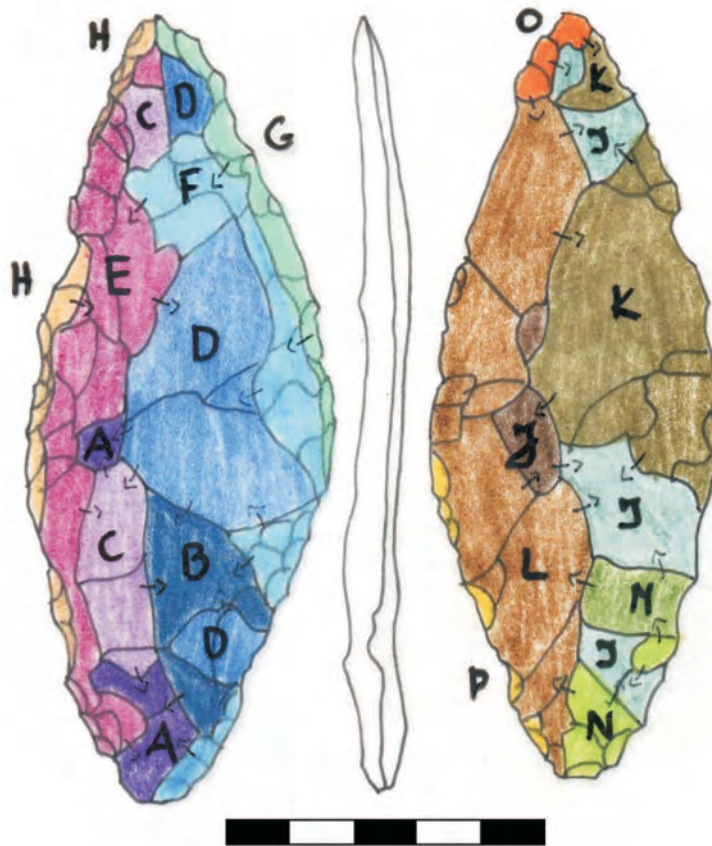


# Plate 117 Mauern 1951\_602

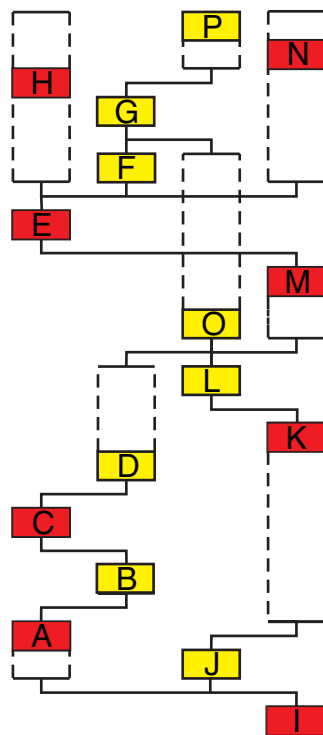


- N. marginal retouch on the lower face, edge resharpening
- P. small, marginal retouch on the lower face, single edge truncations and usewear
- G, F. semi-steep, marginal retouch on the upper face, edge resharpening, created notches along the edge
- M. semi-flat, marginal removals on the lower face, edge angle correction
- O. single, flat removal on the lower face at the base, edge angle correction, thinning
- E, D. semi-flat retouch on the upper face, edge resharpening
- K. flat removals on the lower face, edge angle correction
- L. flat removals near the tip and the base on the lower face, edge angle correction, thinning
- C. semi-flat/semi-steep removals on the upper face, edge sharpening or formation
- R, J. flat removals on the lower face, surface thinning, edge angle formation
- B. semi-flat removals on the upper face, surface formation
- I, H. flat, broad removals on the lower face, surface formation
- A. flat, broad removals on the upper face, surface formation

# Plate 118 Mauern 1951\_603

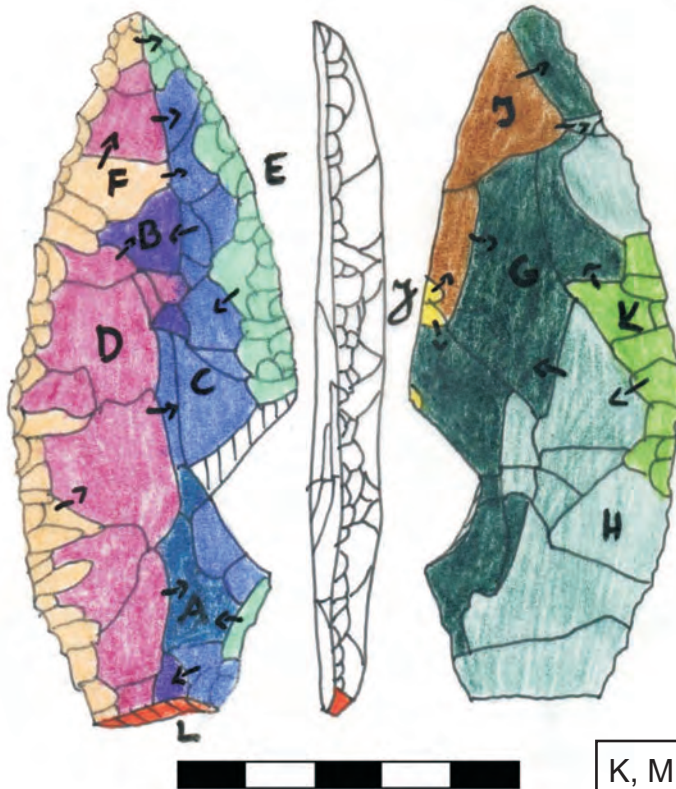


Plano-convex tool with both tips exposed and both edges retouched and reshaped on the upper face. Lower face was used for edge angle correction. Both ends were treated similarly, and both were thinned during rejuvenation. Perhaps tool orientation was changed during one of rejuvenation phases. Notches along edges were created by marginal, steep removals on the upper face.

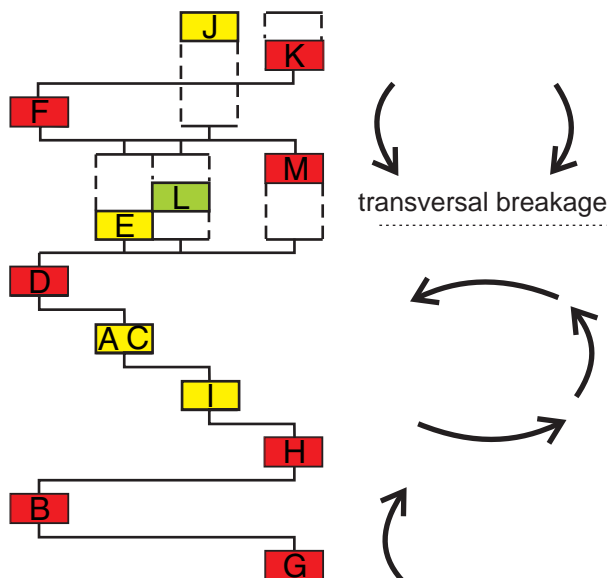


- P. marginal truncation on the lower face
- N. flat retouch on the lower face near the base, edge thinning
- H, G. semi-steep, marginal retouch on the upper face, edge reshaping, created notches along the edge
- F, E. semi-flat removals on the upper face, edge sharpening
- M. flat removals on the lower face, edge angle correction
- O. flat, marginal retouch on the lower face near the tip, edge thinning
- D, A, B, C. flat, broad removals on the upper face, surface formation, thinning
- L, K, I, J. flat removals on the lower face, surface formation

# Plate 119 Mauern 1951\_604

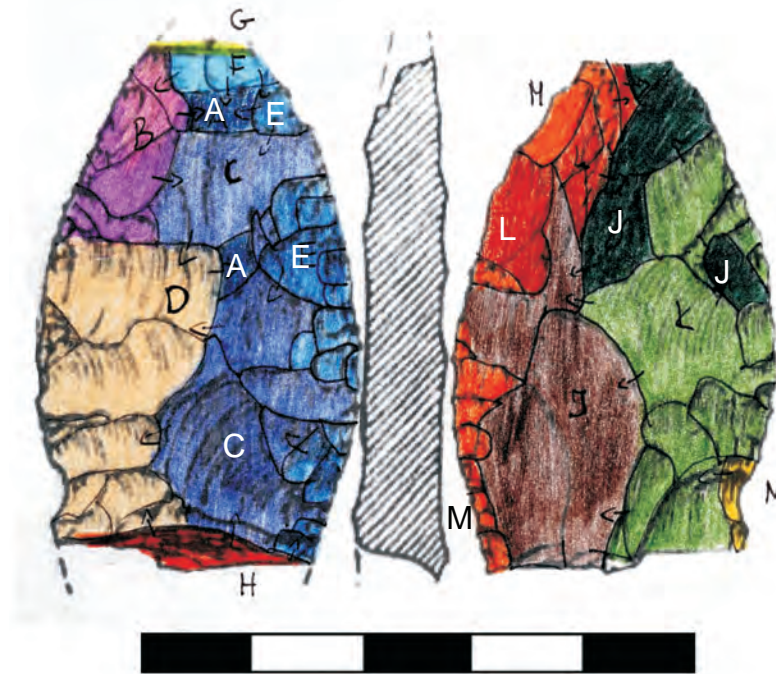


Plano-convex tool with exposed tip and broken base. Both edges were retouched and resharpened on the upper face. Lower face was used for edge angle correction. Both edges were resharpened after base breakage. Breakage scar was flattened by flat retouch.

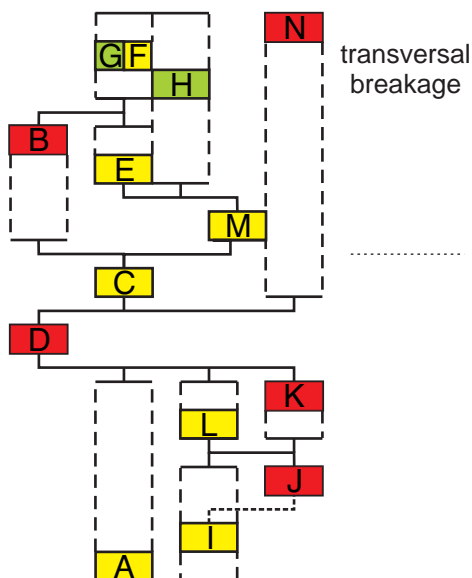


- K, M. flat removals on the lower face, edge angle correction
- F. marginal retouch on the upper face, semi-flat along the edge and more steep near breakage, edge resharpening and usewear
- L. transversal breakage at the base and flat, marginal retouch at the breakage scar, flattening the surface
- E. semi-steep and steep, marginal retouch on the upper face, edge resharpening
- J. flat truncations on the lower face, edge correction
- A, C, D. semi-flat removals on the upper face, edge formation, sharpening
- I. flat removals on the lower face, edge angle formation, surface thinning
- H. flat, partly hinged removals on the lower face, edge angle formation, surface thinning
- B. flat removals on the upper face, earlier stages of manufacturing process
- G. flat, broad removals reaching the opposite edge, surface formation, thinning, flattening

# Plate 120 Mauern 1951\_607



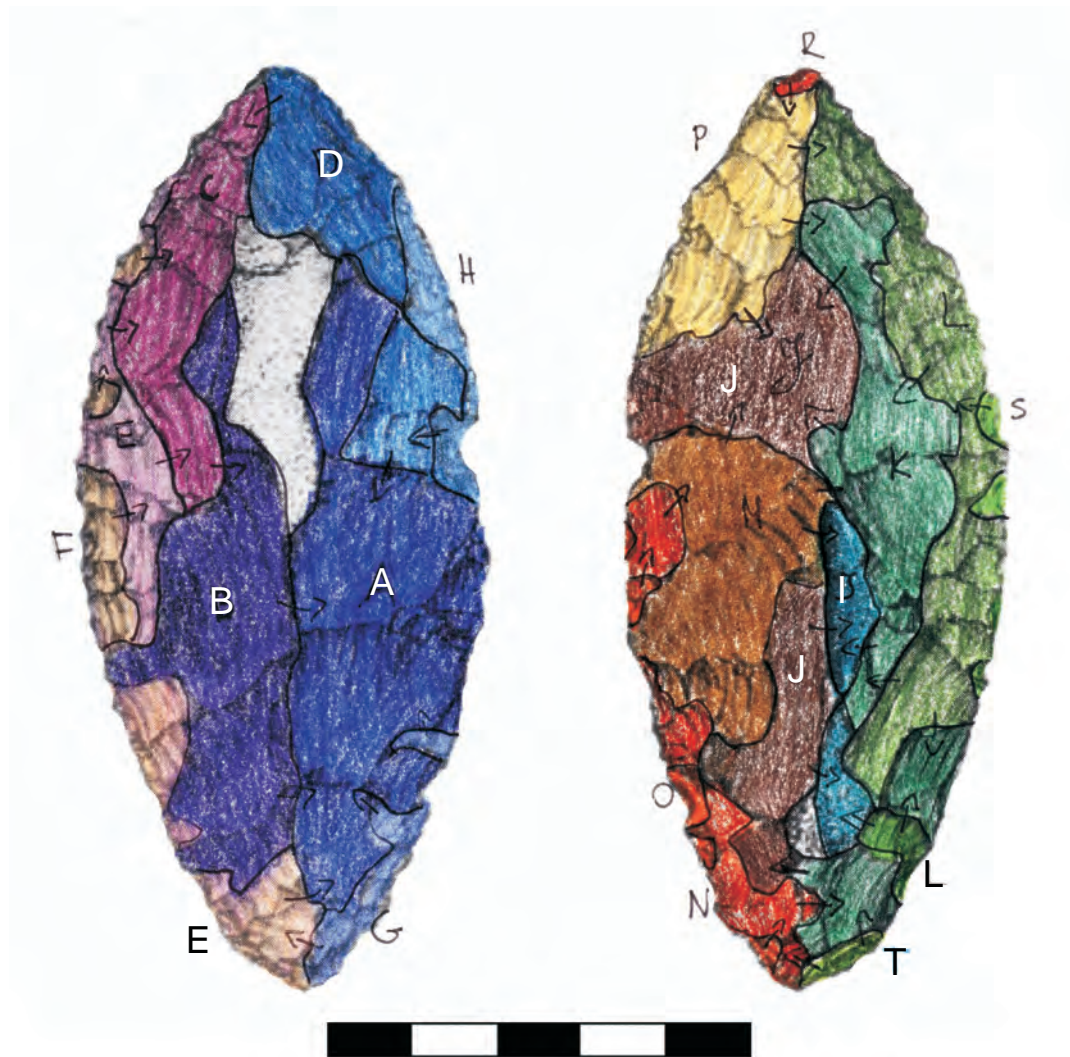
Plano-convex tool with transversally broken base and tip. Both edges were retouched and resharpended. Probably one of edges was resharpended also after base breakage. Notch was created near the base breakage. There are no traces of rejuvenation after tip breakage, which probably caused its abandonment.



- N. steep, marginal removals on the lower face, created a notch near breakage
- G, F. transversal breakage at the tip with a scar going onto the upper face
- H. transversal breakage at the base
- B. deep, irregular removals on the upper face near the tip, edge formation, thinning
- E. flat, precise, marginal retouch on the upper face, edge sharpening
- M. small removals on the lower face, edge angle correction
- C, D. flat removals on the upper face, edge thinning, formation
- K. flat, partly hinged removals on the lower face, edge angle formation, thinning,
- L. semi-flat and flat removals on the lower face, edge angle formation, thinning
- I, J. flat, broad removals on the lower face, surface formation, thinning
- A. flat scars on the upper face, earlier stages of manufacturing process



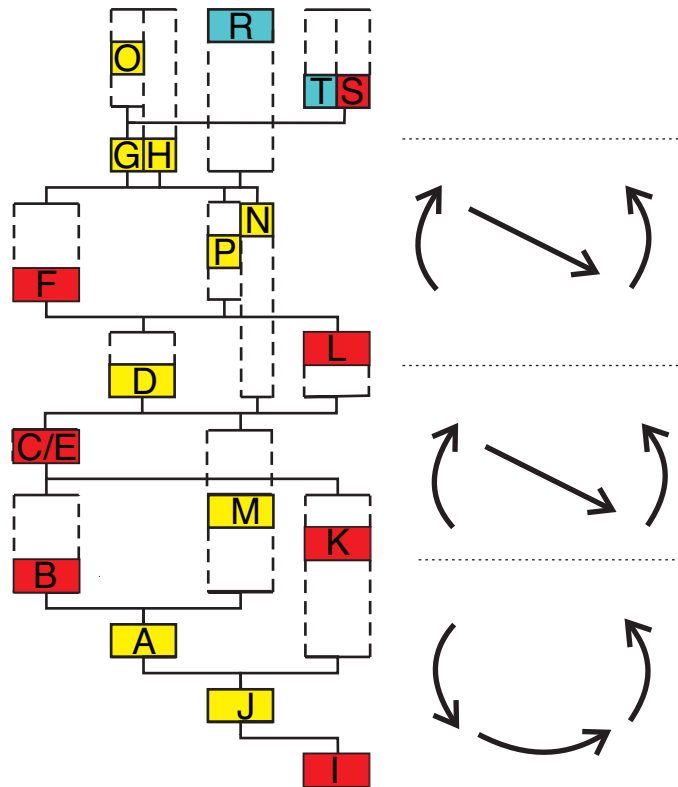
Plate 121 Mauern 1951\_609



Plano-convex, symmetrical tool with exposed and precisely worked both ends. Both convex edges were retouched and resharpened. Deep notch was created along one of edges. Tip was slightly blunted at the end of chaîne opératoire.

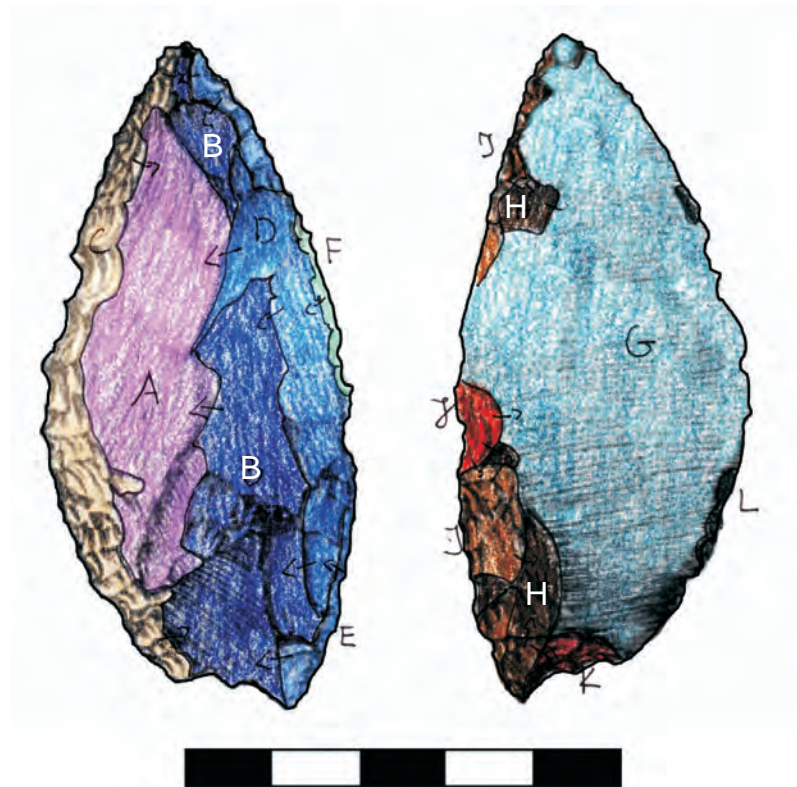


# Plate 121 Mauern 1951\_609

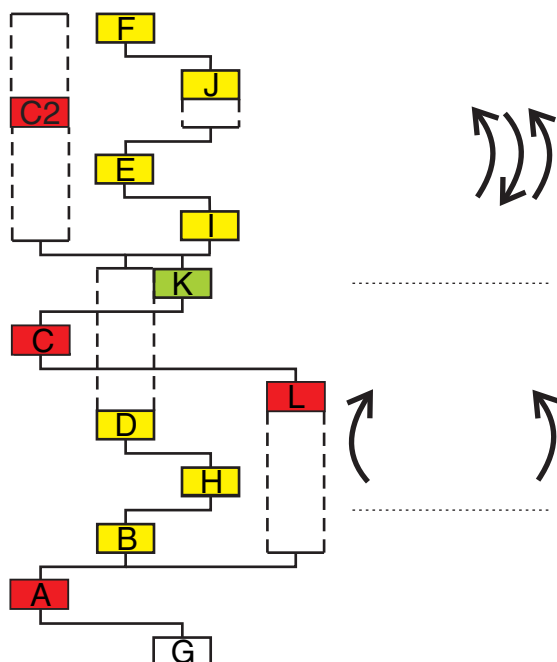


- R. semi-steep, marginal retouch on the lower face at the tip, tip blunting
- T. single, steep removals on the lower face near the base, base formation
- S, O. marginal truncations on the lower face
- H. marginal retouch on the upper face, edge sharpening and steep removals which created a notch in one place
- G. semi-flat, marginal retouch on the upper face near the base, more steep near the base
- N. flat removals on the lower face, edge angle correction
- P. flat, long, regular, removals on the lower face near the tip, edge formation, sharpening
- F. marginal retouch on the upper face, edge resharpening, base formation-thinning
- L. flat removals on the lower face, edge angle formation, thinning, more steep near the tip
- D, C, E. flat removals on the lower face near the tip, edge formation, thinning, shaping
- M, K. flat, long removals on the lower face, surface thinning
- J. flat, broad removals on the lower face, surface formation
- I. flat, deep removals on the lower face, surface formation, decortication
- A, B. flat removals on the upper face, surface formation, decortication

# Plate 122 Mauern 1951\_612

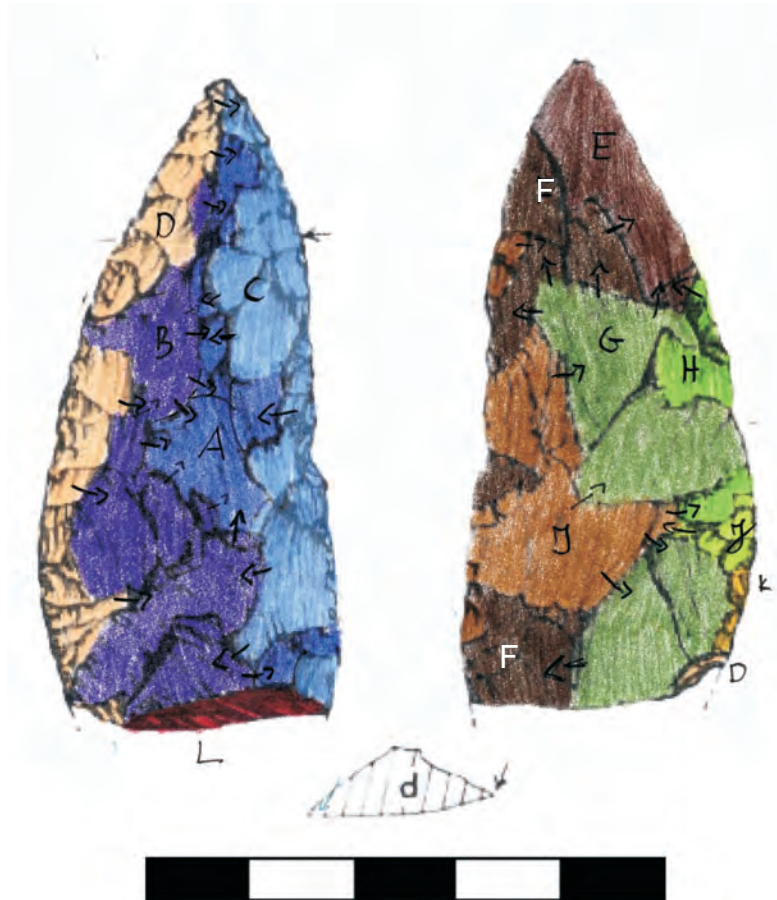


Plano-convex tool made of flake, with exposed tip, both edges retouched and resharpened on the upper face. Lower face was used for edge angle correction. Deep notch was created at the base during rejuvenation process.

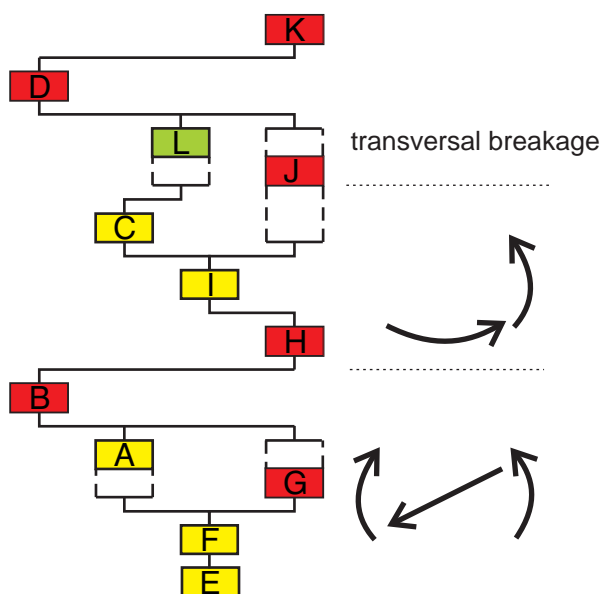


- F. fine, marginal retouch on the upper face, edge resharpening and usewear
- J. single removal on the lower face created a notch at the edge
- E. fine, marginal retouch on the upper face, edge resharpening
- K. semi-steep removals on the lower face created a deep notch located angularly at the base
- C. semi-steep marginal retouch on the upper face, more steep near the tip; probably a few phases of edge resharpening
- L. small, marginal truncations on the lower face, edge angle correction
- I, H. flat, marginal removals on the lower face, edge angle correction
- D. flat removals on the upper face, edge sharpening
- B. flat, broad removals on the upper face, probably partly derived before obtaining the flake,
- A. flat, broad removals on the upper face, derived before obtaining the flake
- G. ventral surface of a flake

# Plate 123 Mauern 1951\_618



Plano-convex tool with exposed tip and transversally broken base. Lower face was used only for edge angle correction. The tool was retouched and resharpener on both edges. One of edges was resharpener also after breakage.

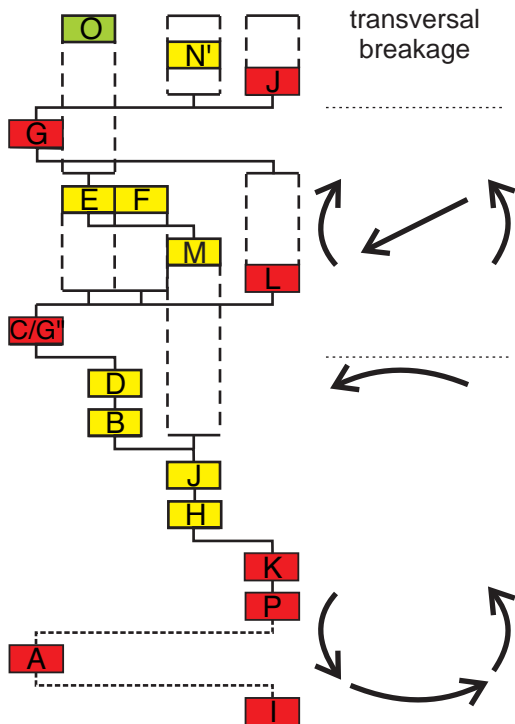


- K. very small, marginal retouch on the lower face near breakage, edge remodeling
- D. marginal retouch on the upper face: semi-flat and more steep near the tip, edge resharpener
- L. transversal breakage at the base
- J. marginal removals on the lower face, edge correction
- C. semi-flat retouch on the upper face, a few phases of edge resharpener
- I, H. flat removals on the lower face, edge angle correction
- B, A. semi-flat removals on the upper face, more flat near breakage, edge resharpener
- G, F. flat removals on the lower face, edge angle correction
- E. single, flat, broad removal on the lower face near the tip, surface formation, thinning

# Plate 124 Mauern 1951\_619



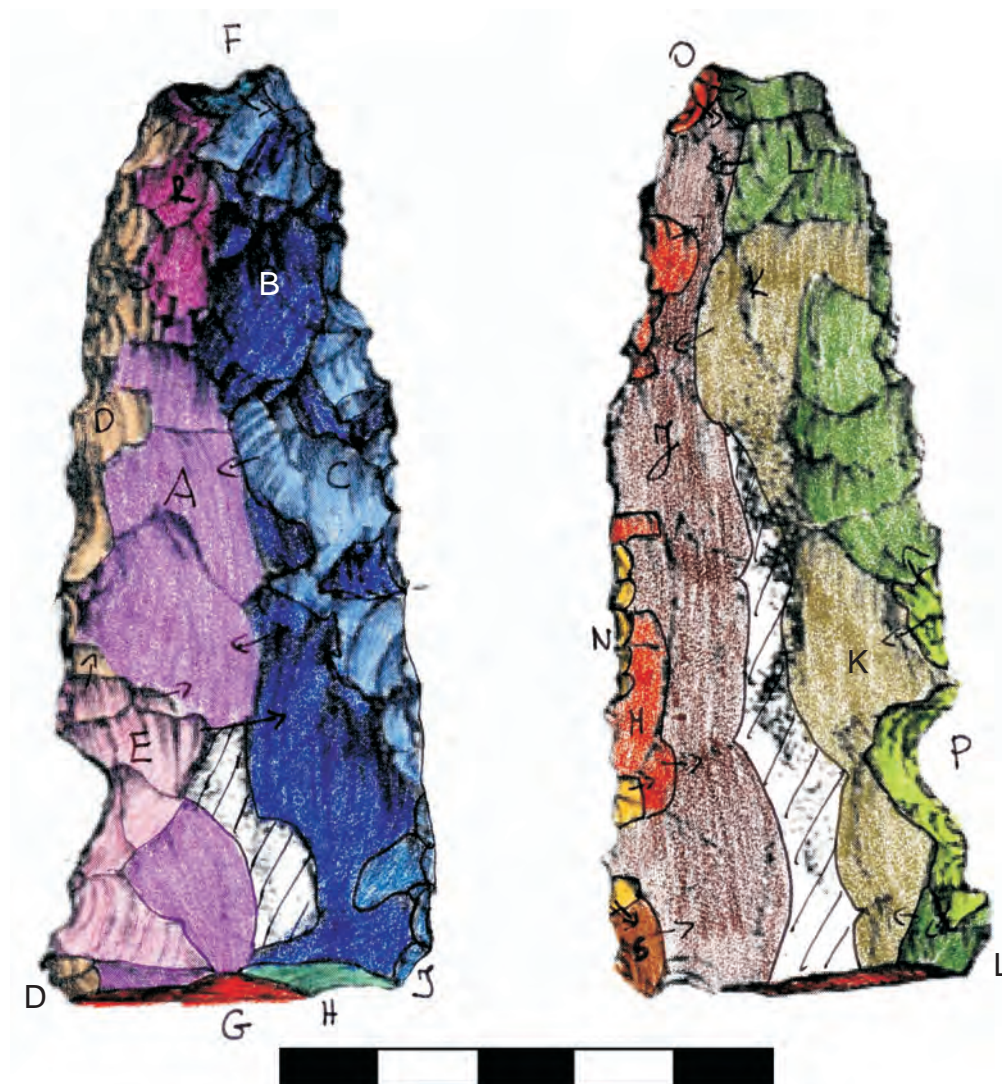
Plano-convex, big, asymmetrical tool with lower face totally flat, transversally broken base and exposed tip. One edge is more vertical and the opposite is more convex. Both edges were retouched on the upper face, and probably resharpened.



- N, N'. small, marginal truncations on the lower face
- G, G'. semi-flat, marginal retouch on the upper face, edge resharpening
- F. semi-flat, marginal retouch on the upper face near the tip, edge resharpening
- E. semi-flat retouch on the upper face, at least two phases of edge resharpening
- M. flat removals on the lower face at the tip, edge angle correction
- L. flat retouch on the lower face near breakage, edge angle formation, thinning
- C. flat removals on the upper face near the tip, edge thinning/formation, sharpening (?)
- D. flat removals on the upper face, edge thinning/formation
- A, B. flat, broad removals on the upper face, surface formation, thinning
- K, J. flat removals on the lower face, surface thinning, edge angle formation
- H, I, P. flat, broad removals on the lower face, surface formation, thinning, flattening
- O. transversal breakage, impact point in the middle of the lower face



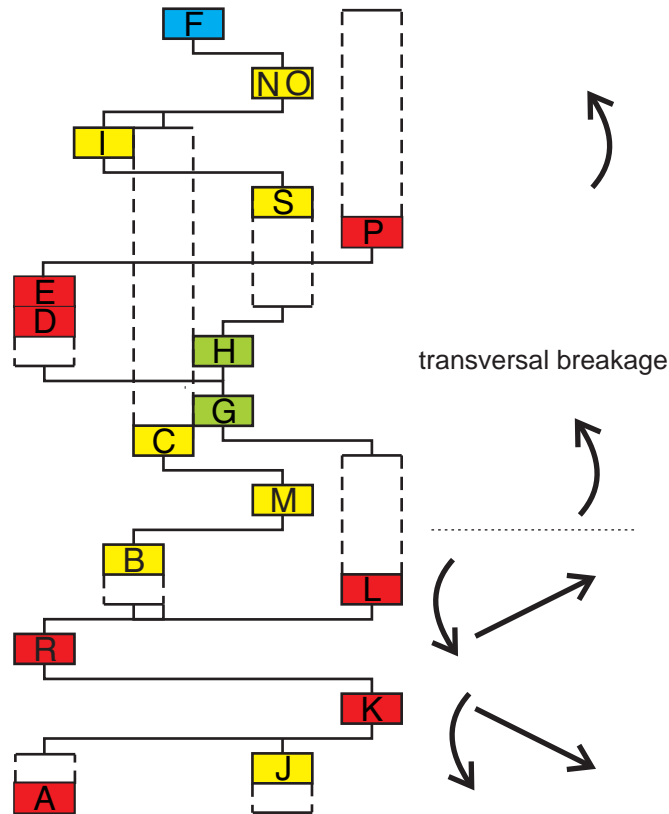
Plate 125 Mauern 1951\_620



Plano-convex tool with transversally broken base and unexposed, blunted tip. Both edges were retouched and resharpened several times. Lower face was used for edge angle correction. The tool was remodeled after breakage and edges near breakage were blunted. Breakage scar was flattened and both edges were resharpened after breakage. Very deep, steep notch was created on one of edges.



# Plate 125 Mauern 1951\_620



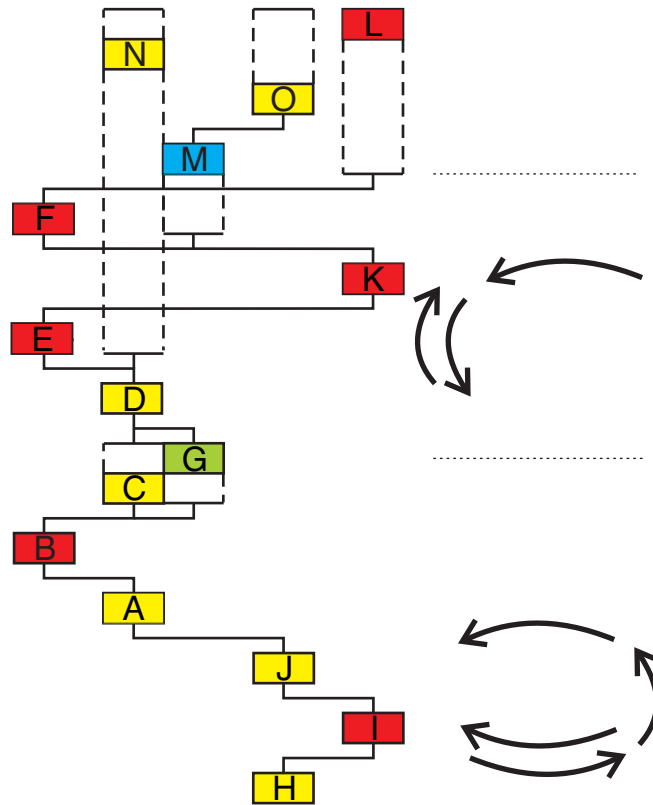
- F. steep truncations on the upper face at the tip, tip blunting, created a notch at the tip
- N. marginal retouch on the lower face, edge resharpener
- O. semi-steep removals on the lower face near the tip, edge remodeling
- I. steep, blunting, marginal retouch on the upper face near breakage, edge remodeling
- S. flat removals on the lower face near breakage, edge angle correction
- P. steep removals on the lower face, created deep notches along the edge
- E. flat removals on the upper face, edge angle correction before sequence P
- D. semi-steep, marginal retouch on the upper face, edge resharpener, partly usewear
- H. steep removals on the upper face at the breakage scar, base formation
- G. transversal breakage at the base
- C. semi-flat, irregular retouch on the upper face, edge resharpener
- L, M. flat removals on the lower face near the tip, edge angle correction, thinning
- R. semi-flat removals on the upper face near the tip, edge thinning
- B, A. semi-flat, broad removals on the upper face, surface/edge formation
- K, J. flat removals on the lower face, surface formation, decortication

Plate 126 Mauern 1951\_621



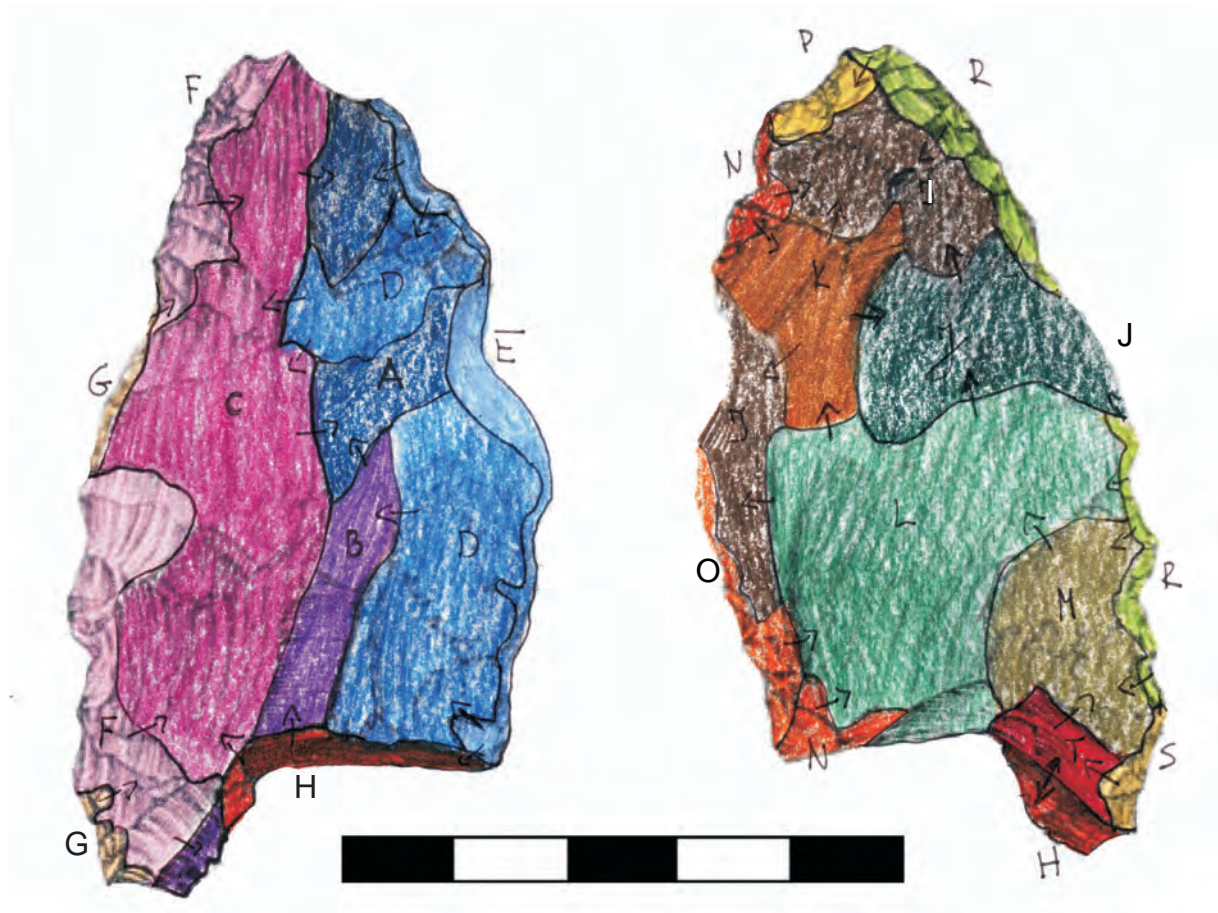
Plano-convex tool with transversally broken base and unexposed, blunted tip. Both edges were retouched and resharpened several times. Lower face was used for edge angle correction. Deep notches were created along edges.

# Plate 126 Mauern 1951\_621



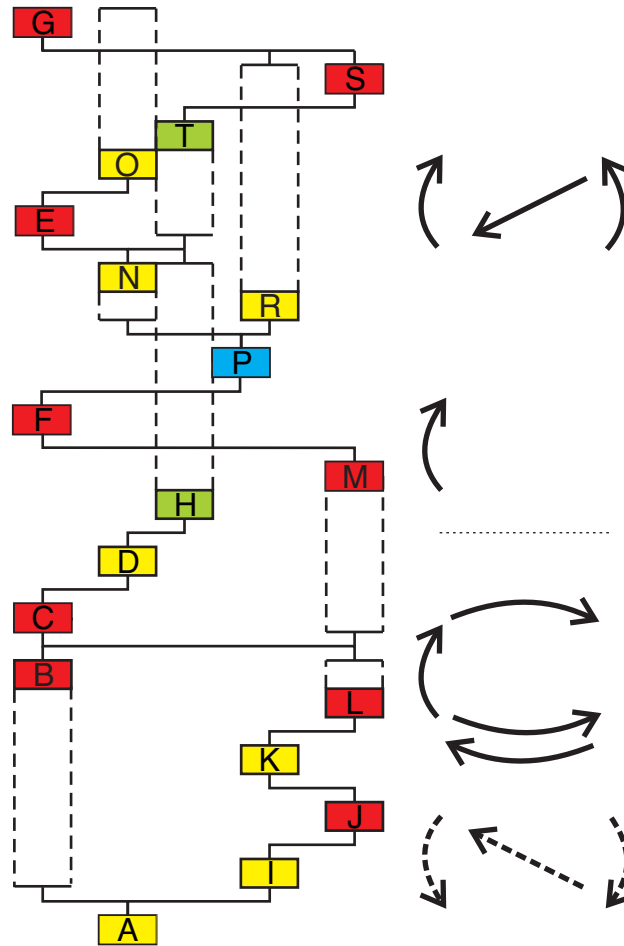
- L, N. semi-steep, marginal truncations on the lower face, created notches
- O. steep removals at the tip, tip blunting
- M. steep removals on the lower face, tip blunting, created a notch at the tip
- F. marginal retouch on the upper face, edge resharpening
- K. flat, marginal removals on the lower face, edge angle correction
- E. flat removals on the upper face near the tip, edge thinning, resharpening
- D. semi-flat, irregular, marginal retouch on the upper face, more steep near the base, edge resharpening
- G. transversal breakage, impact point in the middle of the lower face
- C. semi-flat removals on the upper face near the tip, edge thinning, resharpening
- B. semi-flat, partly hinged removals on the upper face, surface thinning
- A. semi-flat removals on the upper face, surface thinning
- J. flat, broad removals on the lower face, surface formation, thinning
- I. semi-flat removals on the lower face, surface formation
- H. single, flat, very deep scar, earlier stage of manufacturing process

Plate 127 Mauern 1951\_626



Plano-convex tool with transversally broken base and unexposed, blunted tip. Both edges were retouched and resharpened several times. Lower face was used for edge angle correction. Deep notches were created along edges.

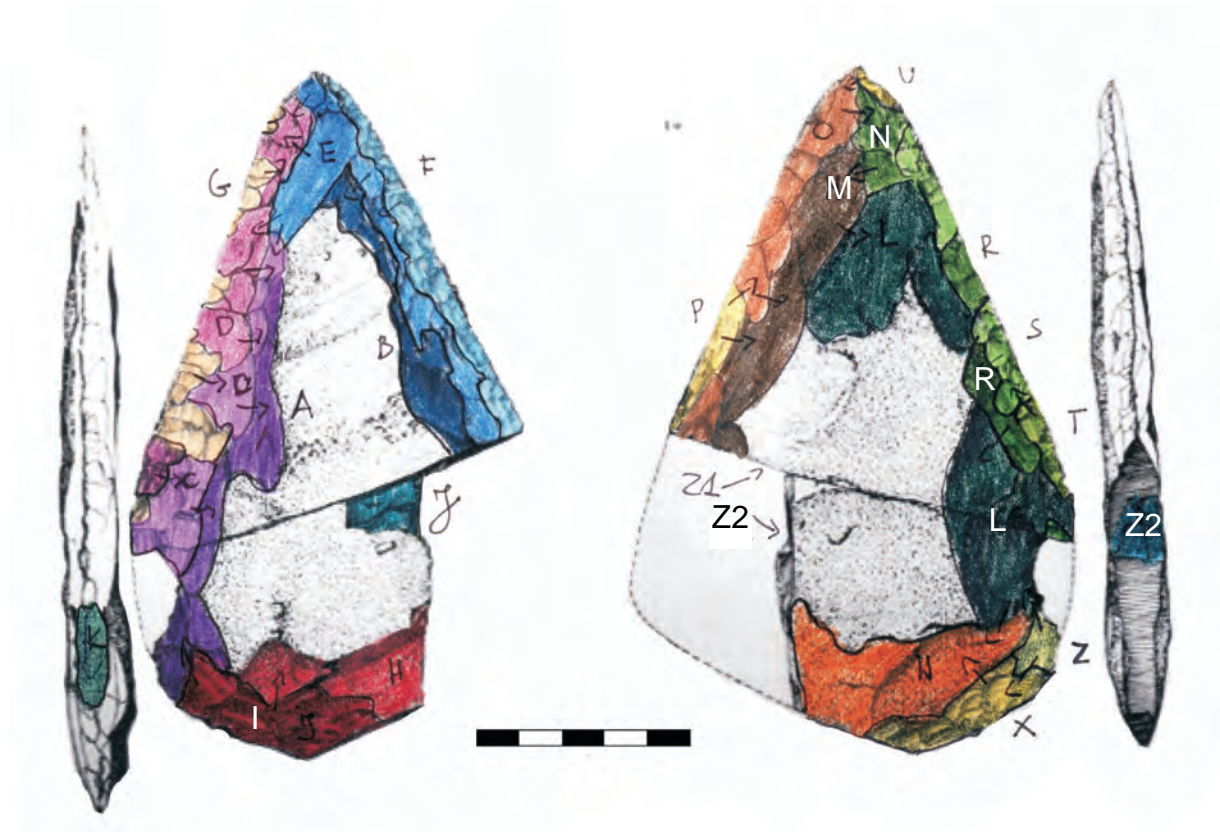
# Plate 127 Mauern 1951\_626



- G. fine, marginal retouch on the upper face, edge resharpening
- O. marginal retouch on the lower face, created a notch near breakage
- S. fine, marginal retouch on the lower face near breakage
- T. flat removals on the lower face, derived from the breakage scar, edge rejuvenation
- R. semi-steep retouch on the lower face, edge resharpening near the tip, edge blunting near breakage
- E. semi-steep, marginal retouch on the upper face, created big notches along the edge, edge resharpening
- N. flat, small removals on the lower face near the tip, edge angle correction
- P. semi-steep removals on the lower face at the tip, tip blunting, edge rejuvenation
- H. transversal breakage at the base
- F. flat, partly hinged retouch on the upper face, edge resharpening
- D. flat removals on the upper face, edge formation, thinning
- K, M, L, I, J. flat, broad removals on the lower face, surface formation, thinning
- A, B, C. flat removals on the upper face, surface formation, thinning

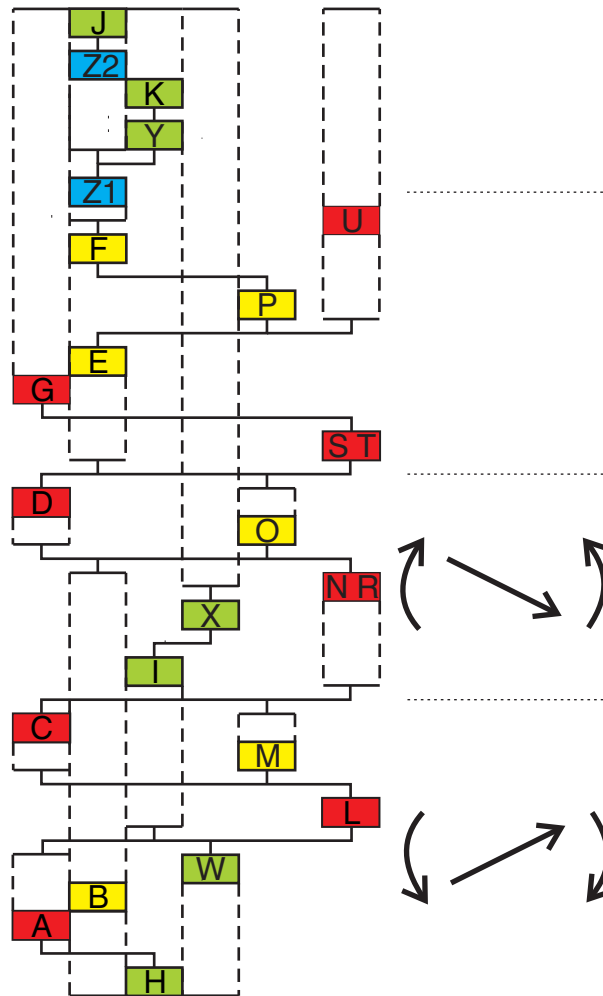


# Plate 128 Mauern 1951\_641



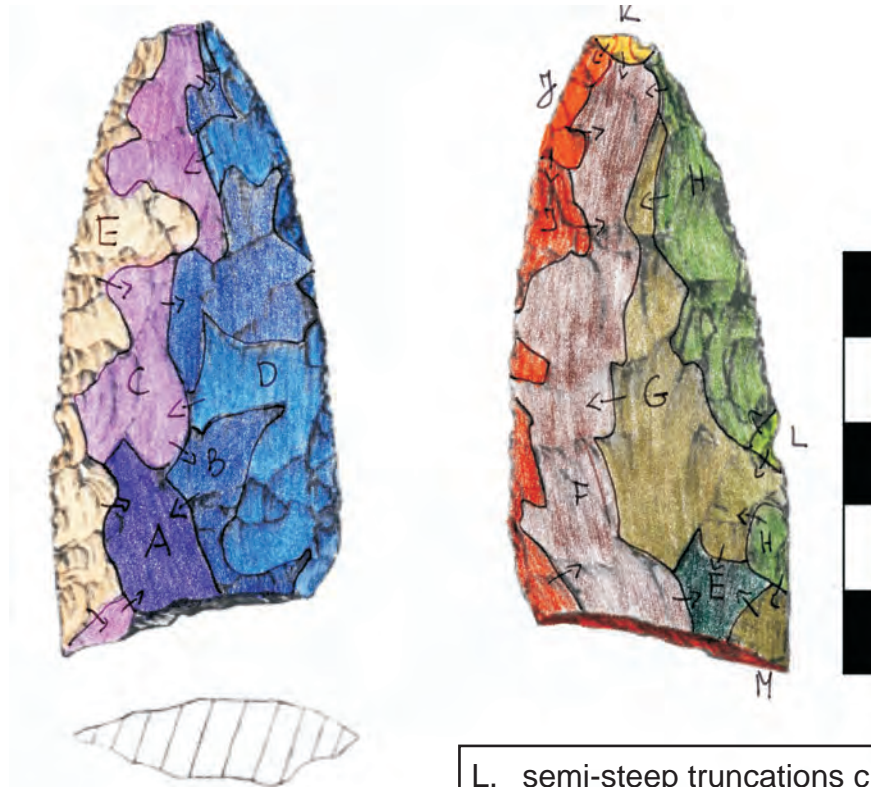
Plano-convex tool made on a flat slab, with both edges retouched on the upper face and probably resharpened. Lower face was used for edge angle correction. The tool was broken in its half at the end of manufacturing process. There are no traces of edge resharpening at the tip part after breakage, but near-the-base part was unsuccessfully remodeled after breakage.

# Plate 128 Mauern 1951\_641

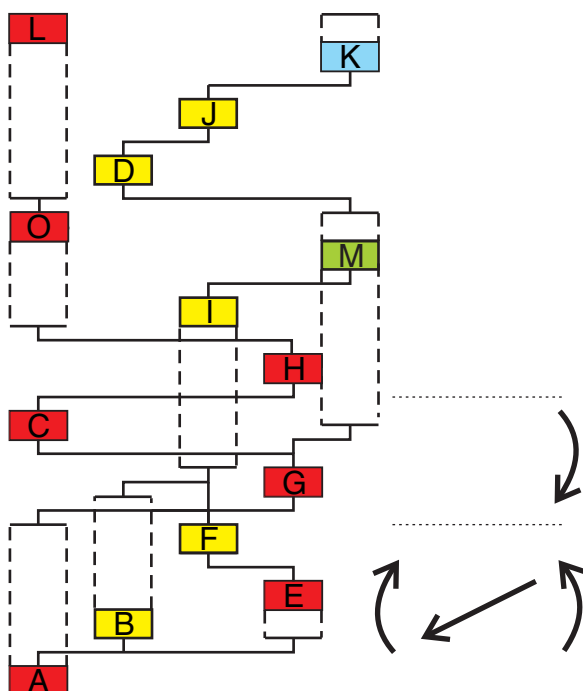


- J. flat, hinged removals on the broken base, derived from the breakage scar Z1 onto the breakage scar Z2, probably aimed at remodeling the edge, unsuccessful because of high hinges.
- Y. semi-flat and semi-steep, hinged retouch on the lower face at the base
- K. single removal derived from breakage scar Z1 onto the edge, probably aimed at edge remodeling and decortication
- Z2. transversal breakage, probably impact point on breakage scar Z1
- Z1. transversal breakage breaking the tool into two pieces
- U. steep, marginal retouch on the lower face near the tip, edge resharpening (?)
- F. semi-steep, marginal retouch on the upper face along the edge, edge resharpening
- G. semi-flat, irregular, marginal retouch on the upper face, edge resharpening
- P, T, S. flat, marginal removals on the lower face, edge angle correction
- E, D. semi-flat removals on the upper face, edge sharpening
- O, N, R. flat removals on the lower face, edge angle correction
- C. flat removals on the upper face, edge formation, thinning
- L, M. flat, broad removals on the lower face, surface formation, decortication and thinning
- A, B. flat, broad removals on the upper face, surface formation, decortication and thinning
- X. multiple marginal removals on the lower face at the base, base formation
- W. flat, cortical removals on the lower face at the base, decortication, thinning
- H. flat, cortical removals on the upper face at the base, decortication, thinning
- I. flat and semi-flat removals on the upper face, at the base, surface thinning

# Plate 129 Mauern 1951\_642

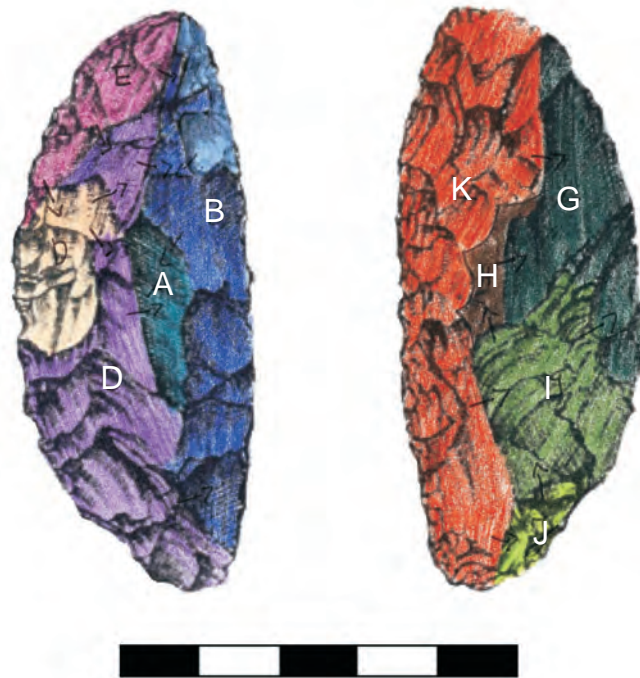


Tool with broken base and blunted tip. Tip was blunted by steep removals derived at last stage of rejuvenation. Both edges were retouched and resharpened several times. One of edges was resharpened after transversal breakage at the base.

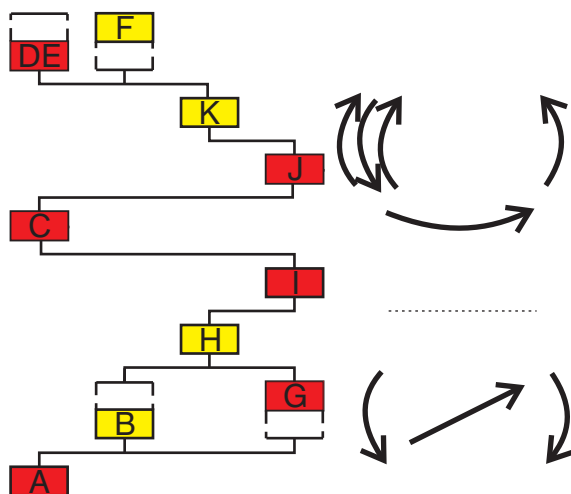


- L. semi-steep truncations created a notch on the lower face
- K. steep removals on the lower face at the tip, tip blunting
- J. marginal removals on the lower face near the tip, edge resharpening
- D. marginal retouch on the upper face: flat near the tip and more steep near the breakage, edge resharpening
- O. regular, marginal retouch on the upper face along the edge, edge resharpening, probably consists of a few reshapening phases
- M. transversal breakage at the base and a few flat, marginal flattening removals on the breakage scar
- I. flat removals on the lower face, edge angle correction
- H. semi-flat removals on the lower face, edge angle correction
- B, C. flat removals on the upper face, edge formation
- A. single, flat, broad removal on the upper face, surface formation
- F, G. semi-flat, broad removals on the lower face, edge/surface formation, thinning
- E. single, flat scar, earlier stages of manufacturing process

# Plate 130 Mauern 1951\_663



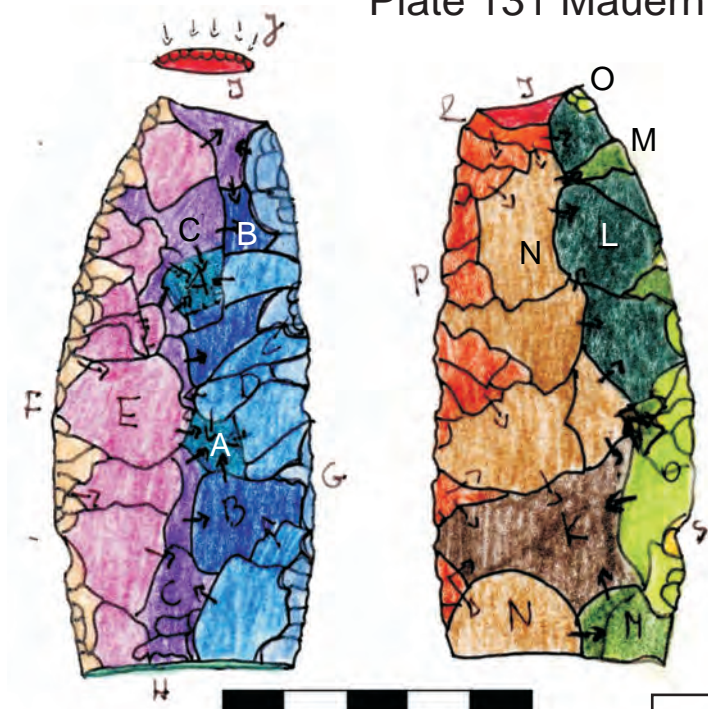
Knife with unexposed tips, single vertical cutting edge and convex distal posterior edge. Both ends were worked analogically, but alternately. Orientation was probably changed during rejuvenation process.



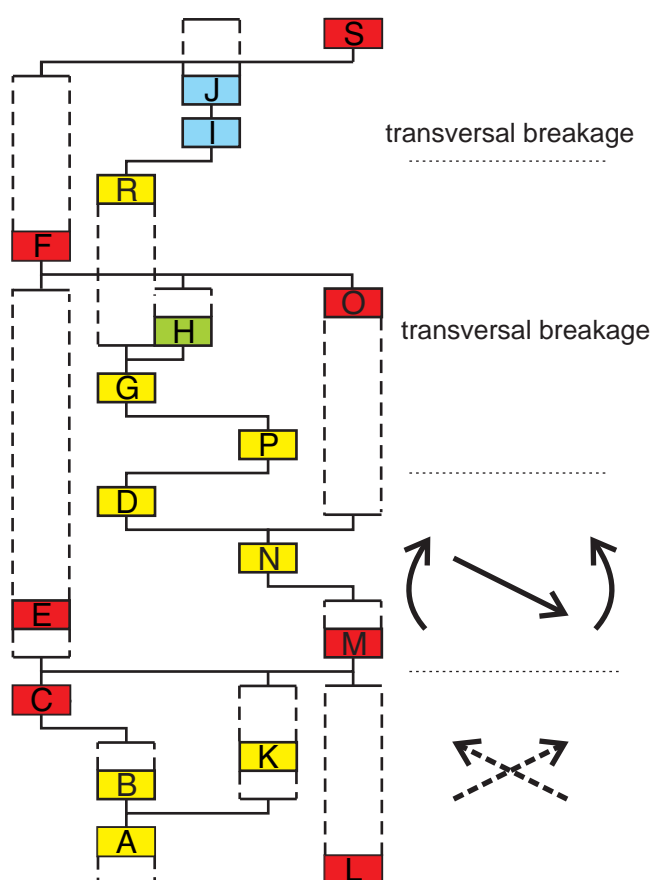
- F. steep, marginal retouch on the upper face near the tip, edge resharpening
- D, E. semi-steep retouch on the upper face, edge resharpening
- K. flat removals on the lower face and steep retouch in the middle part of edge, edge angle correction, edge thinning, only partly successful, unsuccessful thinning in the middle part
- J, I. semi-flat removals on the lower face near the base, edge rejuvenation, thinning
- C. removals on the upper face: semi-flat near the base and semi-steep in the middle part of edge, edge formation, thinning
- H. semi-steep scars on the lower face, earlier stages of manufacturing process, unsuccessfully removed by sequence K
- G. flat and semi-flat, broad removals on the lower face, surface thinning
- B. semi-flat and semi-steep removals on the upper face, edge formation
- A. flat scar from earlier phases of manufacturing process



# Plate 131 Mauern 1949\_777



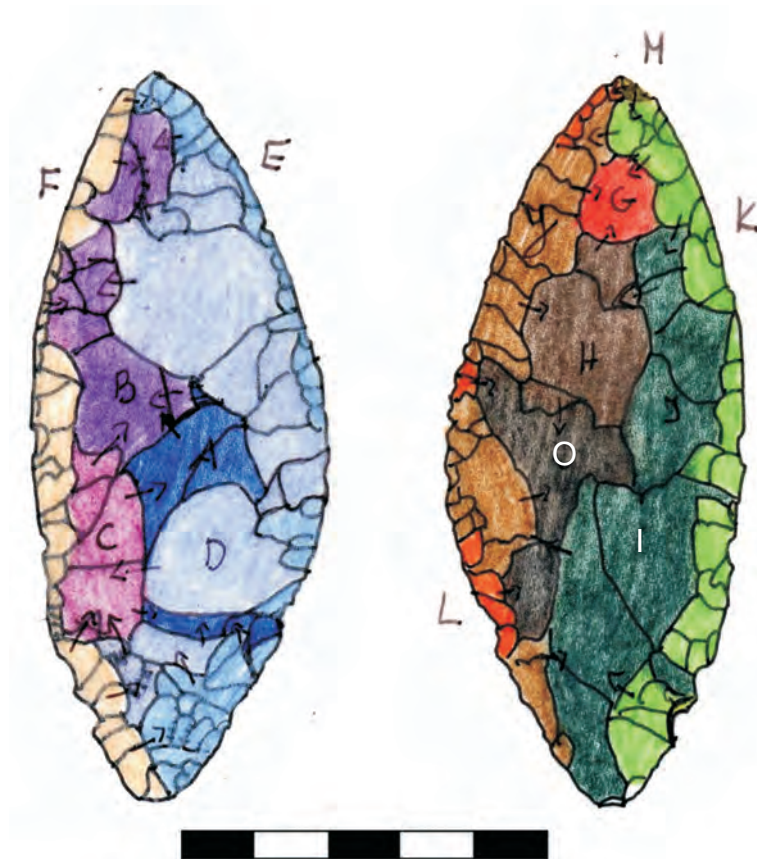
Plano-convex tool with both base and tip transversally broken. The tool was rejuvenated after each breakage, both edges were retouched and resharpened several times. Lower face was used for edge angle correction. One of edges is more vertical and straight, the other one is more convex.



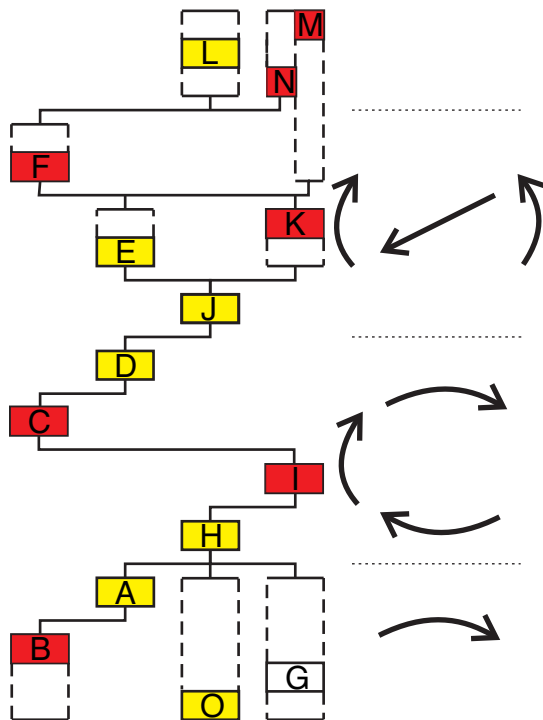
- J. marginal retouch on the breakage scar at the tip, surface flattening or usewear
- I, H. transversal breakage
- R. flat, long removals on the lower face near breakage at the tip, edge rejuvenation, thinning
- F. semi-flat, marginal retouch on the upper face, more steep near the base, edge resharpening
- G. intensive, marginal retouch on the upper face, edge resharpening
- S. marginal truncations on the lower face created a notch on the edge
- O, P, M. flat removals on the lower face, edge angle correction
- D. semi-flat removals on the upper face, edge sharpening
- N. flat, broad removals on the lower face, edge angle formation, thinning
- E. semi-flat removals on the upper face, edge formation, sharpening
- C, A. flat, far going removals on the upper face, earlier stages of manufacturing process
- B. semi-flat removals on the upper face, edge/surface formation
- K, L. flat, broad removals on the lower face, surface formation, thinning, flattening



# Plate 132 Mauern 1949\_780

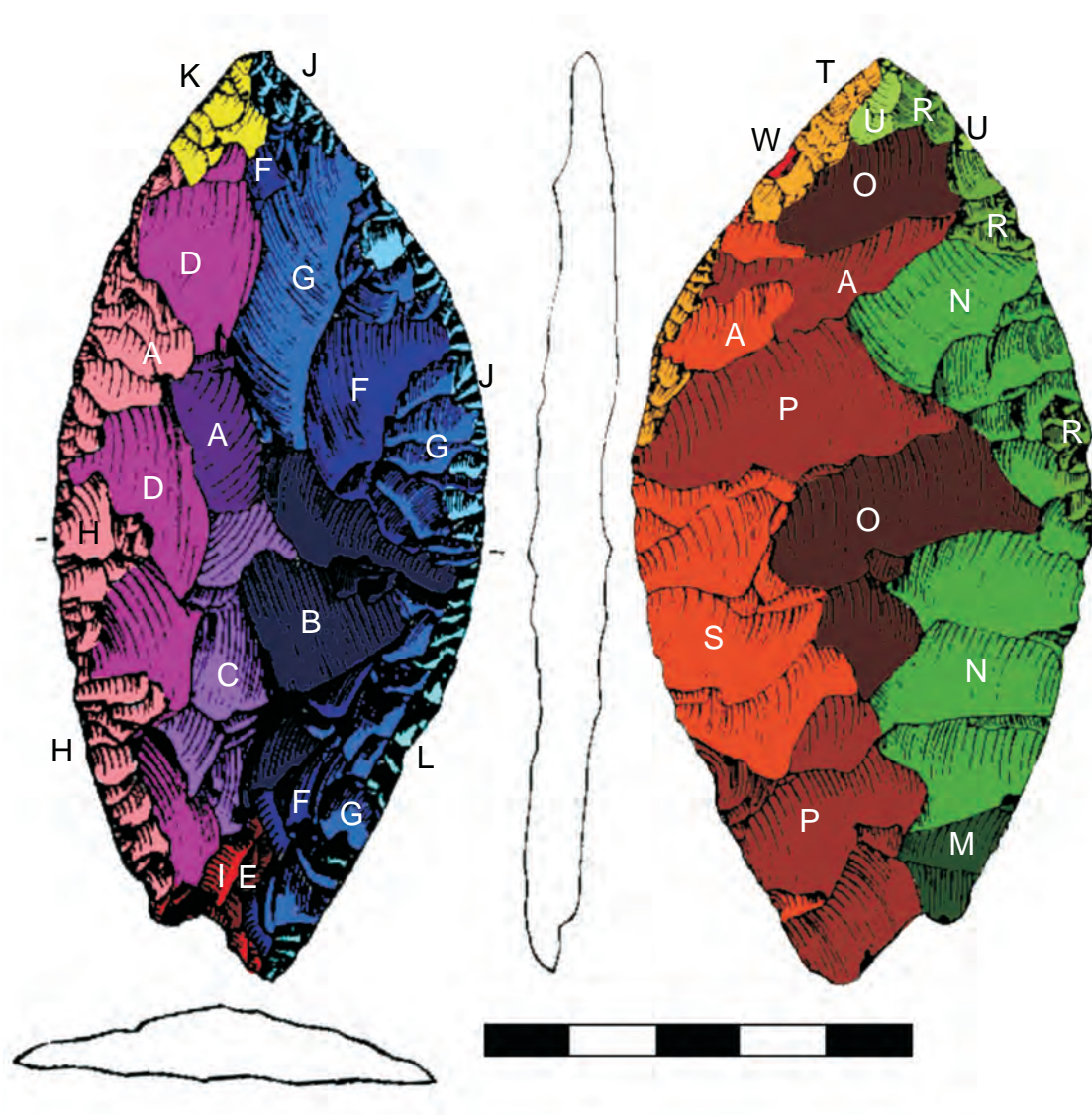


Plano-convex tool with both ends exposed. Both ends were treated similarly, but the tip was knapped slightly more precisely. One edge was shaped vertically, the other one convexly. Both edges were retouched and resharpened. The tool could have its orientation changed during one of rejuvenation stages/phases(?). Notches along edges were created by steep, marginal removals.



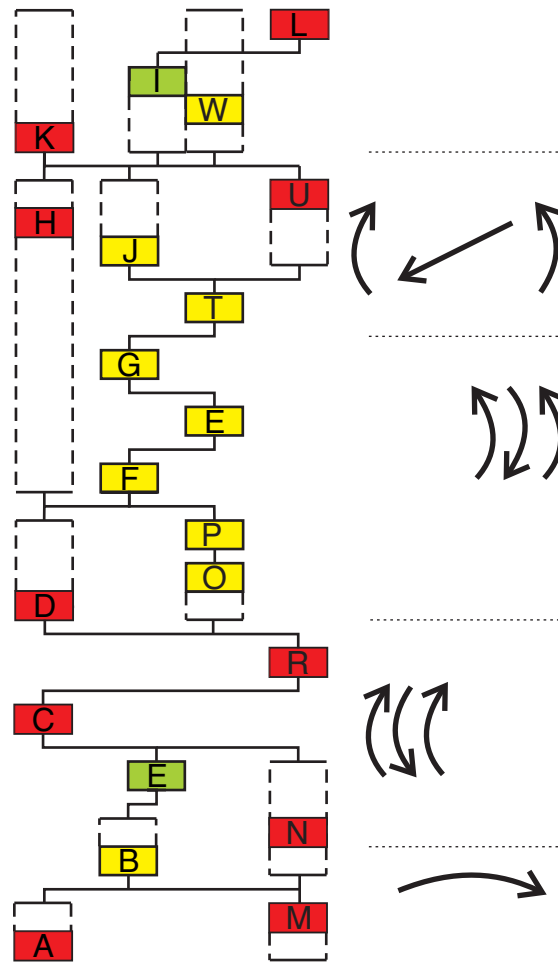
- M. steep, marginal retouch on the lower face at the tip, created a notch at the tip
- L. small, marginal retouch on the lower face, edge correction and usewear
- N. steep removals on the lower face near the base, created a notch
- F. semi-flat and semi-steep, irregular, marginal retouch on the upper face along the edge, edge resharpening
- J, K. flat retouch on the lower face, more precise near the tip, edge angle correction
- E. regular, marginal retouch on the upper face, edge resharpening
- D, C. flat removals on the upper face, surface thinning, edge formation, shaping
- I, H, O. flat, broad removals on the lower face, surface formation, thinning, flattening
- G. flat scar from earlier phases of manufacturing process, impact point direction invisible
- A, B. flat, broad removals on the upper face, surface formation, thinning

Plate 133 Mauern 1949\_786



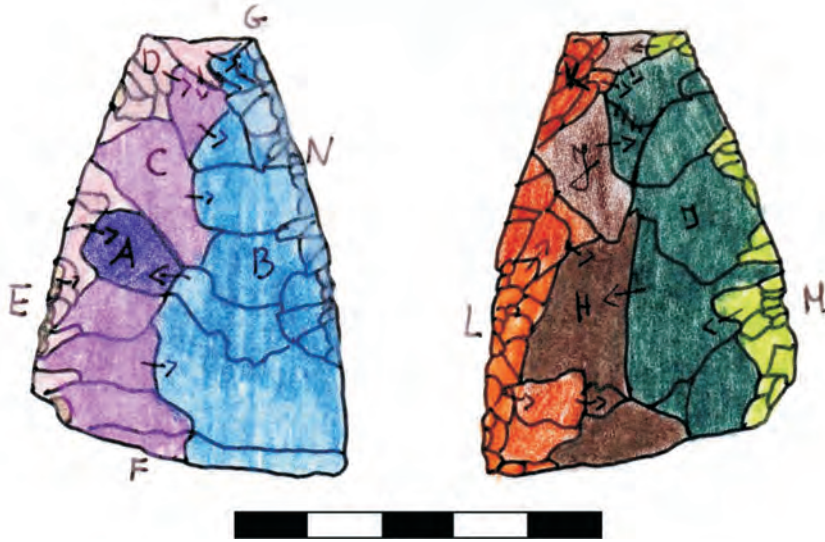
Plano-convex, asymmetrical tool with exposed tip and deep notch at the base, located angularly to main axis. One edge is more convex than the other. Both edges were finely retouched along their whole length and resharpened several times.

Plate 133 Mauern 1949\_786



- L. semi-steep, marginal retouch on the upper face, partly usewear
- I. steep removals on the upper face near the base, created a deep notch at the base
- W..single, marginal truncation on the lower face
- K. flat, marginal retouch near the tip, edge resharpening, partly usewear
- U. flat removals on the lower face near the tip, edge angle correction
- H. semi-flat retouch on the upper face, more steep near the base, edge resharpening and thinning, partly usewear near the tip
- J. marginal retouch on the upper face near the tip, edge resharpening, partly usewear but less intensive than sequence L
- T, R. flat and semi-flat removals on the lower face, edge angle correction
- G, F. semi-flat removals on the upper face, going far near the tip and more steep near the base, edge thinning and sharpening/rejuvenation
- S. flat removals on the lower face, edge angle correction
- P, O. flat, broad removals on the lower face almost reaching the opposite edge, surface formation, thinning, flattening, edge angle formation
- D, C. flat and semi-flat removals on the upper face, edge thinning, sharpening, formation
- E. flat removals on the upper face near the base, surface formation
- A, B. semi-flat and flat, broad removals on the upper face, surface formation
- N, M. flat, broad removals on the lower face, surface formation, thinning, flattening, edge angle formation

## Plate 134 Mauern 1949\_787



Plano-convex tool with transversally broken base and tip. Both edges were retouched alternately and resharpened. Both edges were rejuvenated also after base breakage. The tool was abandoned probably because of tip breakage—no traces of further rejuvenations.

G, F. transversal breakage

N, E. very fine, marginal retouch on the upper face, edge resharpening, partly usewear (?)

L. flat, very regular, marginal retouch on the lower face, edge resharpening near the breakage scar at the base and at the breakage scar

M. marginal retouch on the lower face, edge resharpening and edge correction near the breakage scar at the base

D. marginal retouch on the upper face, edge sharpening

K. marginal retouch on the lower face, edge resharpening

C, B. flat removals on the upper face,  
edge formation

A. flat scar, earlier stages of manufacturing process

I, J. flat removals on the lower face,  
edge formation

H. flat removals on the lower face,  
surface formation

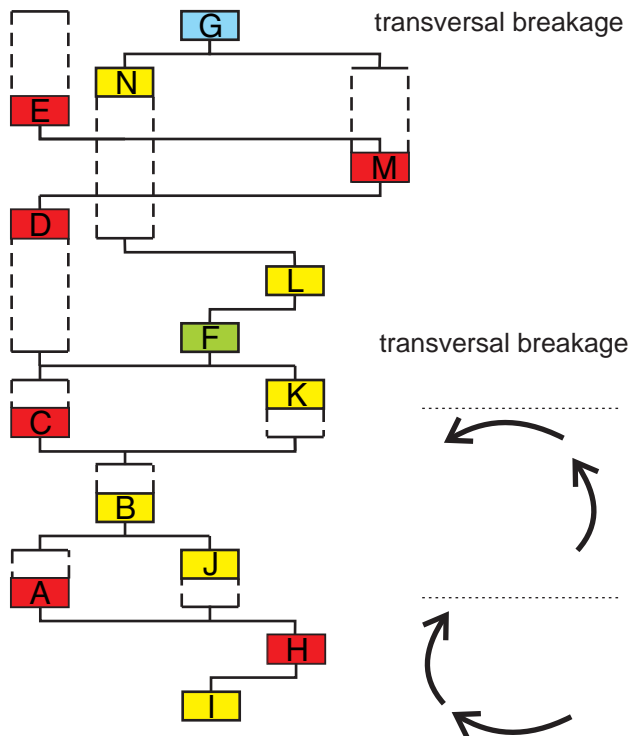
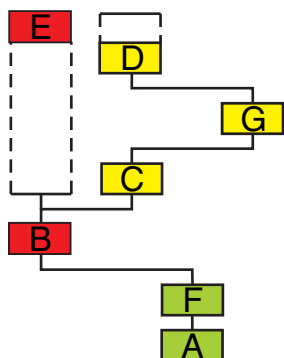




Plate 135 Mauern 1949\_788



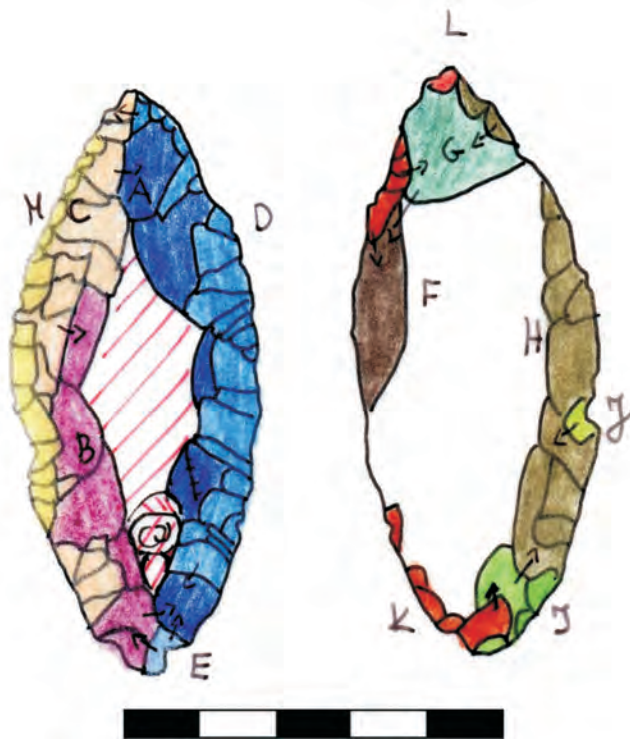
Plano-convex, asymmetrical tool made on a flake with exposed tip. Lower face was only flattened near the base. Bulb was removed by series of flat removals. Both edges were retouched on the upper face.



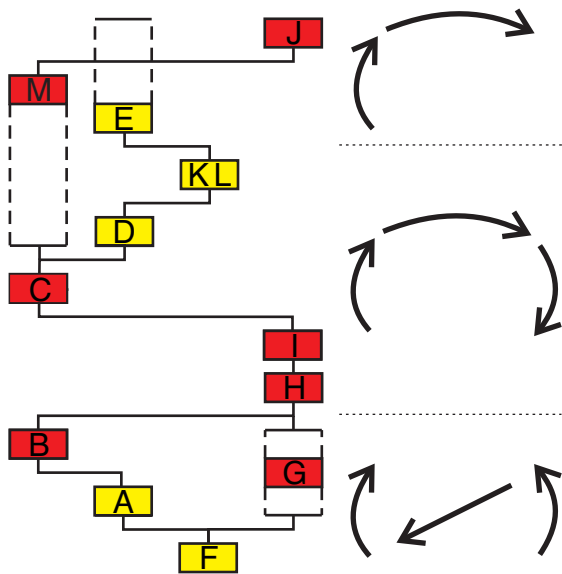
- E. semi-steep, very fine, marginal retouch on the upper face near the tip, edge sharpening
- B, C. semi-flat removals on the upper face, edge decortication, formation
- D. semi-steep retouch on the upper face along the edge, edge sharpening
- G. flat removals on the lower face, surface thinning, bulb removal
- A. single, flat scar of removal derived before obtaining the flake
- F. ventral surface of a flake



Plate 136 Mauern 1949\_790

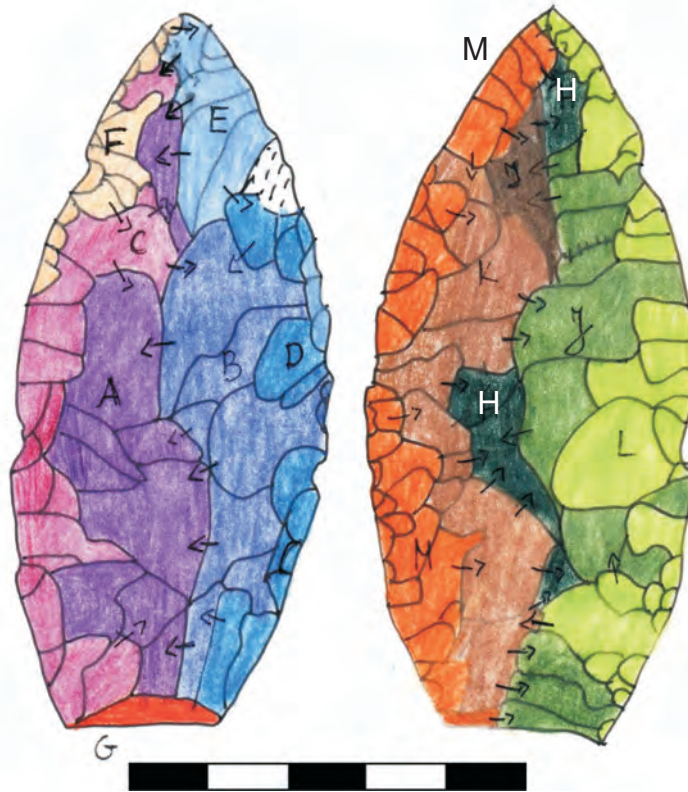


Plano-convex tool made on a thin slab, with both edges retouched and resharpened, and exposed tip.

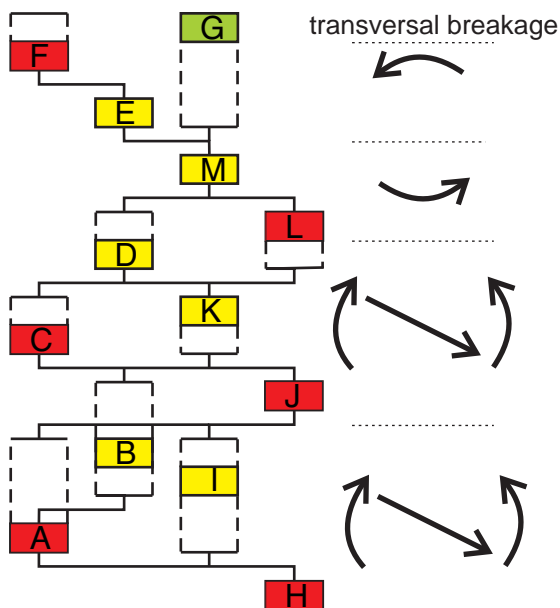


- E. single, steep truncation on the upper face, base formation
- J. single truncation on the lower face
- M. marginal retouch on the upper face, edge resharpening
- K, L. flat, marginal retouch on the lower face, edge correction
- D, C. semi-flat/semi-steep, regular retouch on the upper face, edge resharpening
- I. semi-flat removals on the lower face near the base, edge angle correction, thinning
- H. flat, partly hinged removals on the lower face, edge angle formation
- G, F. flat, broad removals on the lower face, surface thinning
- A, B. semi-flat, partly hinged removals on the upper face, surface formation, decortication

# Plate 137 Mauern 1949\_791

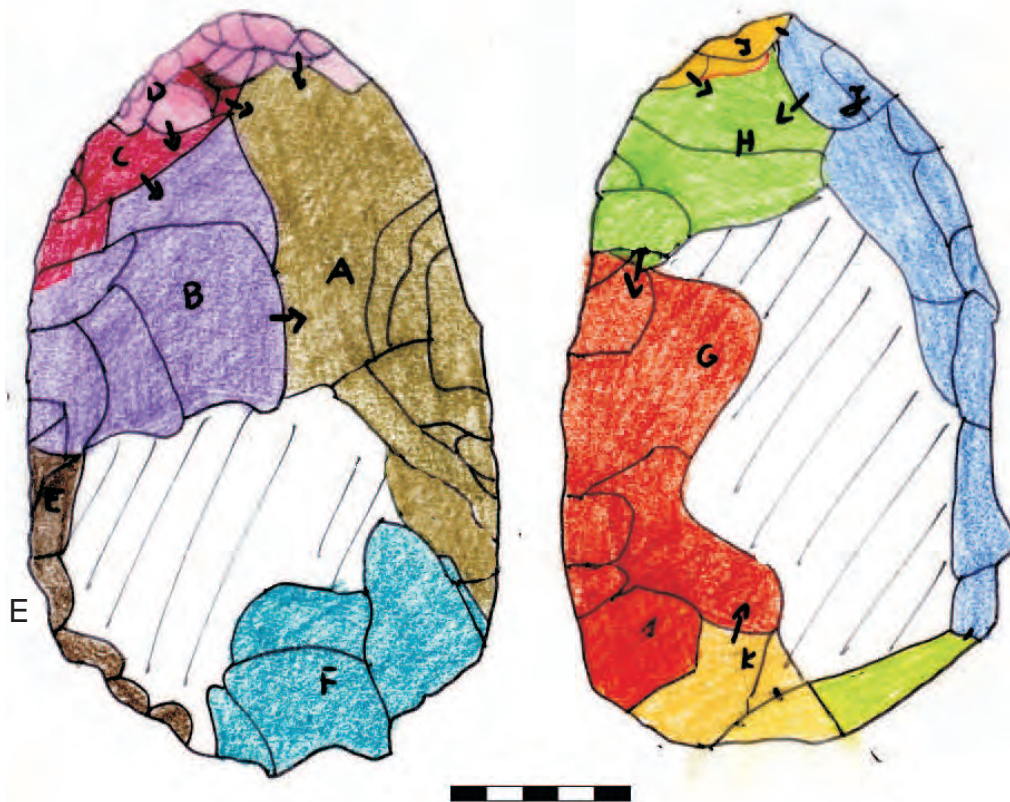


Plano-convex, symmetrical tool with broken base, three notches along edges and very fine, marginal, sharpening retouch along both edges. The tool was precisely worked and retouched along edges; near-the-tip part was shaped.

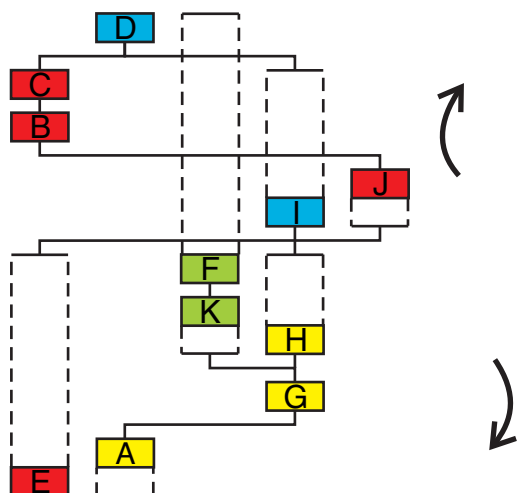


- G. transversal breakage
- F. marginal retouch on the upper face near the tip, edge reshaping, created a notch in one place
- E. flat, long removals on the upper face near the tip, edge formation, shaping (?), near-the-tip part thinning
- M, L. flat retouch on the lower face along the edge, more intensive near the tip and the base, edge formation, edge angle correction
- D. semi-flat removals on the upper face, edge formation or earlier phases of edge sharpening
- C. semi-flat removals on the upper face, edge formation, analogical to sequence D
- K, J. flat removals on the lower face, surface formation, thinning
- H, I. flat, broad removals on the lower face, surface formation, thinning
- A, B. semi-flat removals on the upper face, surface formation

# Plate 138 Rörshain Rh\_1



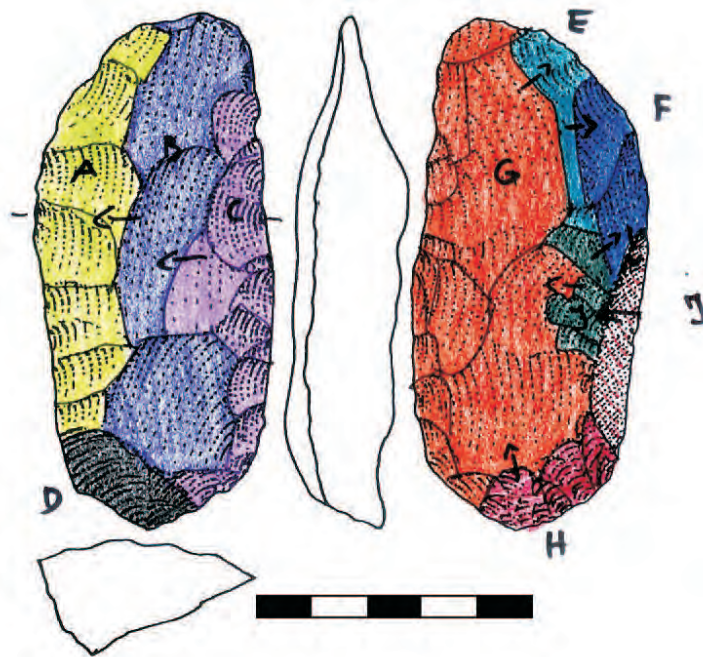
Very big preform, probably made on a huge flake abandoned at the stage of thinning and surface formation. Precisely worked near the tip, bent in profile.



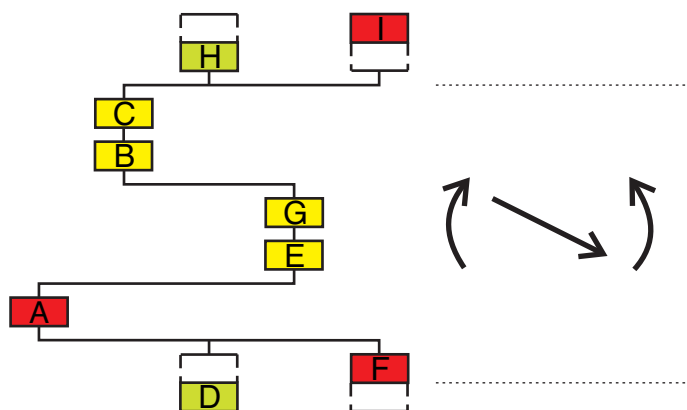
- D. regular retouch on the upper face at the tip
- C. hinged removals on the upper face aimed at thinning the near-the-tip part
- B. flat removals on the upper face near the tip, edge thinning
- J. removals on the lower face: semi-flat near the tip and semi-steep near the base, surface thinning, edge formation
- I. flat removals on the lower face at the tip, edge angle formation before sequence D, edge correction
- F. flat removals on the upper face derived from the base, surface thinning, broken in a half, created a high, interscar border
- K. semi-steep removals on the lower face, derived from the base, surface thinning
- H, G. flat removals on the lower face, surface formation
- A. partly hinged removals on the upper face, surface formation and thinning
- E. irregular removals on the upper face near the base, edge formation



# Plate 139 Rörshain Rh\_5

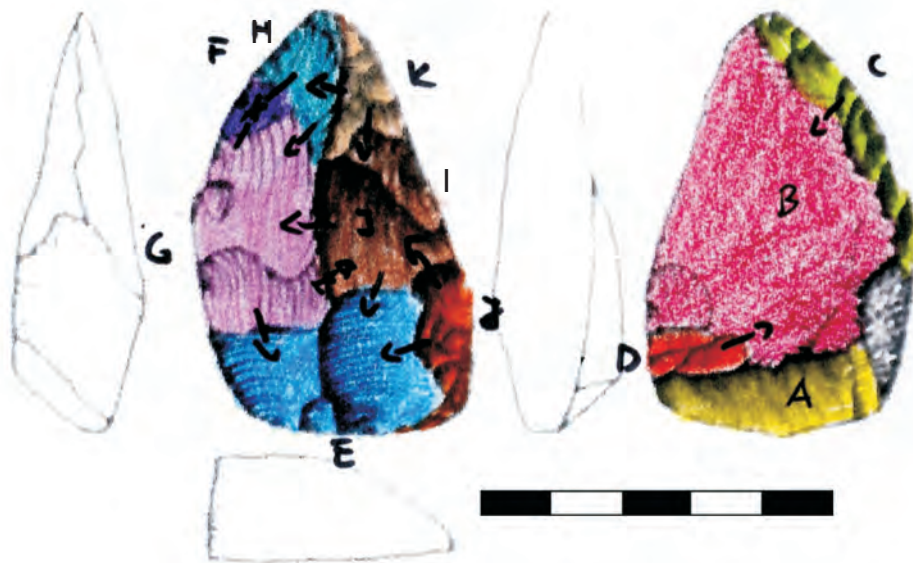


Knife with natural back surface and base formed with semi-steep removals. Only cutting edge has sharpening sequences. Tip is unexposed and very thin, with no traces of retouch.

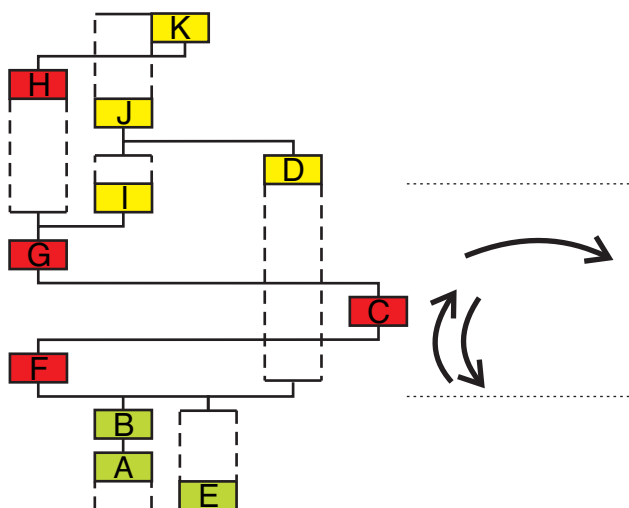


- I. flat, small removals on the lower face derived from the back
- H. semi-steep, intensive removals near the base, base formation
- C. semi-flat retouch on the upper face, cutting edge sharpening
- B. flat removals on the upper face, surface formation
- G, E. flat, very broad and invasive removals on the lower face, surface and edge formation
- A. flat removals on the upper face, surface formation
- F. distal posterior edge formation on the lower face
- D. semi-steep removals on the upper face, base formation

# Plate 140 Rörshain Rh\_7



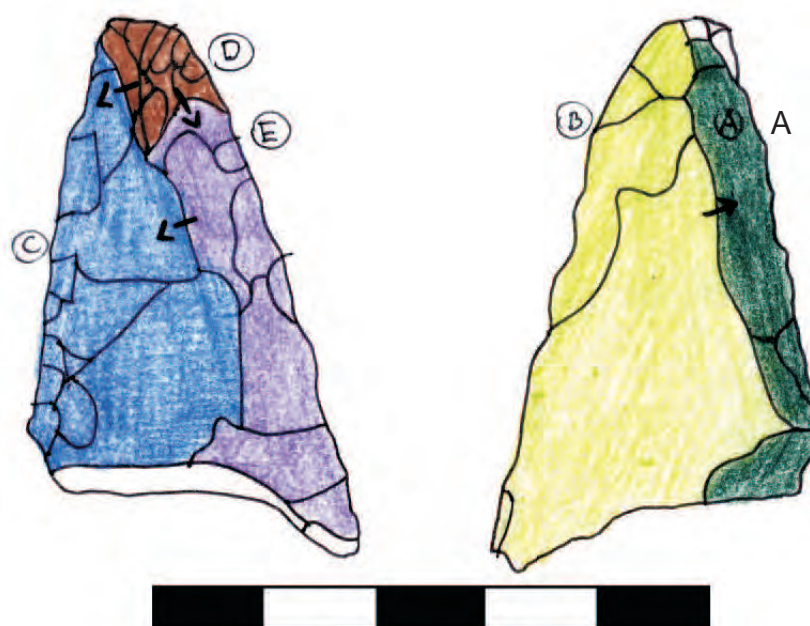
Plano-convex knife made on a flake with cortical back, and base formed by the butt of a flake. Cutting edge was sharpened only on the upper face; therefore, it is straight in profile.



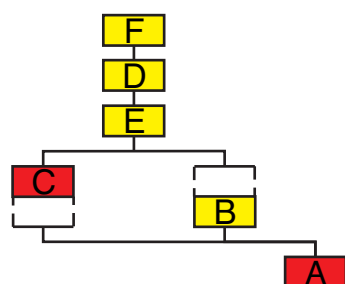
- K. very fine, marginal retouch on the upper face near the tip, cutting edge sharpening
- H. single, angular removal on the upper face, distal posterior edge rejuvenation
- J. marginal retouch on the upper face near the base, cutting edge sharpening
- I. cutting edge formation/sharpening on the upper face
- G, F. flat removals on the upper face, surface formation
- C. marginal, regular retouch on the lower face, distal posterior edge formation
- E. removals derived from the base on the lower face, surface thinning
- A. butt surface of a flake
- B. ventral surface of a flake
- D. edge angle correction on the lower face



# Plate 141 Rörshain Rh\_11

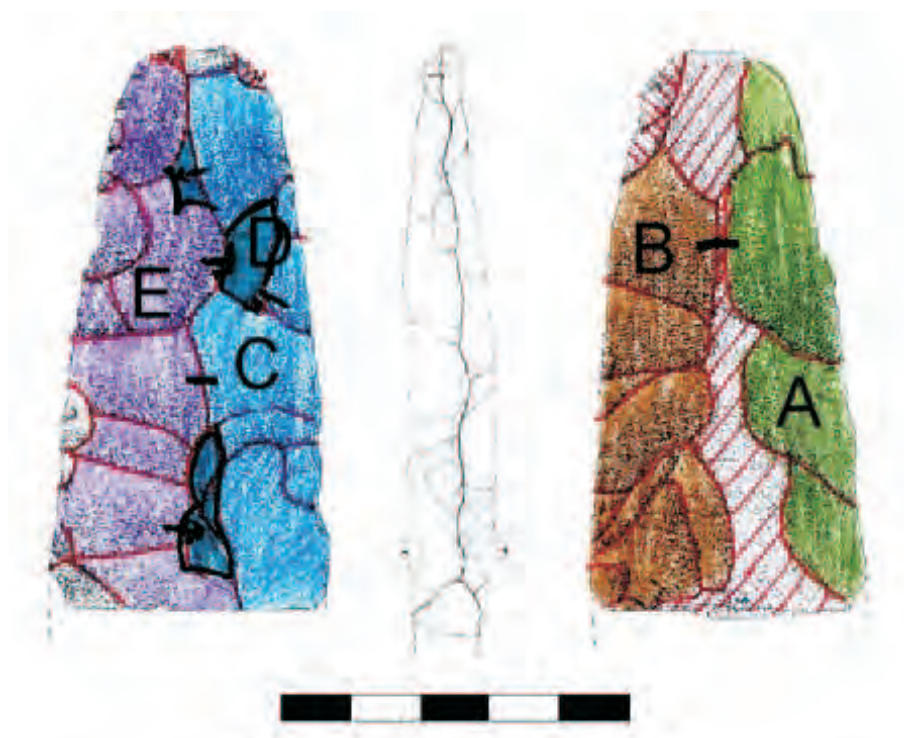


Tool with broken base and two straight edges convergent at the unexposed tip. Retouch at the tip created separate, transversal tip edge. Cutting edge might be retouched after base breakage.

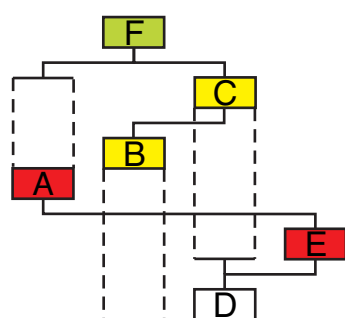


- F. refitted flake near the tip, edge sharpening
- D. small removals near the tip, edge sharpening
- E. semi-steep, partly hinged removals near the tip, edge formation
- C. thinning removals near the tip
- B, A. flat removals on the lower face, surface formation

# Plate 142 Rörshain Rh\_13

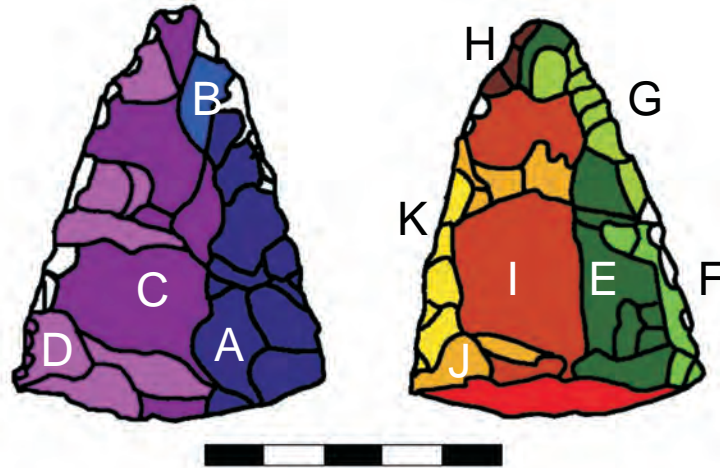


Tool transversally broken near the base, with symmetrical edges, unexposed and very thin tip.

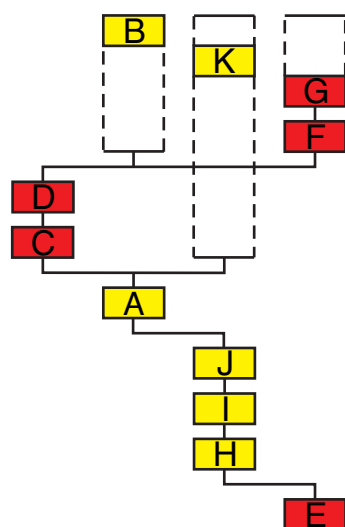


C, B, A, E. flat removals, edge formation  
 D. flat removals, earlier phases of surface formation  
 F. transversal breakage

# Plate 143 Rörshain Rh\_15

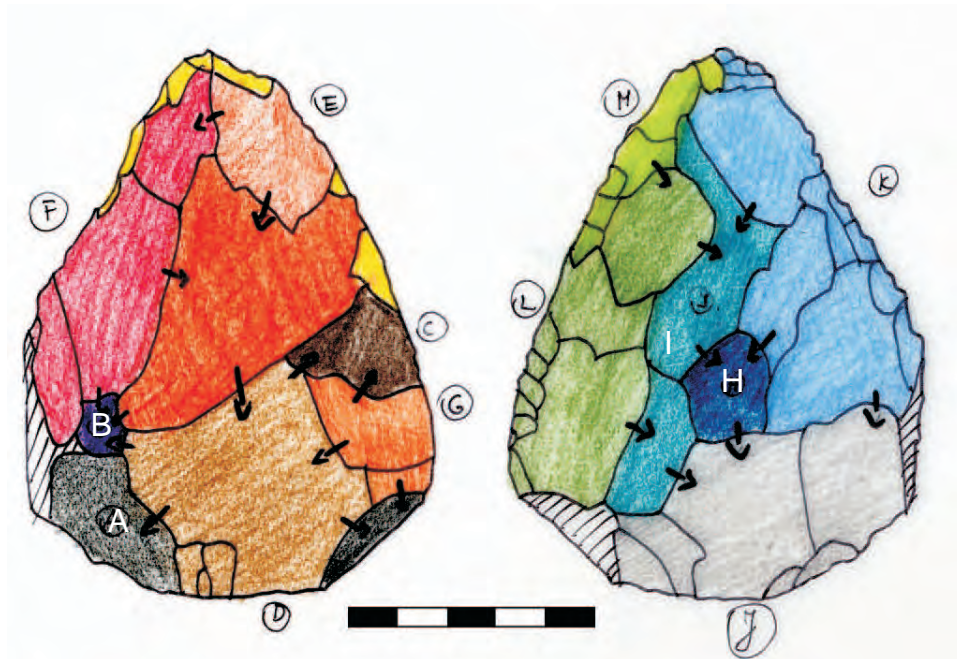


Biconvex tool broken transversally at the base. Tip is exposed but was not retouched; only edges were retouched. Shaping sequences are visible on edges. The tool was not rejuvenated or remodelled after transversal breakage. On the lower face, the earliest sequences are located near the tip.

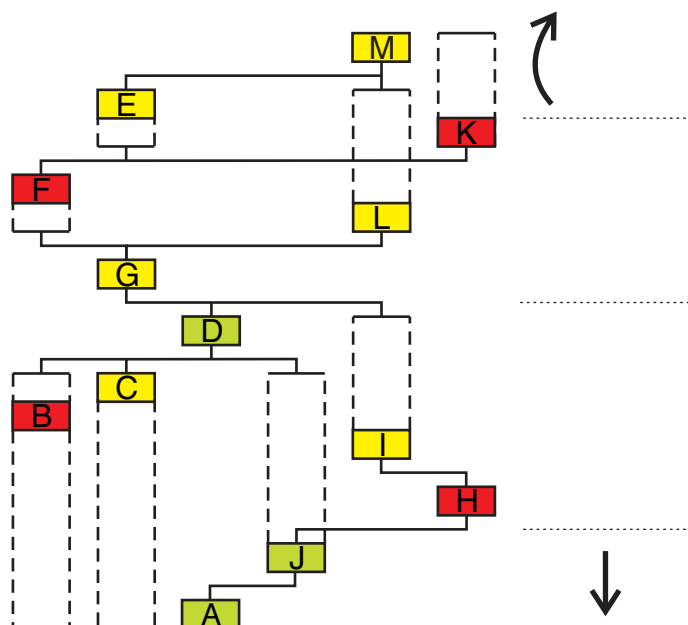


- B. flat angular removals near the tip, edge correction
- K. fine, marginal retouch
- G. hinged removals near the tip, thinning
- F. fine, marginal retouch
- D. thinning removals, surface correction, analogous to sequence J
- C, A, I, E. flat removals, surface formation
- J. thinning removals, surface correction, analogous to sequence D
- H. earlier phases of manufacturing process

# Plate 144 Rörshain Rh\_17

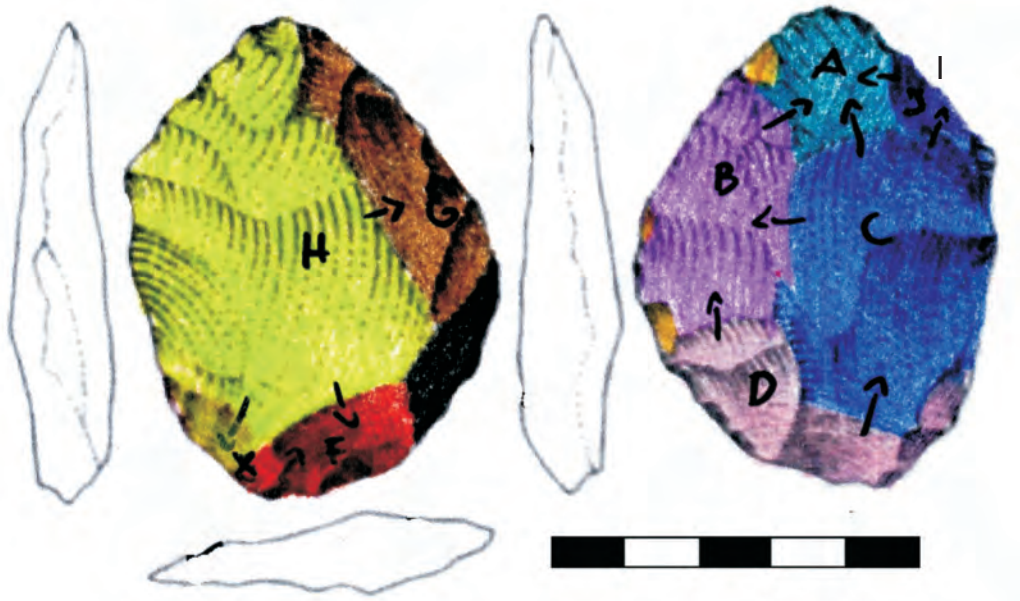


Inverted knife with a cutting edge on the left side of the upper face. Cutting edge was retouched with fine, regular removals and rejuvenated several times. Cutting edge is more straight in profile. Natural, steep surface was left on the back. Distal posterior edge was formed semi-steeply.

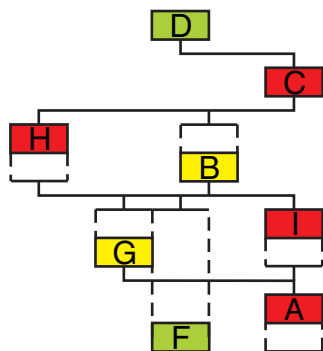


- M. fine removals on the cutting edge
- E. flat removals, cutting edge formation
- K. irregular, partly hinged removals on the lower face, distal posterior edge formation
- F. distal posterior edge formation on the upper face
- L. thinning removals, cutting edge formation
- G. flat removals on the upper face, surface formation
- D. flat removals, base formation
- C. flat removals on the upper face, decortication, surface formation
- B. decortication phase
- I, H. flat removals on the lower face, decortication, surface formation
- J. decorticating removals, base formation on the lower face
- A. first series of decorticating removals derived from the base

# Plate 145 Rörshain Rh\_35



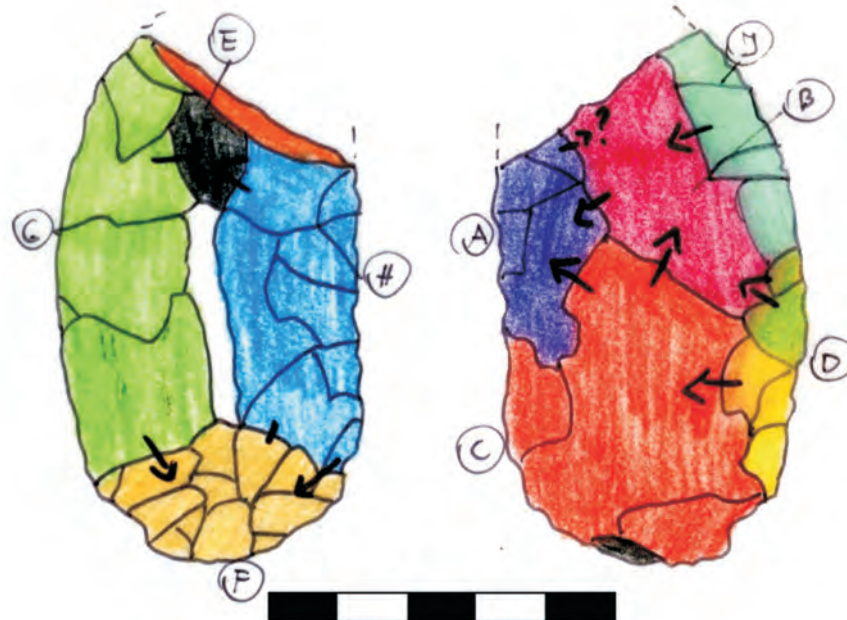
Asymmetrical knife, probably made on a flake. Its distal posterior edge is S-shaped in profile. Tip is left unexposed; some removals were derived from the tip.



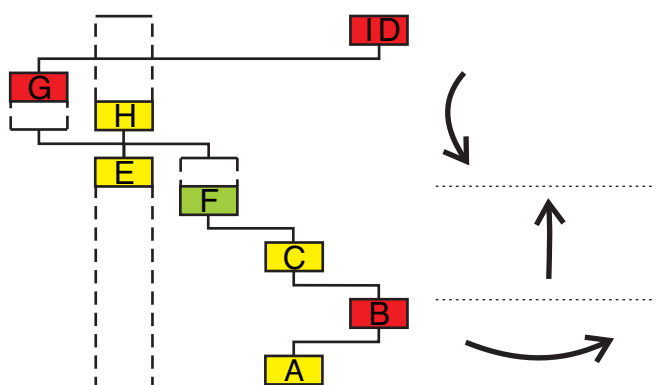
- D. removals on the lower face at the base, base formation
- C. flat, broad, deep/invasive removals on the lower face, created a concave surface of the lower face, surface formation
- B. flat removals on the lower face, surface formation
- H. flat removals on the upper face, surface formation and edge formation near the tip
- G. flat removals on the upper face, surface formation
- I. single removal on the lower face, distal posterior edge formation, edge angle correction before sequence H
- F. single, semi-steep removal, back formation
- A. ventral surface of a flake (?)



# Plate 146 Rörshain Rh\_39

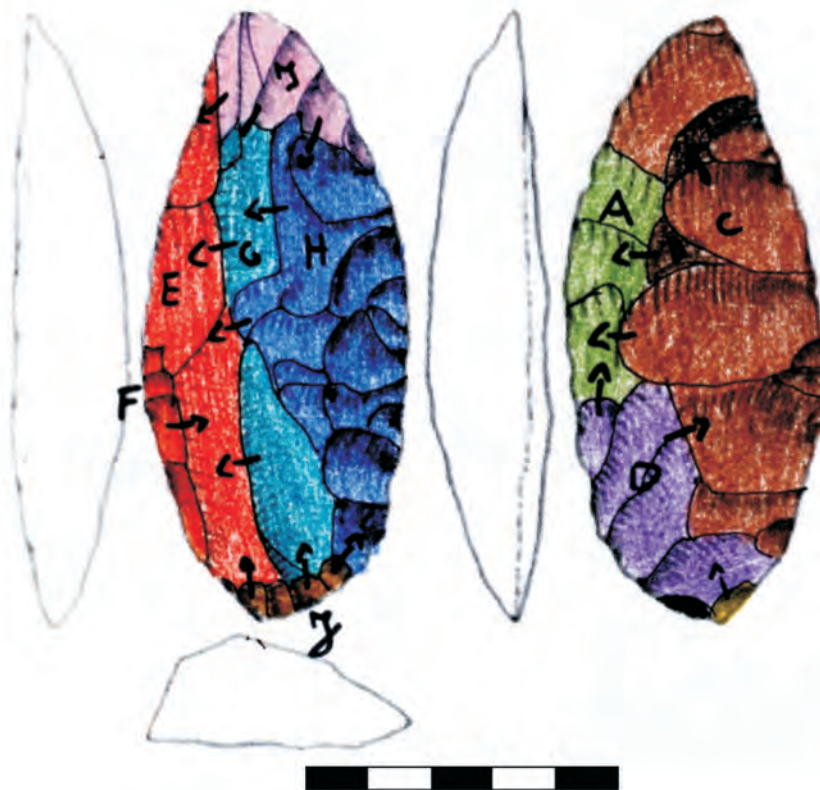


Plano-convex tool, broken angularly on one end. Convex working edge was formed at the opposite end. Probably this end was used as the tip. Retouched on the lower face after breakage.

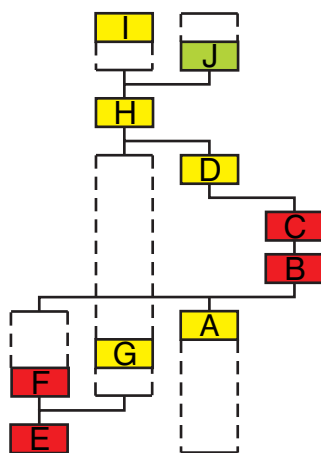


- I. flat removals, edge formation, last of them caused transversal breakage
- D. retouch, edge correction
- H. semi-steep removals on the upper face, edge formation
- G. flat removals on the upper face, edge formation, thinning
- F. removals on the upper face, edge convexity formation
- E. single removal from earlier phases of surface formation
- C. flat, angular removals on the lower face, surface thinning, flattening
- B, A, flat removals on the lower face, flattening

# Plate 147 Rörshain Rh\_42

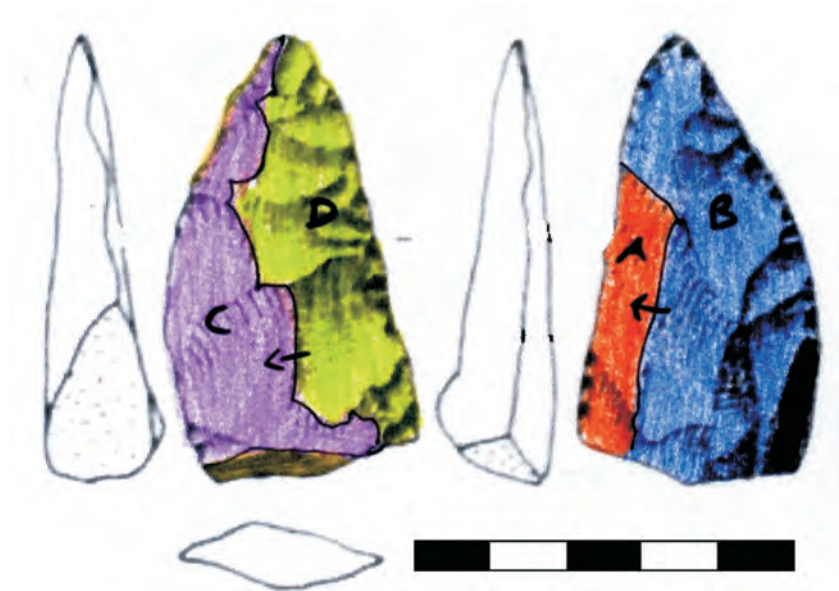


Plano-convex knife with cutting edge retouched and resharpened several times. Back edge was formed abruptly.

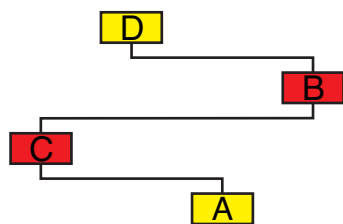


- I. long removals on the upper face derived from the tip, cutting edge resharpening
- J. flat, marginal retouch on the upper face, base edge correction/thinning
- H. semi-flat removals on the upper face, cutting edge sharpening
- D. flat removals on the lower face near the base, flattening, edge correction
- C. flat, deep, highly invasive removals on the lower face, surface flattening and thinning
- B, A. flat, broad removals on the lower face, surface formation
- G. flat, broad removals on the upper face, surface formation
- F, E. steep removals on the upper face, back formation

# Plate 148 Rörshain Rh\_43

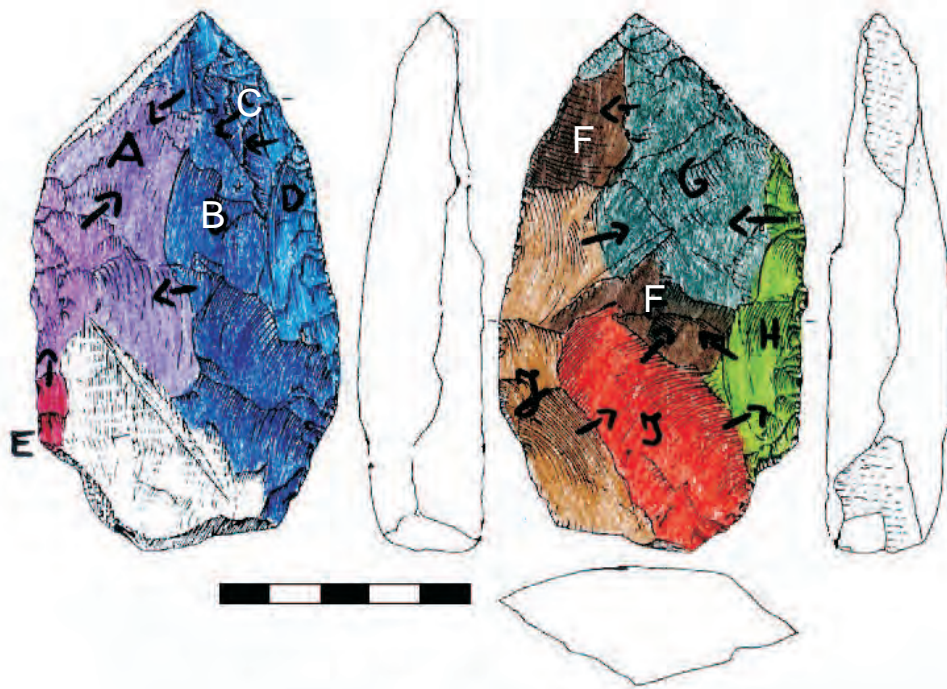


Knife with exposed tip and natural abrupt back and base. It was retouched only on the upper face of cutting edge.

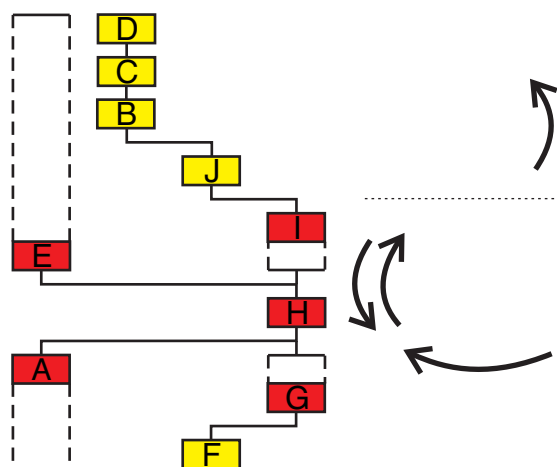


- A. flat removals on the lower face, surface/edge formation
- B. flat removals on the lower face, surface formation and a retouch forming the edge
- C. semi-steep, deep removals on the upper face, surface/edge formation
- D. cutting edge sharpening

# Plate 149 Rörshain Rh\_45



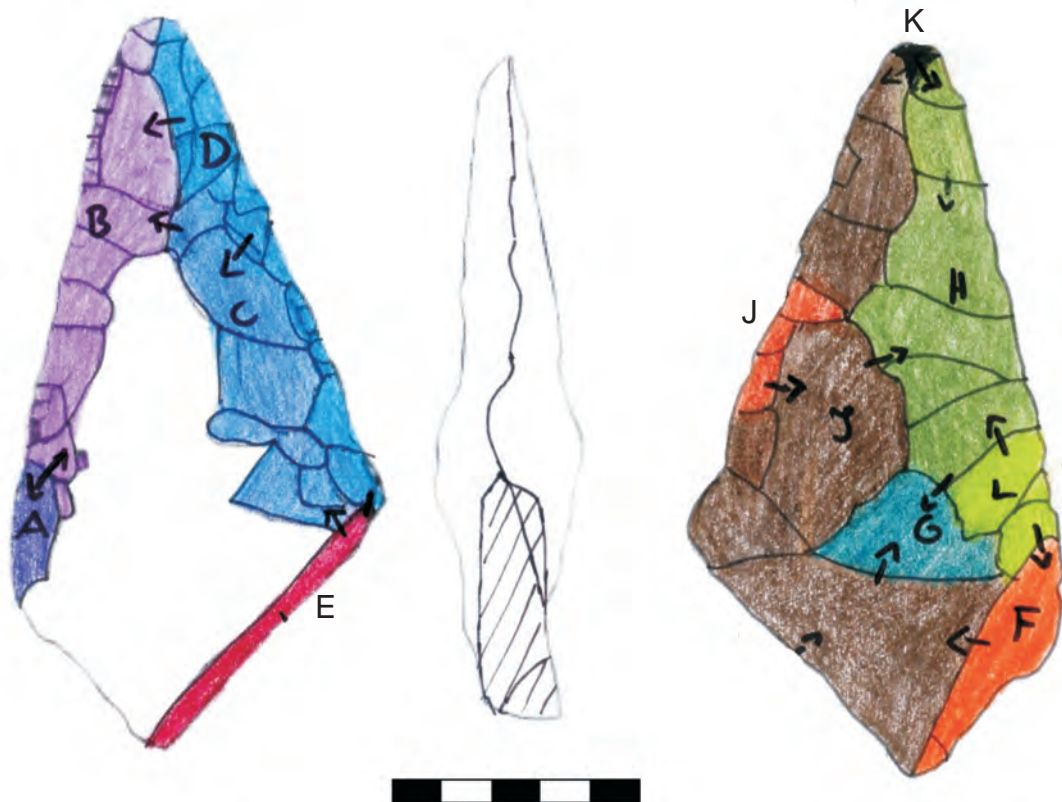
Knife with natural, abrupt surface of distal posterior part and back formed by steep removals derived on the lower face. Upper face is convex, with cutting edge resharpened several times on the upper face.



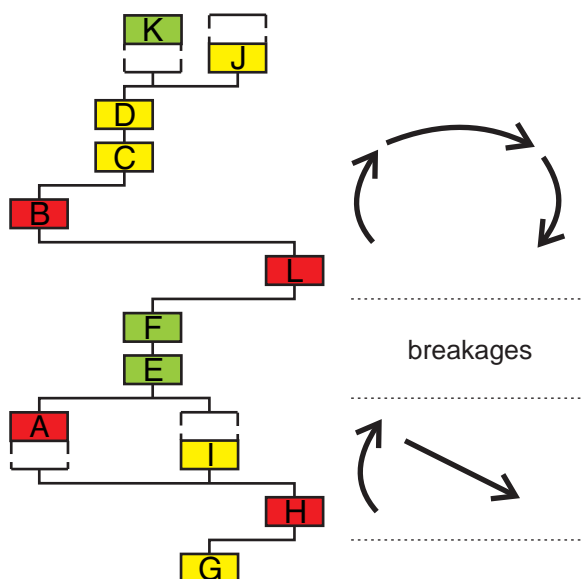
- C,D. flat, semi-flat and semi-steep retouch on the upper face near the tip, subsequent resharpening sequences
- B. semi-flat removals on the upper face, cutting edge formation
- J. semi-flat removals on the lower face, cutting edge formation near the base
- I. flat, angular removals on the lower face derived from the base, surface formation, thinning and flattening
- H. semi-steep removals on the lower face, back surface formation
- G. flat removals on the lower face, surface formation, partly unsuccessful—too deep
- E. single, steep removal on the upper face, back surface correction
- A. flat removals on the upper face, surface formation, perhaps also a very high hinged (>7mm) removal near the base belongs to this sequence
- F. flat, broad removals on the lower face, surface formation



# Plate 150 Rörshain Rh\_53



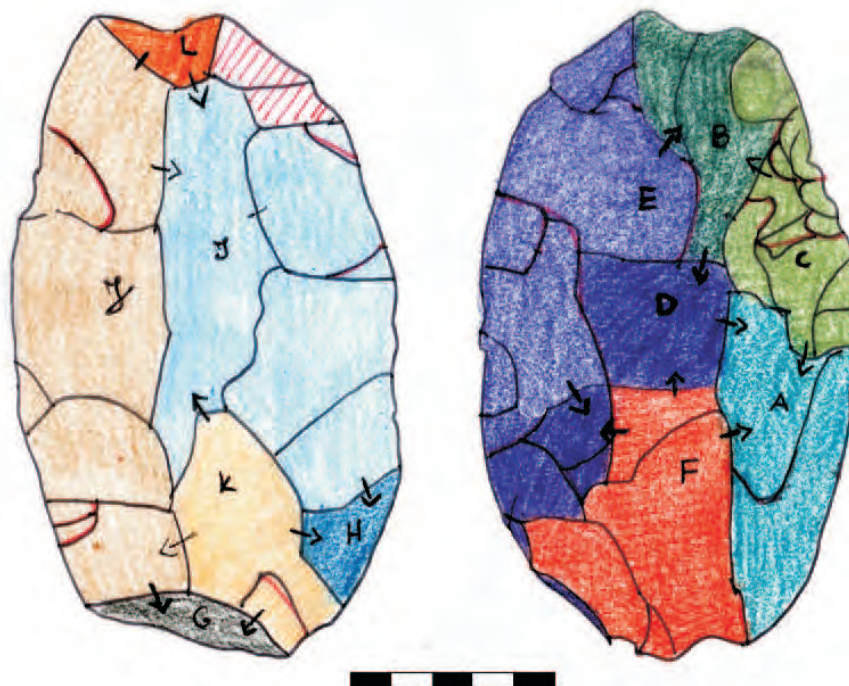
Symmetrical tool with base formed by two angularly located, transversal breakage scars. Edges converge at the tip which is poorly exposed and was not retouched. The tool was intensively retouched along edges, near the tip.



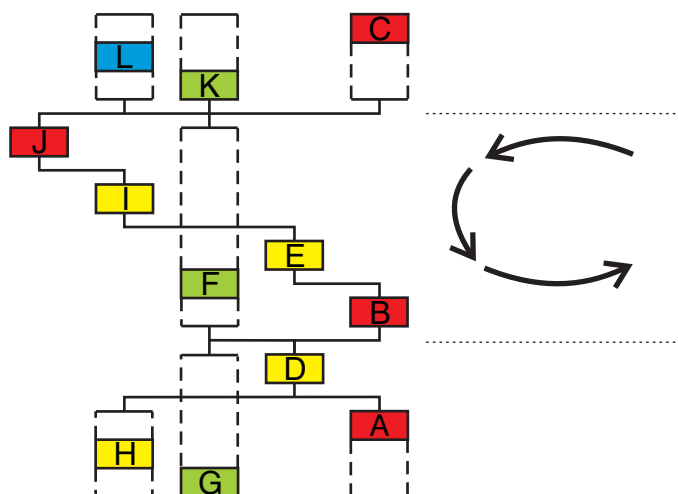
- K. transversal breakage near the tip
- J. small removals on the lower face, edge correction
- D. semi-flat and semi-steep removals on the upper face, edge sharpening, intrusion inside the nodule prevented further sharpening
- C, B, A. decorticating removals on the upper face, surface formation
- L. edge correction on the lower face after breakage
- F. transversal breakage located angularly to vertical axis, impact point located in the middle of surface, hinged/bent
- E. transversal breakage located angularly to vertical axis, impact point was located in the middle of lower face
- I. flat, hinged removals on the lower face, surface formation
- H, G. single, flat removal on the lower face, surface formation



# Plate 151 Rörshain Rh\_57

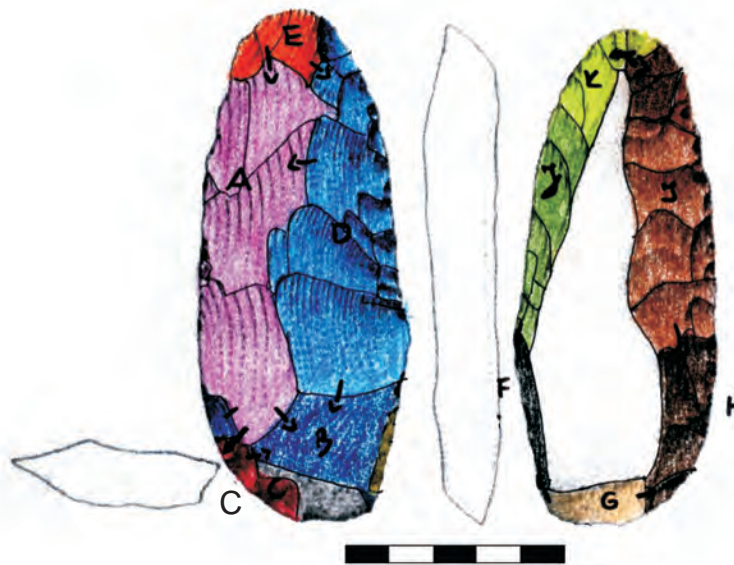


Very big preform, with initial formation of one working edge (sequence C), and base formed semi-abruptly. It was abandoned at the stage of thinning and surface formation

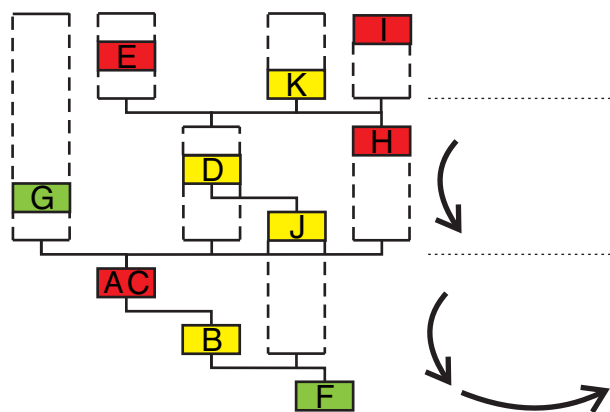


- C. flat removals near the tip, edge sharpening
- L. single, semi-steep removal on the lower face, removing the tip
- K. flat, angular removal near the base, surface thinning
- J, I, H. flat removals, surface formation
- E, B. flat, thinning removals near the tip
- D, A. flat and semi-steep removals, surface formation, thinning
- G. single, semi-steep removal from the initial stages of manufacturing process
- F. flat removals derived from the base, surface formation, thinning

# Plate 152 Rörshain Rh\_59

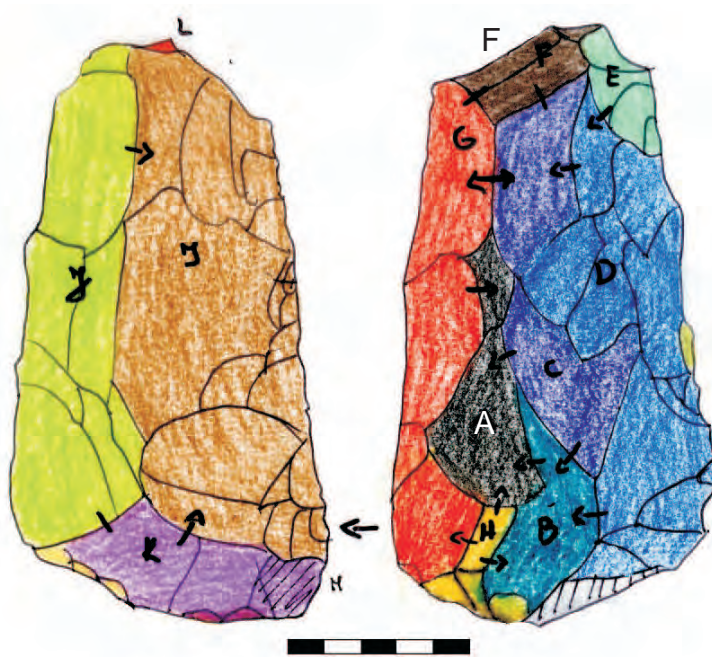


Plano-convex knife with abrupt back and unexposed tip; blunting removals were derived at the tip. The cutting edge was retouched and resharpened.

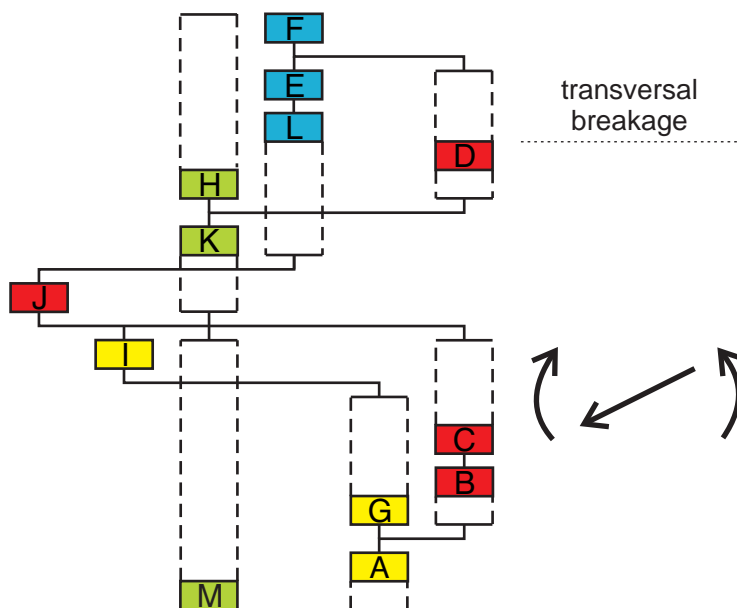


- K. steep retouch on the upper face of tip, blunts the tip and created a separate, concave tip edge
- E. flat removals on the lower face near the tip, thinning, surface correction
- I. semi-flat retouch of cutting edge, partly decorticating the blank, resharpening (?)
- H. semi-steep retouch of cutting edge near the base, partly decorticating the blank
- D. flat, highly invasive removals on the lower face, forming nearly concave surface of the lower face
- A. flat, broad removals on the lower face, surface formation, flattening
- J. semi-steep removals, back formation
- B. flat removals on the lower face, surface decortication and formation
- G. single, flat removal on the upper face derived from the base, decortication
- C. semi-flat removals on the upper face derived from the base, edge angle correction before sequence G
- F. steep removal or a natural surface, forming a back surface near the base

# Plate 153 Rörshain Rh\_79



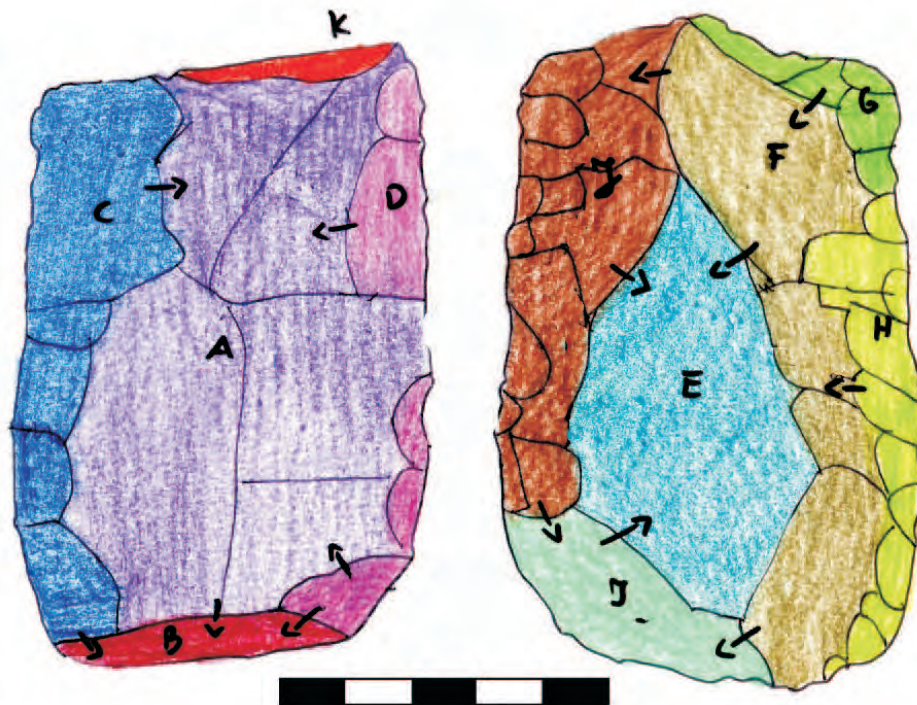
Preform with broken tip.  
Breakage scar was removed  
by further sequences.



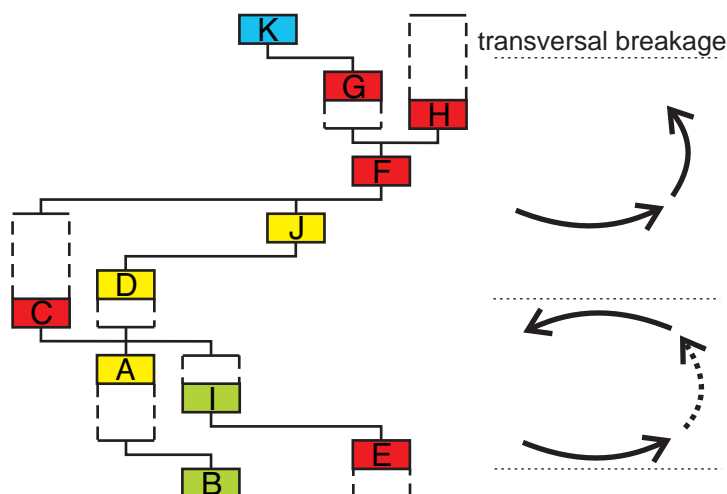
- E. retouch near the tip
- F. semi-steep removals on transversal breakage, removing the breakage scar
- L. transversal breakage
- H. flat, small removals from the base, edge correction
- K. semi-steep removals, base formation
- M. single removal blunting the base
- J. semi-flat, partly hinged removals, surface thinning
- D. hinged removals, edge formation, thinning
- I. semi-flat, broad removals, surface/edge formation
- C, B, A. flat removals, surface formation
- G. broad removals, surface thinning



# Plate 154 Rörshain Rh\_83

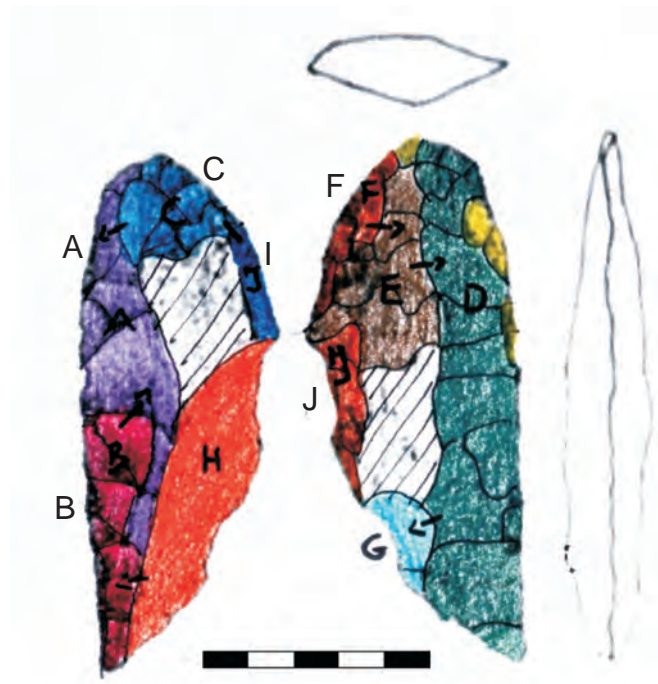


Big preform with transversal breakage in the middle of its length, and base formed by abrupt removal. It was abandoned at the stage of surface formation. One of edges (edge I) is straight in profile, the other one (edge II) was blunted near the base.

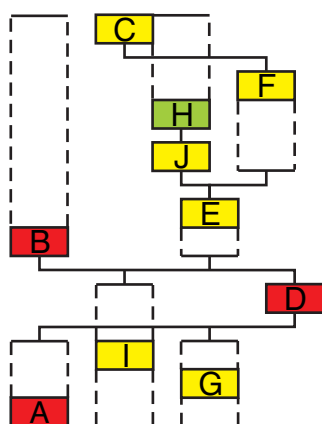


- K. transversal breakage, caused perhaps by a removal from sequence G
- G. edge thinning removals on the lower face
- H. hinged removals on the lower face along the edge, unsuccessful thinning
- F. flat removals on the lower face, surface formation
- E. single, flat removal from the initial stages of manufacturing process
- C. semi-flat removals on the upper face, edge formation
- D. semi-steep removals along the edge and the base on the upper face, edge formation
- A. flat, broad, very invasive removals, surface formation
- I. flat, broad removals on the lower face, surface formation
- B. base blunting, edge angle formation, initial stages of manufacturing process

## Plate 155 Rörshain Rh\_88



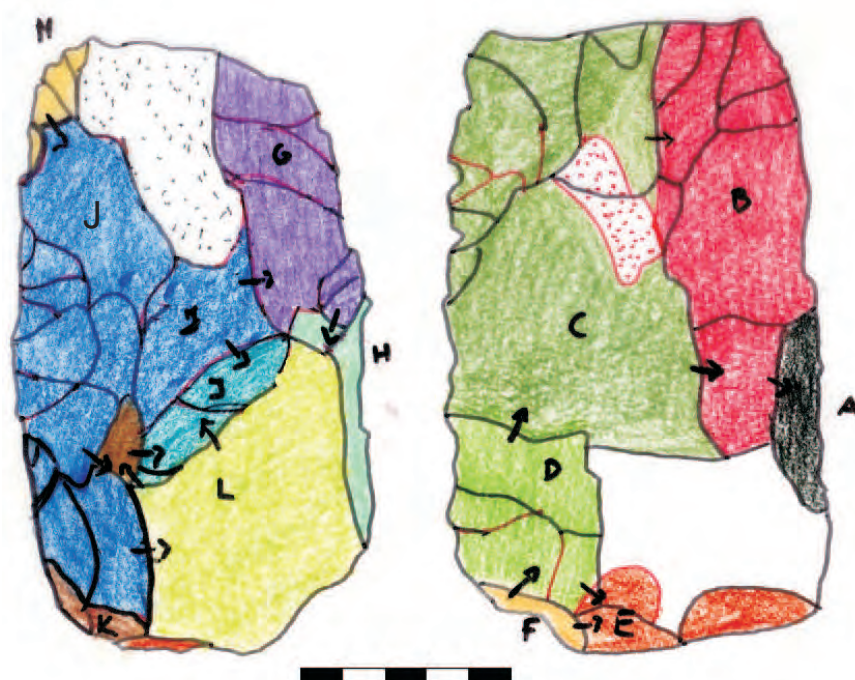
Tip part of broken tool with breakage in the form of overpassed percussion removing the tip (remaining) part. Tip is unexposed and unretouched. The tool was broken in the middle of manufacturing process; therefore, it was not fully decorticated. Perhaps resharpened and used after breakage.



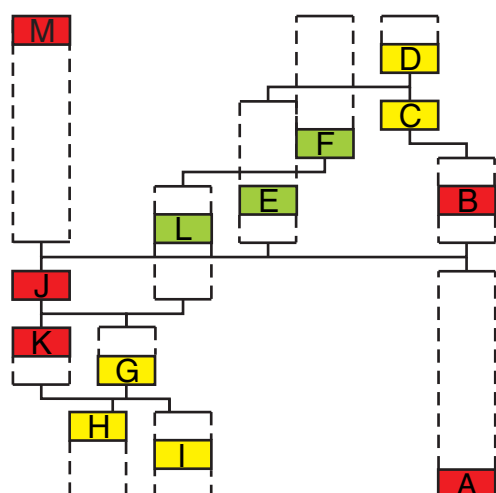
- H. transversal breakage after a hinged removal (sequence J)
- J. flat, hinged removal aimed at decortivating the surface, caused breakage
- C. flat retouch near the tip
- F. flat, marginal retouch near the tip
- E. flat removals, surface decortication near the tip
- B. flat removals, edge formation
- D. decortivating removals, surface formation
- A. flat, broad removals, surface formation, decortication
- I. unsuccessful decortivating removal, surface formation
- G. flat, deep removals, surface formation, decortication



# Plate 156 Rörshain Rh\_89

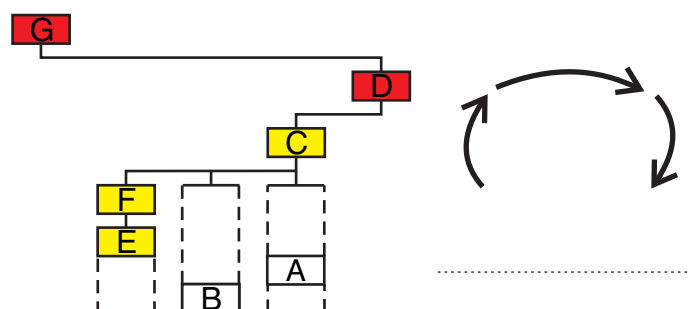
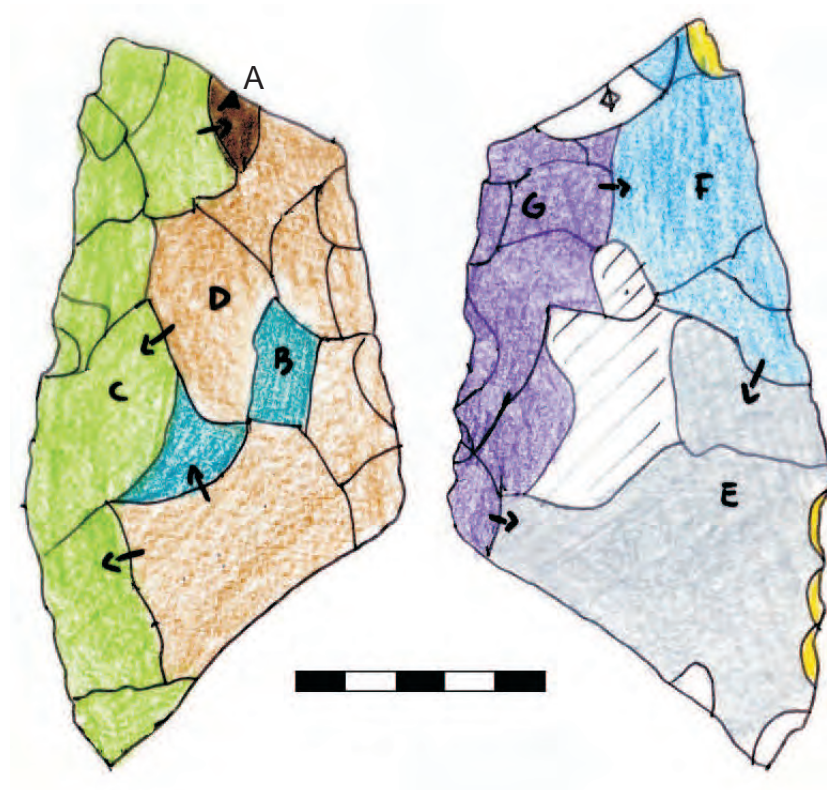


Preform of bifacial tool with transversal breakage at the tip; abandoned at the stage of surface decortication and thinning.



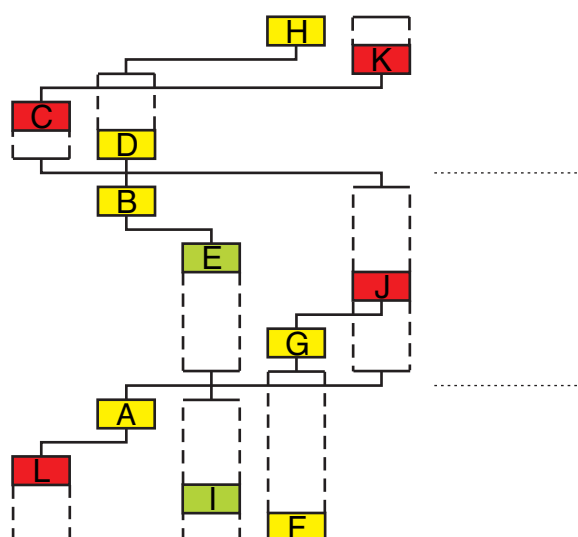
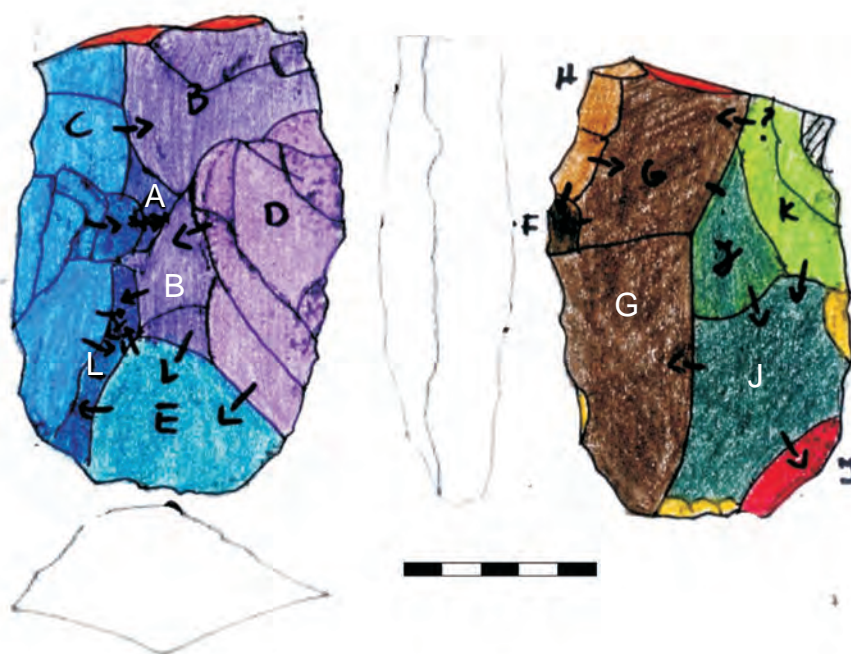
- H. hinged removals, middle part of tool thinning
- D. flat removals, near-the-base surface thinning and decortication
- B, C. flat removals, surface formation
- J. flat, hinged removals, unsuccessful thinning
- K. semi-steep removals near the base, surface formation
- G, M. flat removals, surface decortication and formation
- L. deep removals near the base, surface formation, thinning, partly the consequence of unsuccessful thinning (sequence J)
- E. steep removals, edge angle preparation before further sequence L
- F. edge angle preparation or unsuccessful base thinning
- H, I, A. initial surface formation

# Plate 157 Rörshain Rh\_91



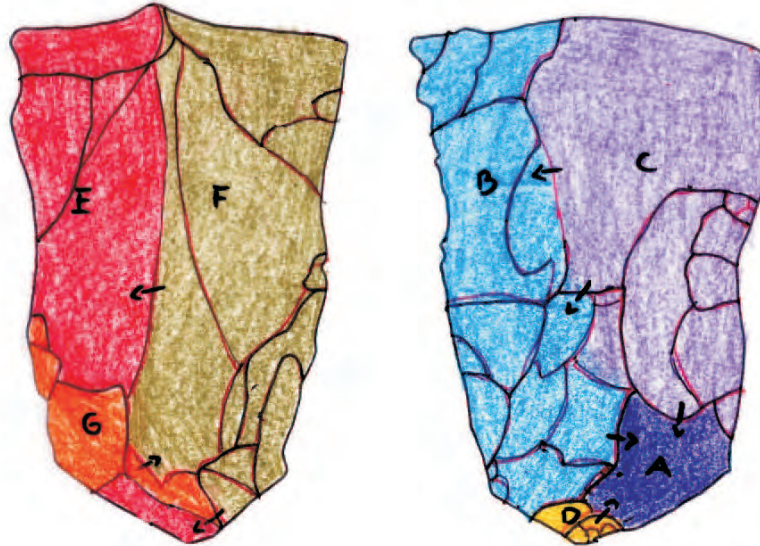
- G. steep removals, surface formation, partly unsuccessful thinning which blunted the edge
- D. hinged removals, surface formation, unsuccessful thinning in the middle part of tool,
- C. flat and semi-flat removals on the upper face, surface formation
- F. flat removals on the lower face, surface formation
- E. flat removals on the lower face, surface formation
- B. highly damaged/eroded scars of earlier phases of tool thinning in its middle/thickest part
- A. flat removals, surface formation, perhaps analogical to sequence B

# Plate 158 Rörshain Rh\_92

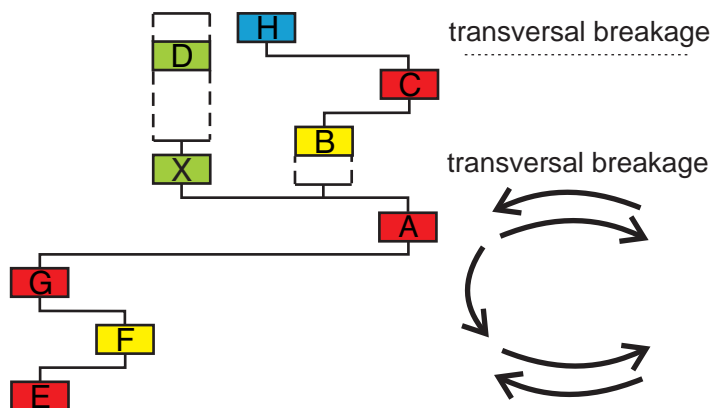


- H. semi-flat, marginal removals, perhaps one of them caused the transversal breakage
- K. hinged removals aimed at thinning the preform, crea a big notch
- C. semi-flat, marginal removals, surface formation
- D. hinged removals, aimed at thinning the preform, deep removals do not reach the other side, cause concavity next to the edge and create a hinge in the thickest part of tool
- B. flat, broad, parallel removals, surface formation
- E. semi-flat removals derived from the base, base thinning
- J, G. flat, broad, parallel removals, surface formation,
- F. single, semi-steep removal next to the edge, remnants of earlier reduction phases
- A. flat removals, surface formation, perhaps analogical to sequence B
- L. flat removals, surface formation
- I. single, steep removal, base formation

# Plate 159 Rörshain Rh\_93



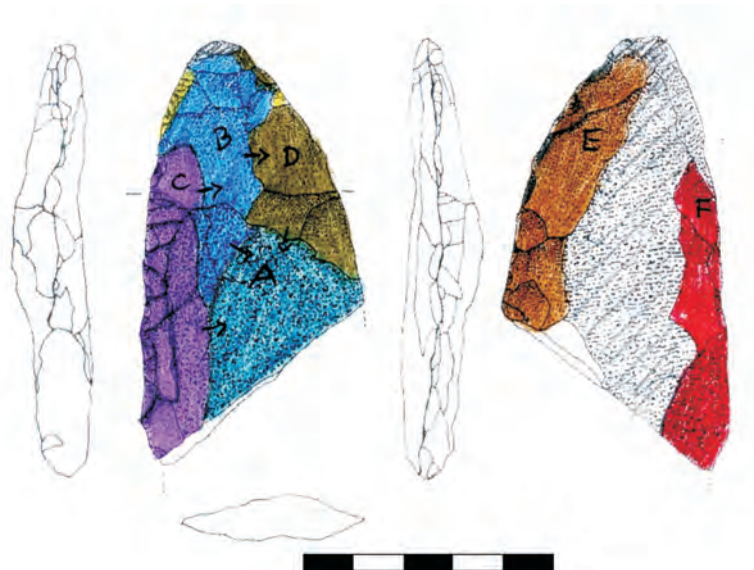
Big preform broken transversally in the middle of its length, with base formed by natural surfaces or two transversal breakages located angularly to vertical axis.



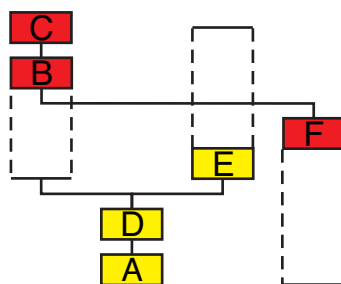
- D. flat removals on the upper face derived from the base, near-the-base part correction
- C, B. flat removals on the upper face, surface formation
- A. single, flat, broad removal, earlier stages of surface formation
- G, E. flat removals on the lower face, surface formation
- F. flat, partly hinged removals on the lower face, surface formation
- H, X. transversal breakage or natural surface at the base, angular to vertical axis



# Plate 160 Rörshain Rh\_101



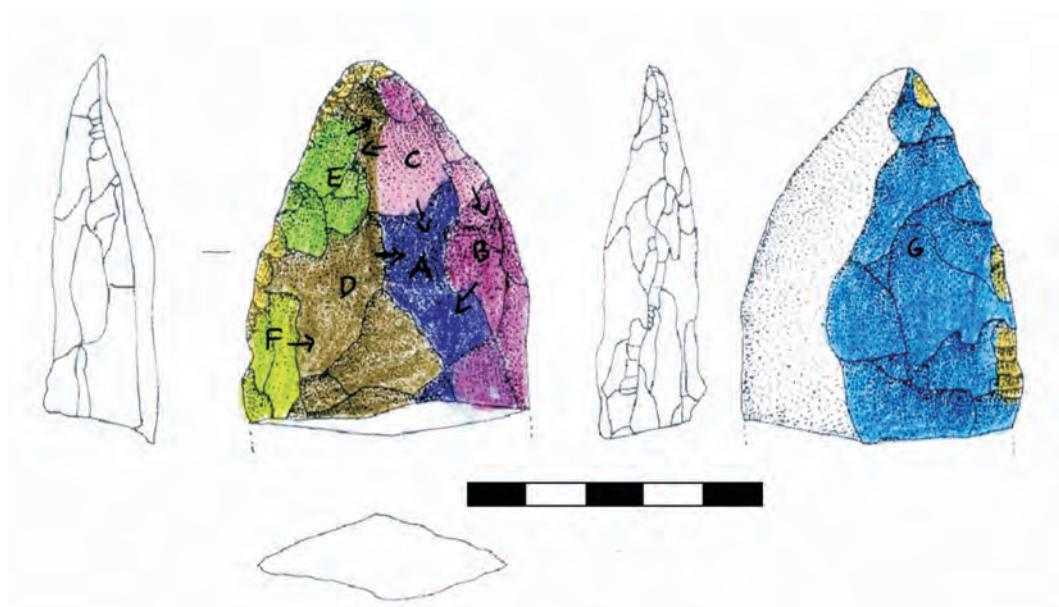
Big tool with transversal breakage at the base, located angularly to axis. One of edges was retouched (sequence C), and the second edge is roughly worked and S-shaped in profile.



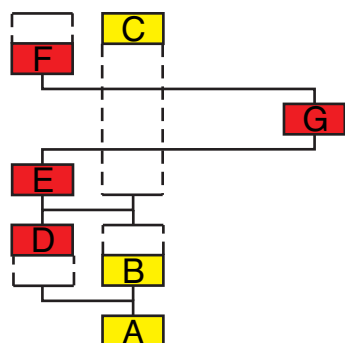
- E. flat removals, surface decortication and formation
- D. semi-flat removals, surface formation
- C. flat, small removals, edge formation
- B. flat, broad, partly hinged removals, partly unsuccessful thinning, surface formation
- F. flat removals, surface decortication and formation
- A. flat removals, surface formation



# Plate 161 Rörshain Rh\_102

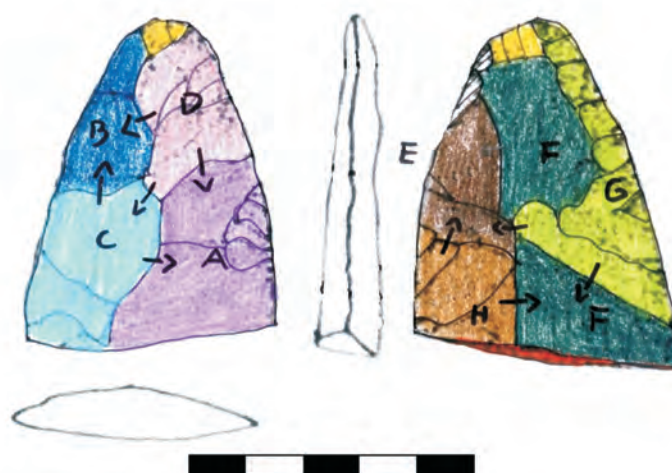


Tool with base formed by transversal breakage, and one edge blunted (sequence B). Only the near-the-tip part of distal posterior edge and the whole opposite edge were retouched.

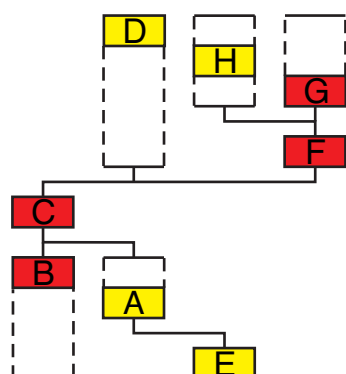


- C. flat removals on the upper face near the tip, edge formation/resharpening (?)
- F. steep, hinged retouch near the tip on the upper face, unsuccessful thinning
- G. flat removals on the lower face, thinning, ventral flake surface flattening
- E. flat removals on the upper face, edge correction
- D, A. flat removals on the upper face, surface formation
- B. steep removals on the upper face, unsuccessful thinning near breakage (?)

# Plate 162 Rörshain Rh\_103

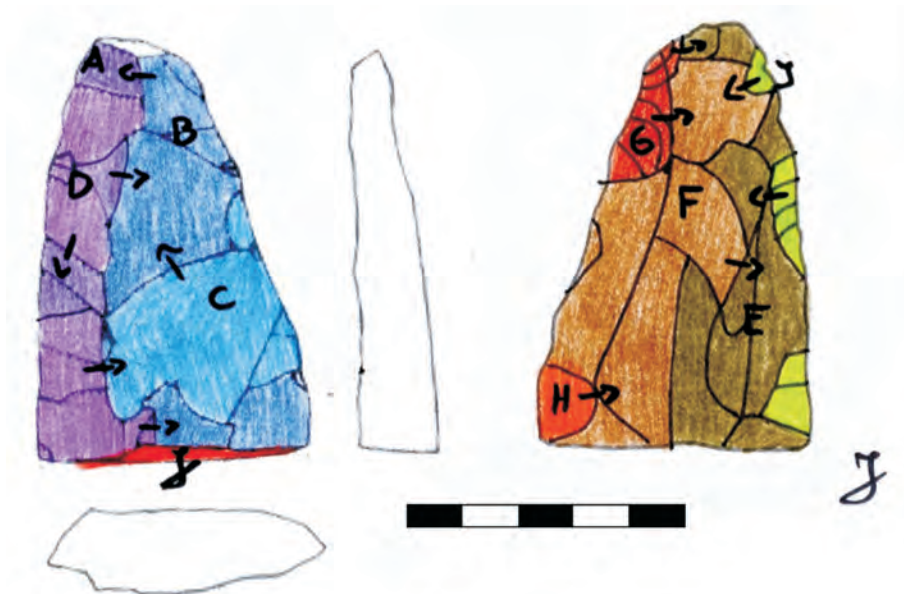


Biconvex tool with poorly exposed, unretouched tip, analogical formation of both surfaces and transversal breakage near the base. It was retouched alternately near the tip. Perhaps sequences H and C were derived after breakage.

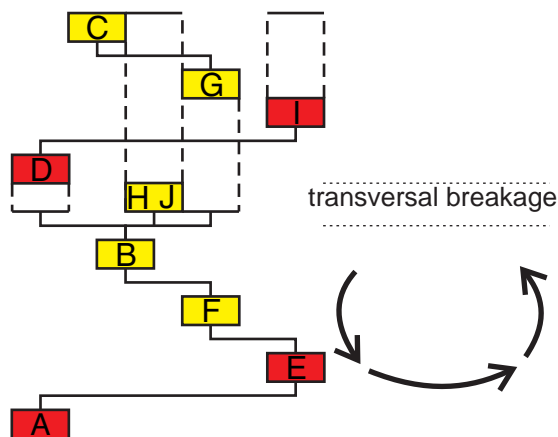


- D. flat retouch near the tip, edge rejuvenation/resharpening (?)
- H. thinning removals on the lower face
- G. flat, fine retouch on the lower face
- F. flat, broad removals on the lower face, surface/edge formation
- C, B. semi-flat removals on the upper face, edge formation
- A. flat, broad removals on the upper face, surface/edge formation
- E. single, flat removal on the lower face, surface/edge formation

# Plate 163 Rörshain Rh\_104

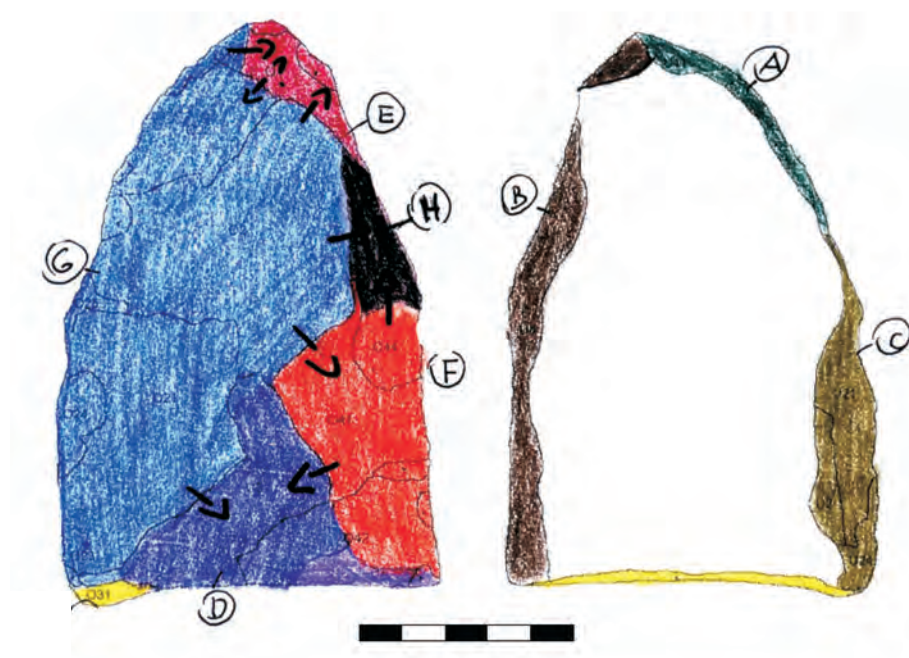


Tool with transversal breakage at the base and the tip. Rejuvenated after breakage near the base. Breakage at the tip exists from the beginning of manufacturing process, which is visible on surface. Tip is now exposed and transversal surface was not removed. There was no care for symmetry during formation process. One of edges is more S-shaped in profile and retouched semi-steeply near the tip, the other is more straight and finely retouched.

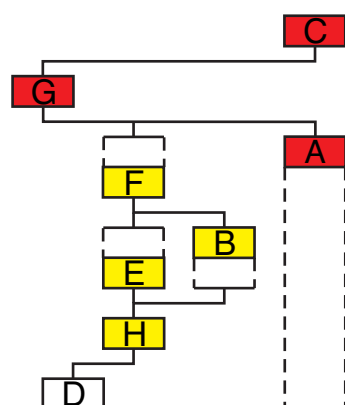


- J. transversal breakage
- H. semi-flat removals which could cause breakage (sequence J)
- C. flat removals on the upper face, flattening
- G. flat removals on the lower face, aimed at removing hinged scars near the tip
- I. irregular retouch on the lower face, edge correction
- D. retouch on the upper face: semi-flat near the tip and semi-steep near the breakage
- B. flat removals on the upper face, surface/edge formation
- F, E. flat removals on the lower face, surface/edge formation
- A. semi-flat removals on the upper face, surface formation

# Plate 164 Rörshain Rh\_105

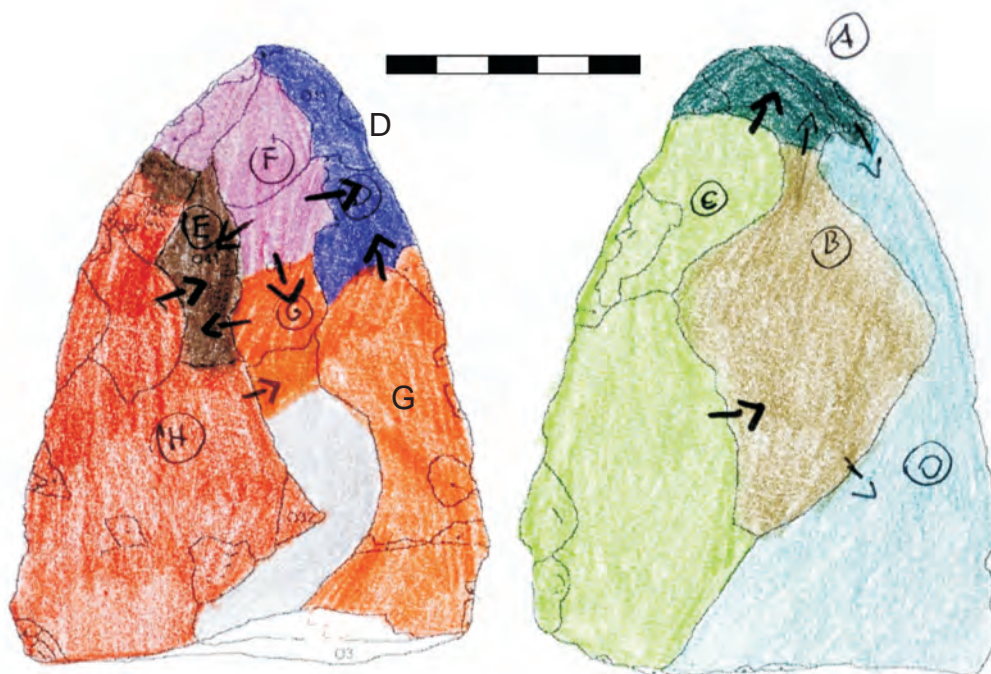


Big preform with transversal breakage at the base. Abandoned at the stage of unsuccessful decortication. Transversal breakage could have appeared at the beginning of manufacturing process.

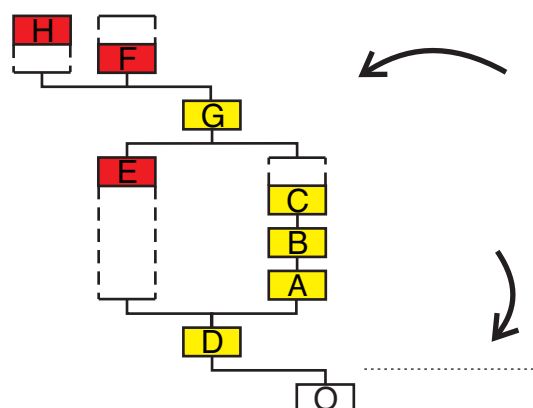


- C. hinged removals, unsuccessful initial decortication
- G, D, E. flat, broad removals, surface thinning, formation
- F. flat removals, surface formation
- H. ventral surface of a flake or earlier stages of surface formation
- B. flat, hinged removals, unsuccessful decortication
- A. semi-steep removals, decortication, edge angle preparation before deriving flat removals on the opposite surface

# Plate 165 Rörshain Rh\_107



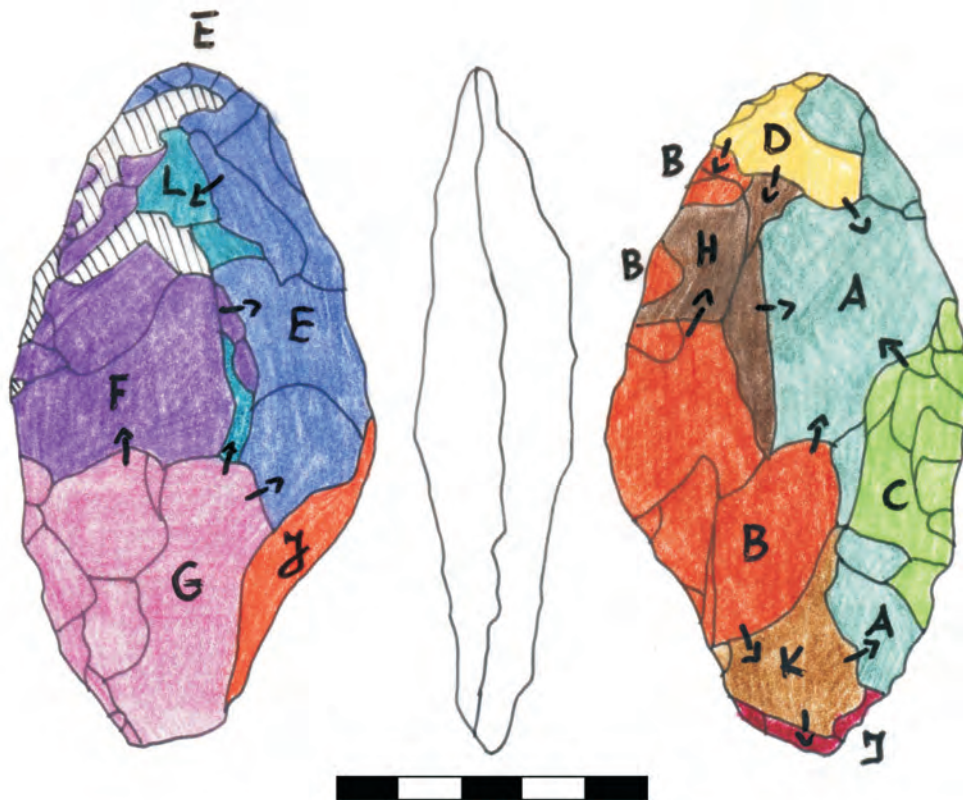
Big preform made on a flake with transversal breakage at the base. Abandoned at the stage of surface formation and thinning.



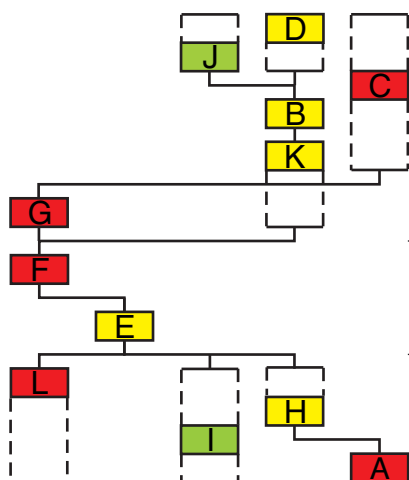
- F. flat removals on the upper face near the tip, surface thinning
- H, E. flat, broad removals on the upper face, surface thinning
- G. flat, broad, partly hinged removals on the upper face, surface thinning
- C, B, A. flat removals on the lower face, surface formation
- D. semi-steep removals, earlier stages of manufacturing process
- O. ventral surface of a flake



Plate 166 Rörshain Rh\_109

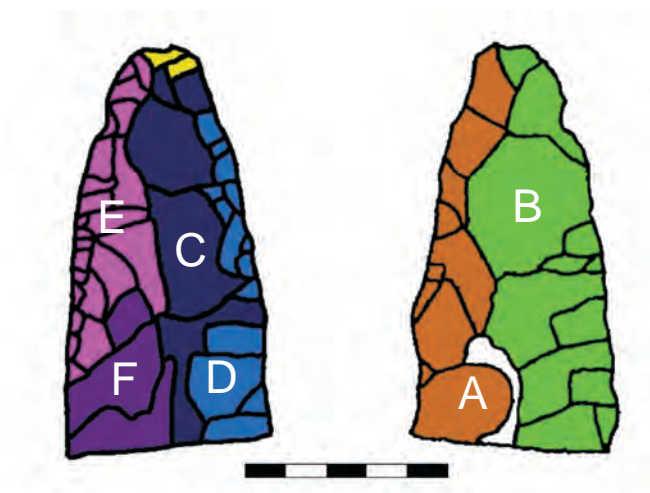


Plano-convex knife with one retouched cutting edge, two breakage scars at the base and unworked back. Surface is highly eroded; therefore, scars are not well visible.

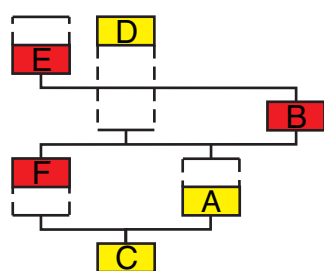


- M. heavily eroded scars, near-the-tip part thinning
- C. flat removals, aimed at removing the thick middle part of tool, analogical to sequence B
- G. thinning, edge formation
- F. flat removals, thinning, removing the hinged scars, surface formation
- E. semi-steep removals, surface thinning
- B. flat, irregular removals aimed at removing the thick middle part of tool, analogical to sequence C
- D. flat removals, tip formation
- H, A, K, J. flat removals, surface formation
- L. flat, broad removals, earlier phases of manufacturing process, almost entirely removed

# Plate 167 Rörshain Rh\_110

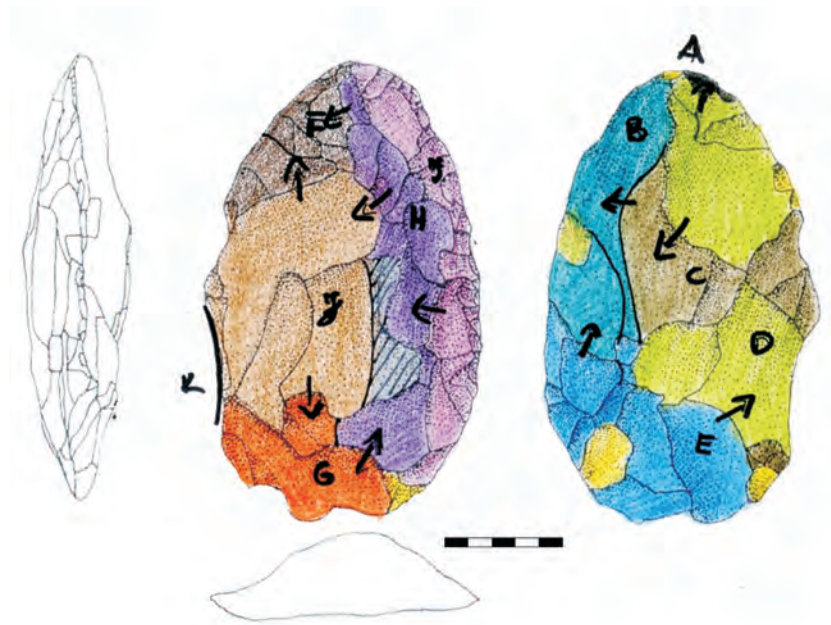


Tool broken transversally near the base, with two symmetrical edges and unexposed tip. No traces of edges resharpening or rejuvenation after breakage. Retouch near the tip symmetrised the tool.

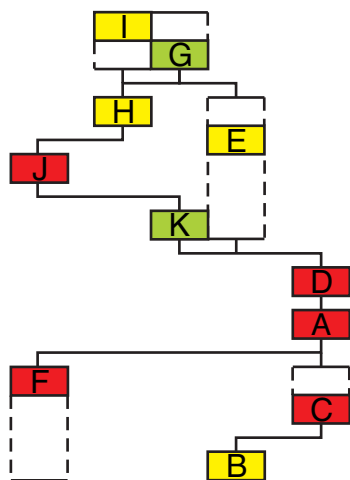


- D. small, partly hinged removals on the upper face, edge formation/retouch
- E. semi-flat removals on the upper face, edge formation, thinning
- B. flat removals on the lower face, edge formation
- F. far going removals on the upper face, surface formation
- A. flat removals on the lower face, surface formation
- C. semi-flat removals on the upper face, surface formation

## Plate 168 Rörshain Rh\_113

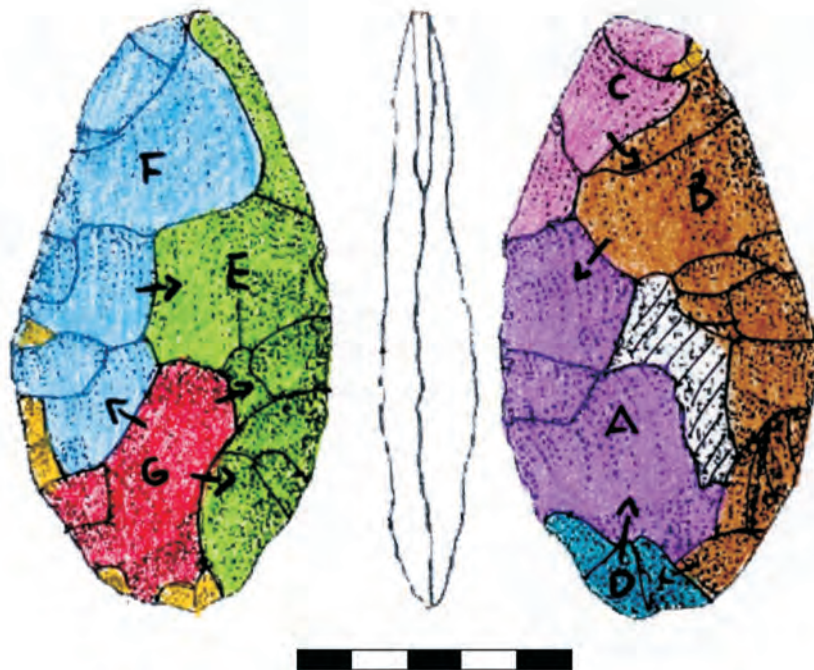


Plano-convex knife with blunted back, unexposed tip, cutting edge retouched along the whole length and base which remains roughly worked. Fine retouch was derived on both edges only near the tip.

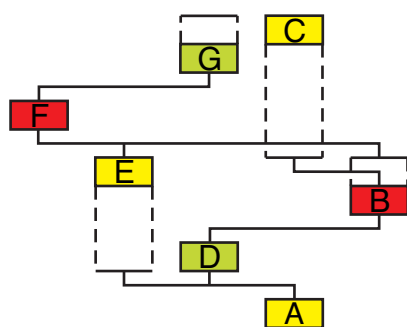


- I. regular removals on the upper face, cutting edge sharpening/resharpening (?)
- H. flat/semi-flat removals on the upper face, cutting edge formation
- J. flat, broad, partly hinged removals on the upper face, unsuccessful thinning from the back edge
- G. flat removals, back and base formation
- E. flat removals on the lower face, base formation and thinning near the cutting edge part of base, probably aimed at removing the flake butt
- D. flat removals on the lower face, surface thinning, formation
- F. distal posterior edge formation on the upper face
- A. remains of scars on the lower face at the tip, earlier phases of manufacturing process
- C, B. flat, broad removals on the lower face, surface formation
- K. abrupt surface or breakage forming the back surface

# Plate 169 Rörshain Rh\_114



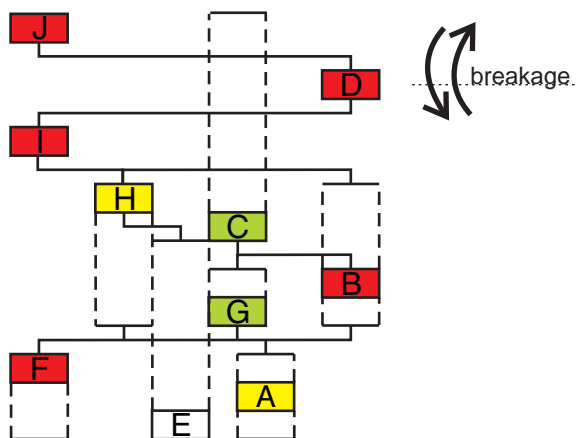
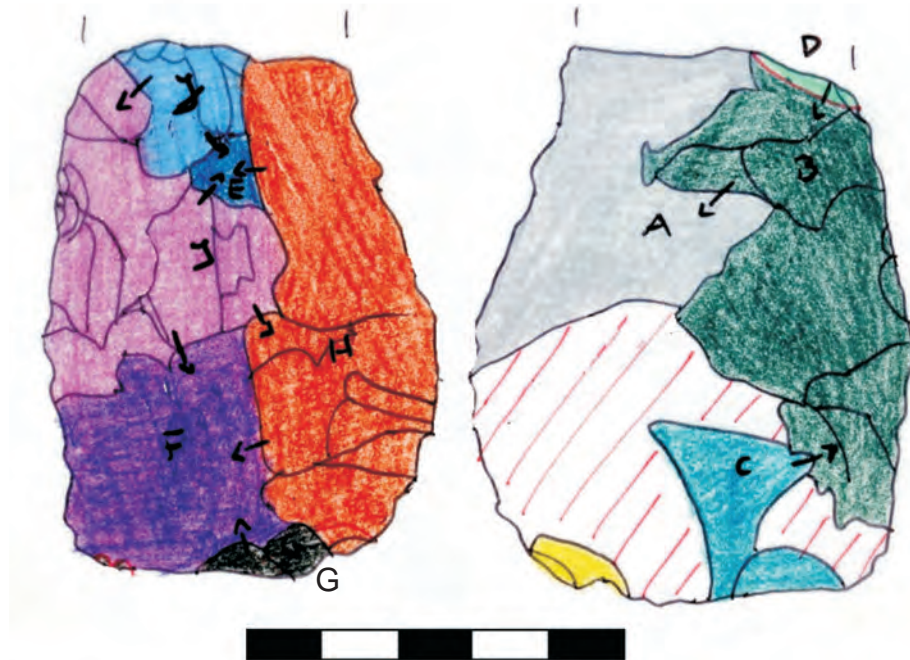
Thin tool with highly eroded surface. All scars are barely visible, which makes analysis very difficult. Two concave edges converge at the unexposed tip. Last removals were derived from the tip. The tool has no blunted back and base was formed as a concave edge. Edge I is more S-shaped in profile than edge II.



- C. flat removals on the lower face
- G. flat removals on the upper face, derived from the base
- F. flat removals on the upper face, surface formation
- E. flat, broad removals on the upper face, surface formation
- B. flat, partly hinged removals on the lower face, unsuccessful surface flattening and formation
- D. flat removals on the lower face, base formation
- A. flat removals on the lower face, surface formation



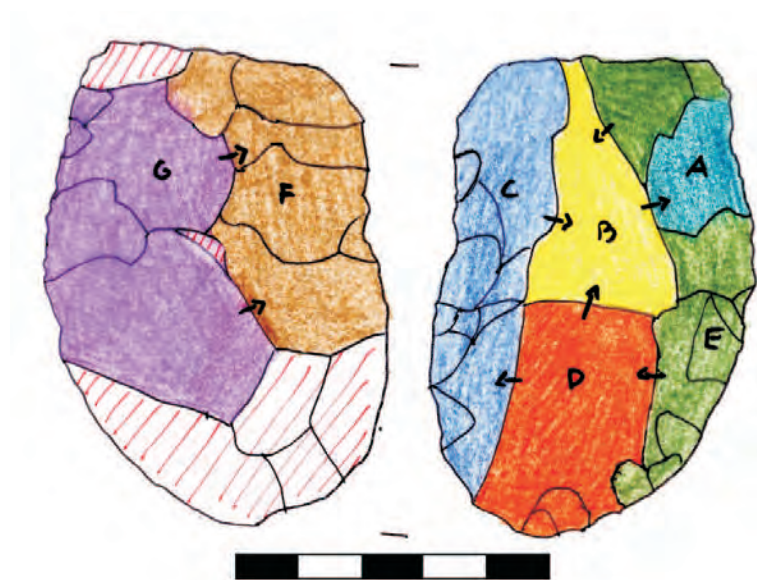
# Plate 170 Rörshain Rh\_127



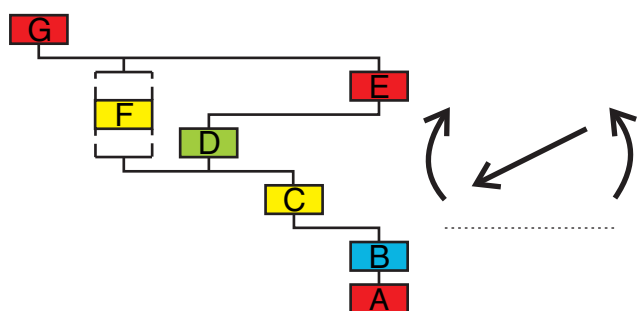
- J. flat, hinged removals, derived from the edge of transversal breakage (at the tip)
- D. transversal breakage
- I. flat and semi-flat, partly hinged removals, surface formation
- H. semi-flat, regular removals, surface formation
- C. flat removals on the lower face derived from the base, surface formation
- G. semi-steep removals, base formation
- B. flat removals on the lower face, surface formation
- A. single, flat removal on the lower face, probably derived from the tip, surface formation
- F. single, semi-flat removals on the upper face, surface formation
- E. removal scar or natural surface, perhaps from the stage of surface formation



# Plate 171 Rörshain Rh\_140

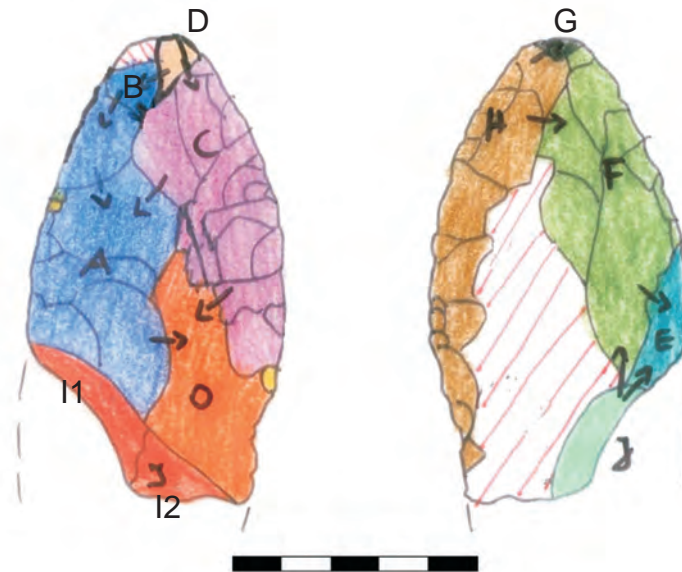


Bent tool, transversally broken in its half; with traces of axis correction by thinning removals on the lower face. Rejuvenated after breakage (sequence G). Convex working edge was formed at the opposite end, and was perhaps used as the tip.

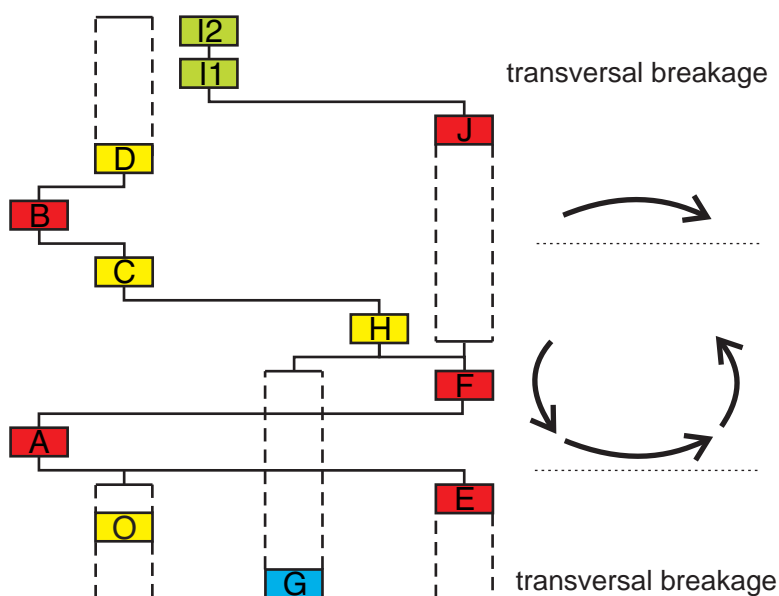


- G. flat removals on the upper face, decortication, surface formation
- F. flat and semi-flat removals on the upper face, decortication, surface formation
- E. thinning, partly hinged removals on the lower face, surface formation
- D, E. single, thinning removal on the lower face
- C. flat, partly hinged removals, thinning
- A. initial phase of manufacturing process, surface formation

# Plate 172 Wahlen WH\_4c

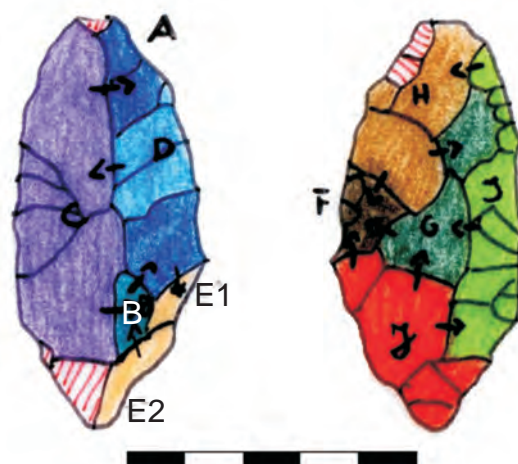


Tool made on a cortical flake, with transversally broken base and poorly exposed tip. Transversal breakage or natural, abrupt surface left at the tip. Tip remained unretouched, although there are traces of tip thinning (sequences D, B) at the last stage of chaîne opératoire. Base was remodeled after breakage to remove the acute angle and blunt the base.

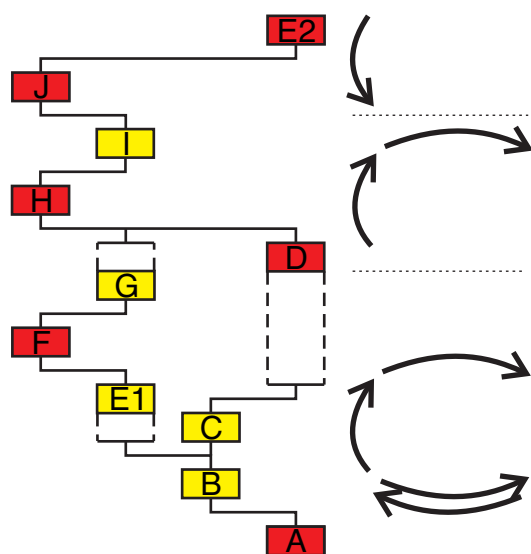


- I2. single, steep removal derived on the breakage scar, base remodeling
- D, B. small removals on the upper face at the tip, tip thinning
- C. semi-flat, precise removals on the upper face, edge sharpening
- H. removals on the lower face, decortication, edge angle formation
- F. flat removals on the lower face, decortication, edge formation
- A. flat, broad removals on the upper face, surface formation, thinning
- E. flat scar, earlier phases of manufacturing process
- J. very deep, flat removal on the lower face, earlier stages of manufacturing process
- G. transversal breakage or steep scar at the tip
- I1. transversal breakage at the base
- O. ventral surface of a flake

# Plate 173 Wahlen WH\_5c

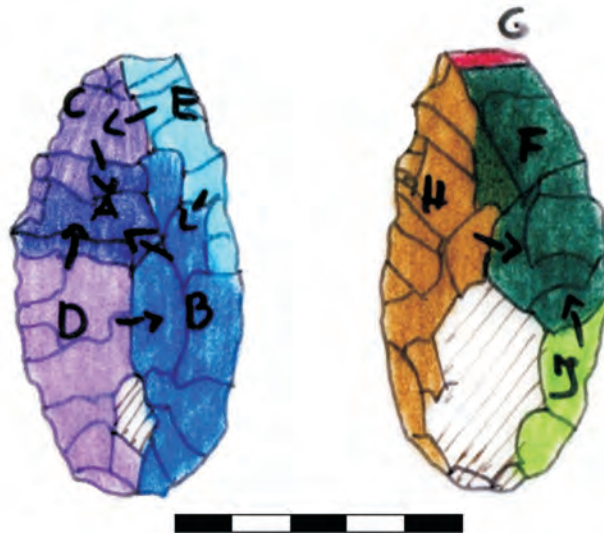


Plano-convex, exhausted knife with single cutting edge, poorly exposed tip and blunted back. Cutting edge and near-the-tip part were rejuvenated several times.

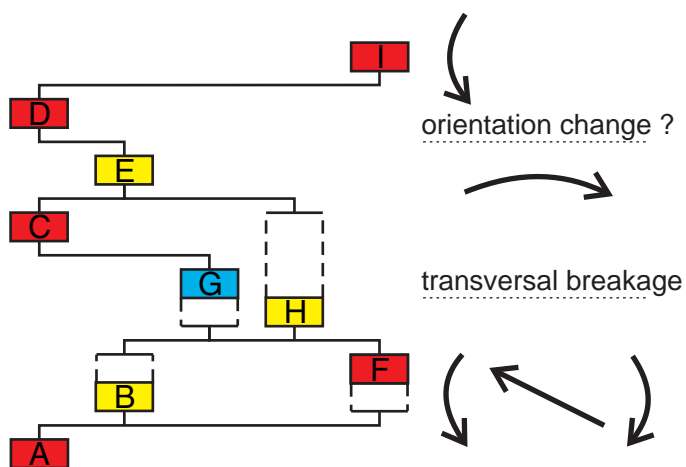


- E2, E1. steep removal on the lower face near the base, back formation, edge blunting
- J. flat removals on the upper face, near-the-base part thinning
- I. flat, marginal retouch on the upper face, edge resharpening
- H. semi-flat removals on the upper face near the tip, edge thinning, rejuvenation
- G. flat and semi-flat removals on the upper face, edge formation, earlier stage of edge resharpening (?)
- F. steep removals on the upper face, back edge formation, rejuvenation
- D. single, semi-steep removal on the lower face, edge angle correction
- C. flat removals on the lower face, surface formation, thinning
- B. flat scar, surface formation
- A. semi-flat, broad removals on the lower face, edge/surface formation

# Plate 174 Wahlen WH\_34a

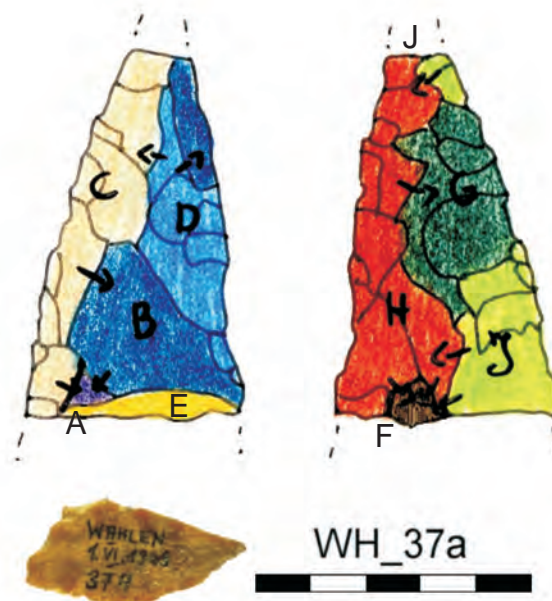


Plano-convex knife with broken tip. Near-the-tip parts of both edges were remodeled after breakage, and the tip itself was blunted on the lower face. Resharpener sequence E was not successful, and tool orientation was changed probably at last rejuvenation stage. The near-the-base part of one of edges was then precisely sharpened (sequence D).

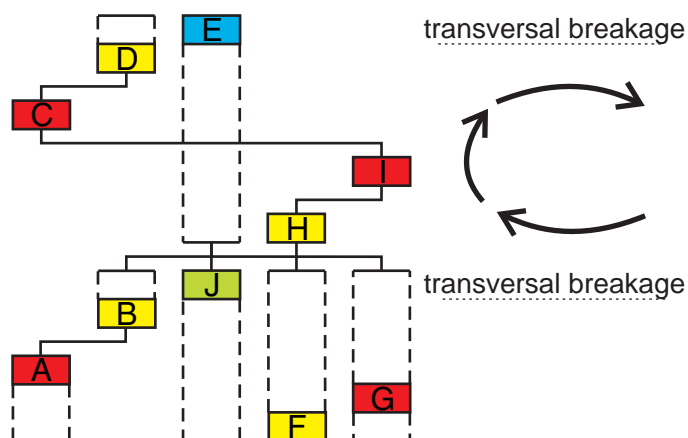


- I. semi-flat removals on the lower face near the base, edge formation, orientation change (?)
- D. flat, precise retouch on the upper face near the base, edge resharpener, orientation change (?)
- E. hinged removals on the upper face near the tip, unsuccessful edge resharpener
- C. flat removals on the upper face near the tip, edge resharpener, remodeling after tip breakage
- G. transversal breakage of tip and its remodeling by three steep removals on the lower face, derived after breakage
- H. flat removals on the lower face, edge and edge angle formation
- B. steep removals on the upper face, edge formation, rejuvenation (?)
- F. flat removals on the lower face, surface formation, thinning
- A. flat removals on the upper face, surface formation, thinning

## Plate 175 Wahlen WH\_37a



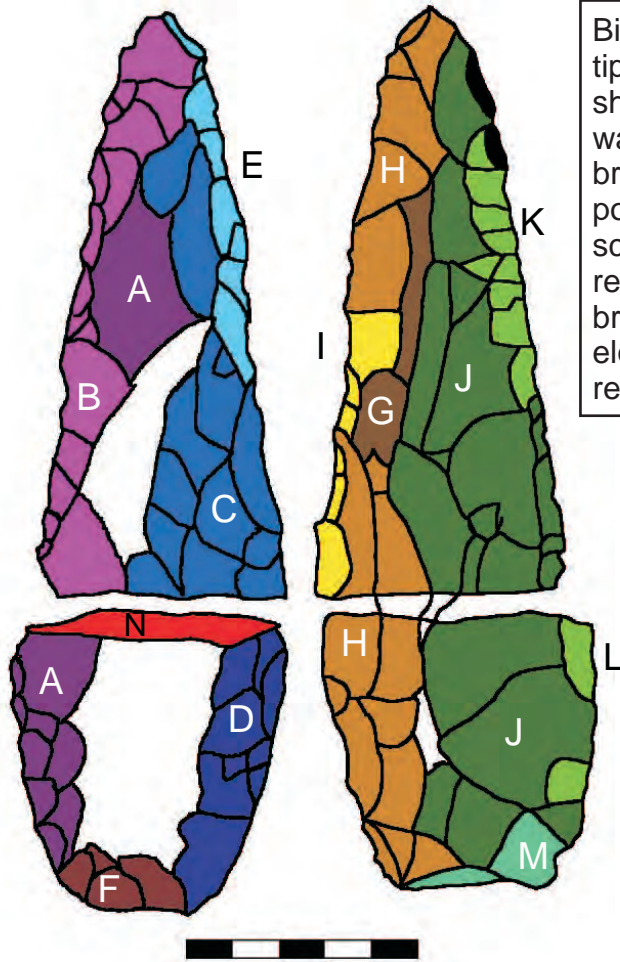
Plano-convex, triangular tool with broken base and tip. Edge II was more steeply knapped and blunted near the base. It is not sure if the tool was rejuvenated after breakage at the base. It was definitely remodeled after breakage at the tip, although the tip was not fully exposed.



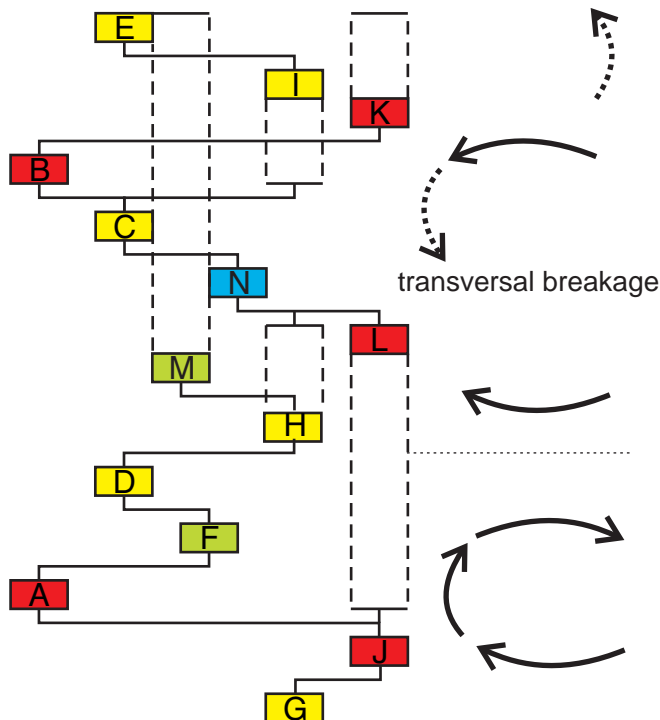
- D. semi-steep removals on the upper face, edge shaping, rejuvenation (?)
- H. flat, partly hinged removals on the lower face, edge formation
- C. steep, partly hinged removals on the upper face, more flat near the tip, edge formation
- I, G. flat removals on the lower face, edge angle formation, surface formation
- F. flat scar on the lower face, earlier stages of manufacturing process
- A. semi-flat scar on the upper face, earlier stages of manufacturing process
- B. flat and semi-flat, broad removals on the upper face, surface formation, thinning
- E. transversal breakage at the base, probably caused by one of removals belonging to sequence C (?)
- J. transversal breakage at the tip



# Plate 176 Wahlen WH\_49

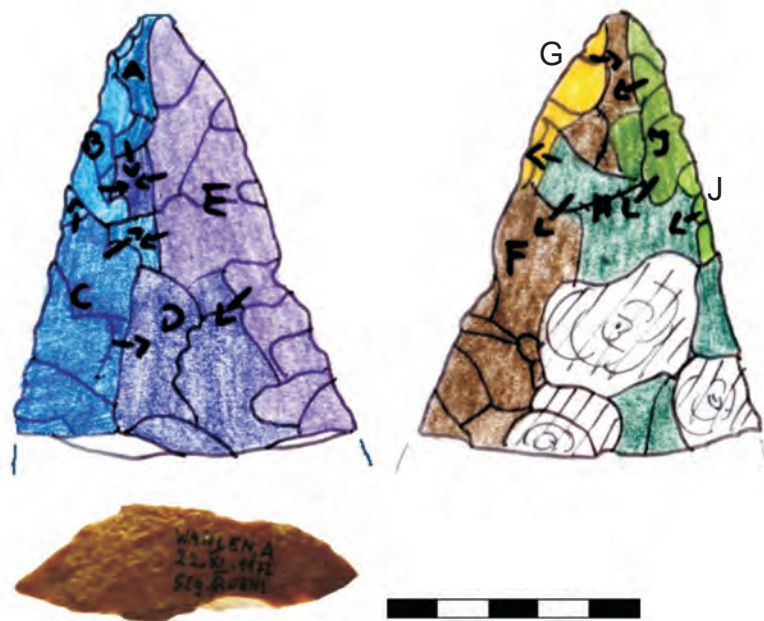


Biconvex tool with broken base, refitted, tip was remodeled after breakage, shaped and retouched, breakage scar was polished, base was not used after breakage except for using it as a polishing slab, probably for breakage scar. Traces of grinding and eroded removal scars on the upper face of broken base part. Tip was shaped into elongated triangle; no traces of resharpening or rejuvenation.

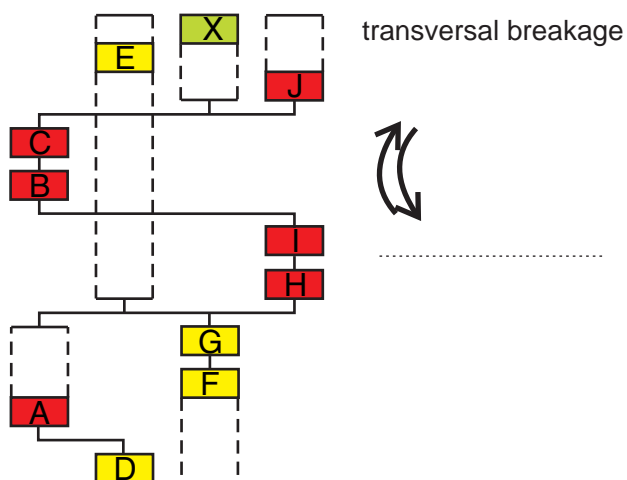


- E. flat, hinged retouch on the upper face near the tip, edge correction, shaping, sharpening
- I. irregular, marginal removals on the lower face, edge correction
- K. marginal removals on the lower face, edge correction
- B, C. partly hinged removals on the upper face, edge formation, shaping and sharpening
- N. transversal breakage, impact point in the middle of the upper face
- L. removals on the lower face near the base, edge formation
- M. steep removals on the lower face, base formation
- F. flat removals on the upper face, edge angle formation for sequence M
- H. steep and semi-steep removals on the lower face, more flat near the tip, surface formation, thinning
- D. semi-steep removals on the upper face, surface formation, thinning
- A. semi-flat, broad removals on the upper face, surface formation, thinning
- J. semi-flat, partly hinged removals on the lower face, surface formation, thinning, decorticating
- G. flat, broad removals on the lower face, surface formation, thinning

# Plate 177 Wahlen WH\_52g

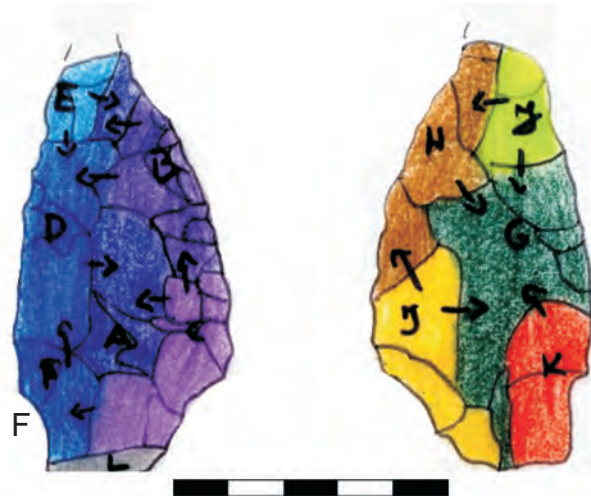


Plano-convex tool with transversally broken base, straight edges and exposed tip. Edge I was more precisely retouched, but it can be due to hinged B sequence which damages the opposite edge. No traces of remodeling or rejuvenation after breakage.

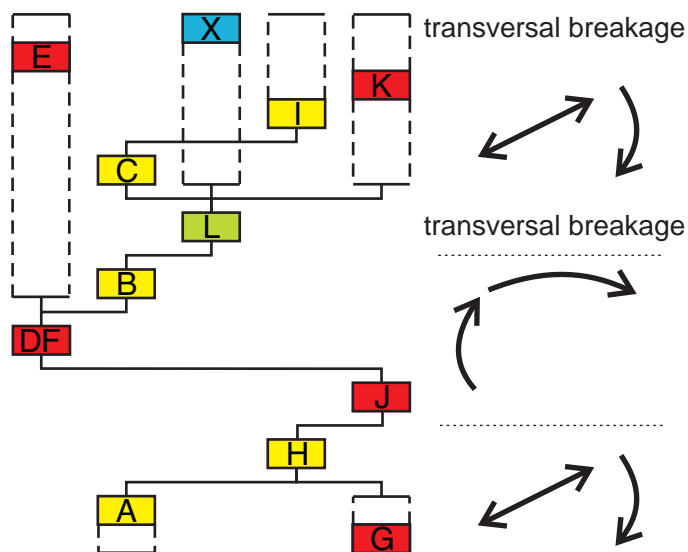


- E. semi-flat/semi-steep, regular removals on the upper face, edge formation, sharpening
- J. marginal truncations on the lower face
- C. semi-flat removals on the upper face, edge thinning
- B. hinged removals on the upper face near the tip, unsuccessful thinning
- I, G. flat, small removals on the lower face near the tip, edge angle formation
- H, F. flat, broad removals on the lower face, surface formation
- A. flat scars on the upper face, earlier stages of surface formation
- D. flat and semi-flat, broad removals on the upper face, surface formation

# Plate 178 Wahlen WH\_52g-C13

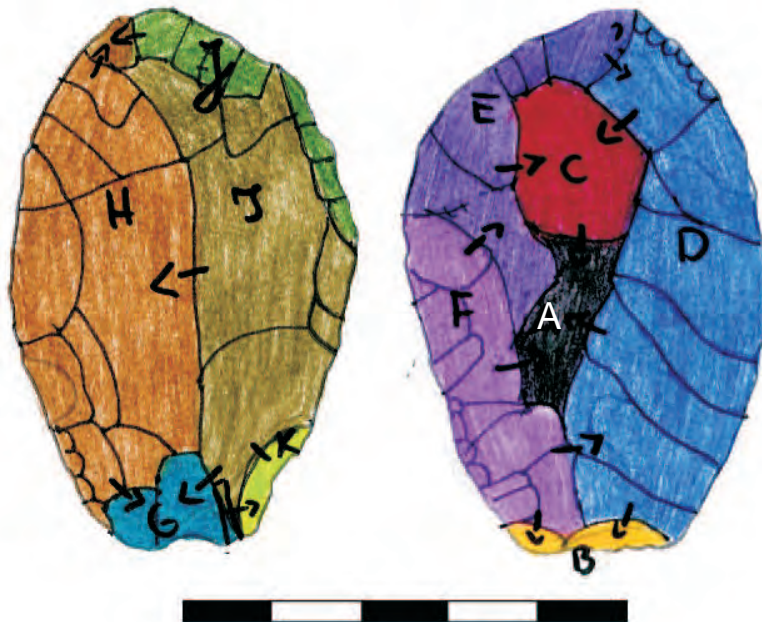


Plano-convex tool with broken base and tip, remodeled after each breakage. Both edges were rejuvenated; one of them, which is more straight, was treated more precisely (edge II) and bears traces of resharpening. The second edge is curved in line and S-shaped in profile.

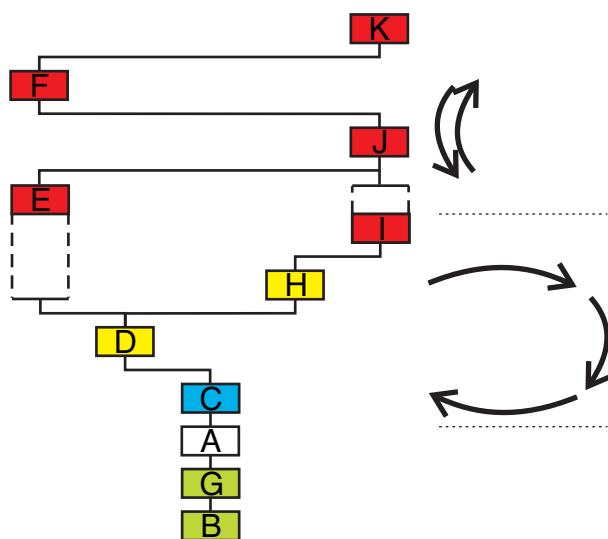


- E. small, marginal removals on the upper face near the tip, probably caused the tip breakage
- J. removals on the lower face near the tip, edge angle correction, thinning
- K. deep removals on the lower face near breakage, edge correction, unsuccessful thinning, created a tang near the breakage
- I. steep removals on the lower face near breakage, back edge formation after breakage, created a tang near the breakage
- C. removals on the upper face near breakage, edge angle formation before sequence I
- L. transversal breakage at the base
- B. flat/semi-flat retouch on the upper face, edge sharpening
- D, F. semi-flat removals on the upper face, edge formation
- H. semi-steep removals on the lower face near the tip, edge formation
- A. flat removals on the upper face, surface formation, thinning
- G. flat removals on the lower face, surface formation, thinning

# Plate 179 Wahlen WH\_54



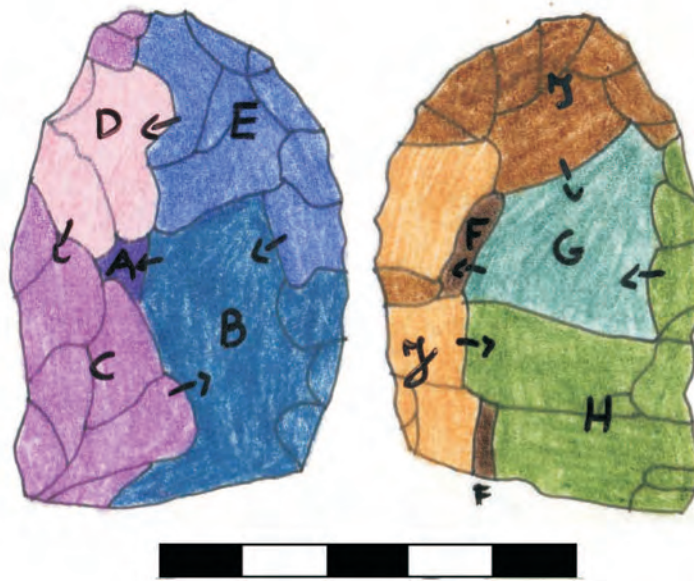
Plano-convex tool made on a flake with unexposed tip. Sequences E and J made the tip even less exposed and moved it out of vertical axis. Orientation was probably changed at the last stage of rejuvenation (edge II was retouched precisely near the base).



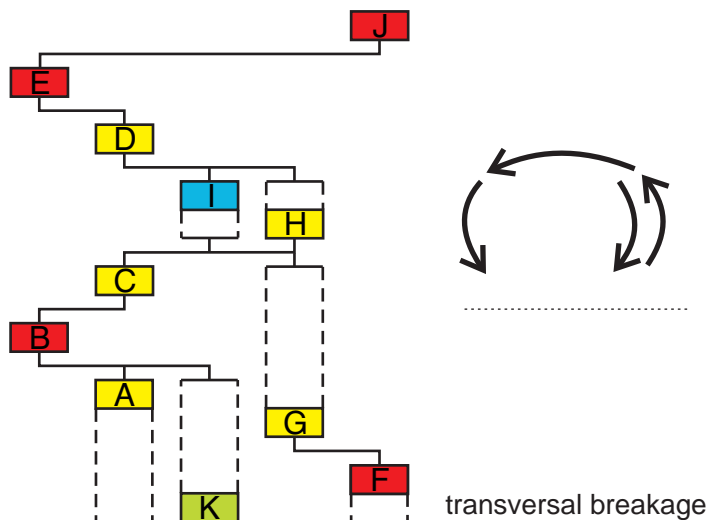
- K. single, semi-steep removal on the upper face near the base
- F. flat retouch on the lower face near the base, edge thinning, sharpening
- J. semi-flat and semi-steep, marginal removals on the upper face near the tip, edge resharpening/formation (?)
- E. flat removals on the lower face near the tip, edge thinning, edge angle formation
- I. flat removals on the upper face, surface formation
- H. flat and semi-flat removals on the upper face, surface formation
- D. very flat removals on the lower face, surface thinning, edge angle formation
- C. single, flat, broad removal on the lower face, surface thinning
- A. ventral surface of a flake
- G. scars derived before obtaining the flake
- B. semi-steep removals, probably remains of a flake butt



# Plate 180 Wahlen WH\_56



Tool with unexposed, but retouched tip and near-the-tip parts of edges. It was broken in the middle and remodeled after transversal breakage.

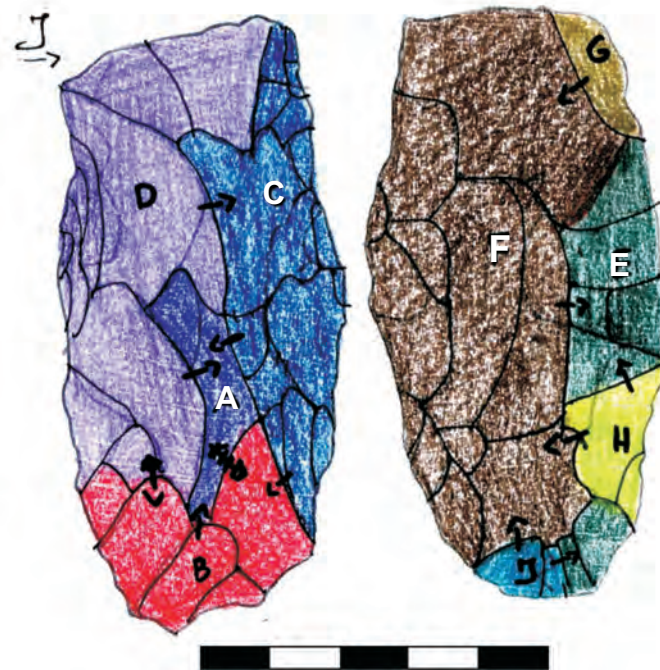


transversal breakage

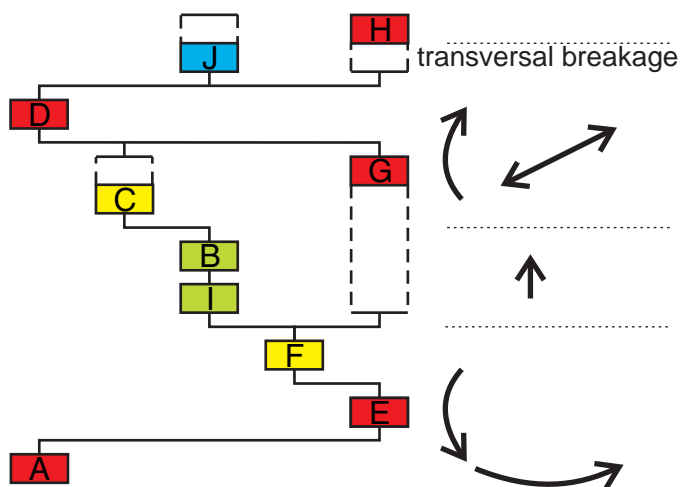
- J. flat removals on the lower face, edge sharpening
- E. flat removals on the upper face near the tip, edge sharpening
- D. semi-flat removals on the upper face near the tip, edge sharpening
- I. semi-flat removals on the lower face at the tip, near-the-tip part sharpening
- H. flat removals on the lower face, edge formation, thinning
- C. flat removals on the upper face, edge formation, thinning
- A. flat scars of the upper face, earlier stages of manufacturing process
- F. flat scars of the lower face, earlier stages of manufacturing process
- B. flat, broad removals on the upper face, surface formation, thinning
- K. transversal breakage at the base, impact point in the middle of lower face
- G. single, flat, broad removal on the lower face, surface formation, thinning



# Plate 181 Wahlen WH\_107

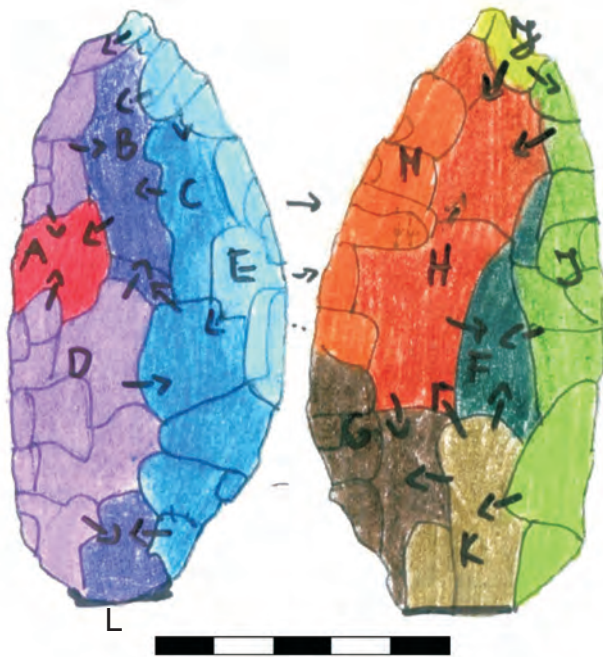


Broken, plano-convex preform, unsuccessfully thinned on the upper face, very coarsely worked, with blunted base; probably abandoned after breakage.

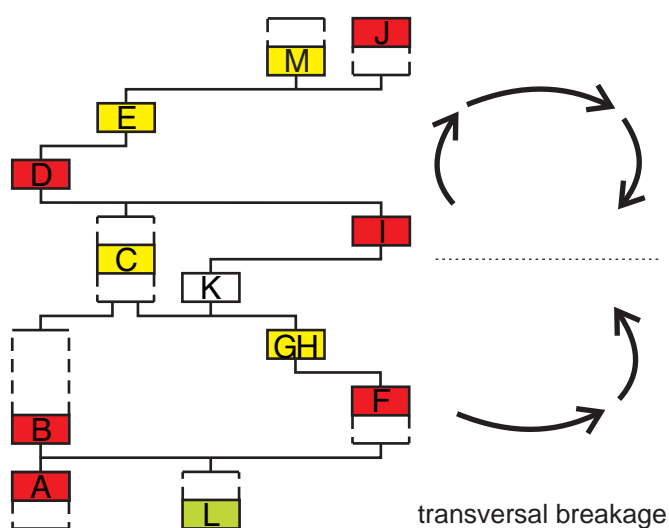


- J. transversal breakage caused by one of removals belonging to sequence D (?)
- D. semi-steep, partly hinged removals on the upper face, surface thinning
- G. single, deep removal on the lower face, edge angle formation before sequence D
- C. semi-steep, partly hinged removals on the upper face, surface thinning, more steep and invasive than sequence D
- B. steep removals on the upper face derived from the base, base formation
- I. flat removals on the lower face at the base, edge angle formation before sequence B
- F. flat, broad removals on the lower face, surface formation
- E. semi-steep removals on the lower face, surface formation
- A. flat scars on the upper face, earlier stage of manufacturing process
- H. semi-steep removals on the lower face, thinning

# Plate 182 Wahlen WH\_129



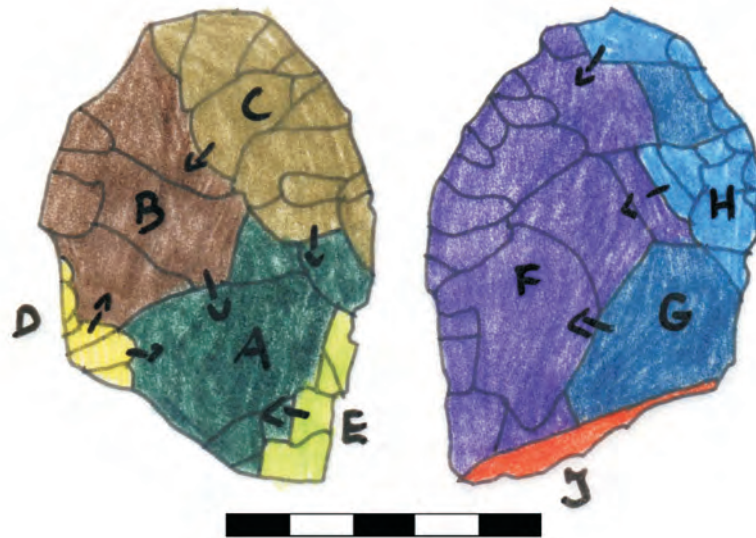
Plano-convex, thick knife with cutting edge rejuvenated several times, base formed by transversal breakage, and notch created near the tip.



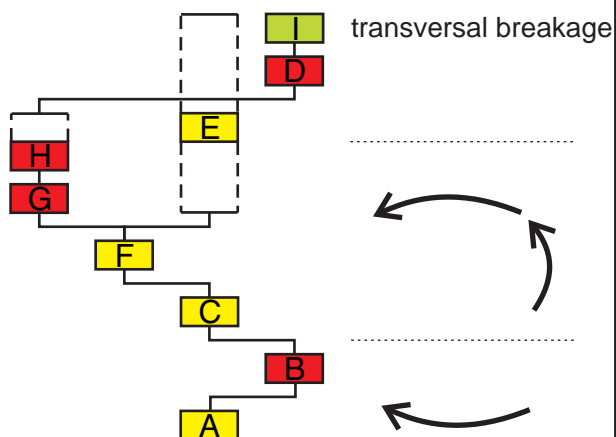
transversal breakage

- J. semi-flat, deep, marginal removals on the lower face near the tip, create a notch
- M. flat removals on the cutting edge, edge rejuvenation, resharpening (?)
- E. marginal retouch on the upper face of cutting edge, semi-flat near the tip and more steep near the base, edge resharpening
- D. semi-flat removals on the upper face, edge formation/rejuvenation (?)
- C. semi-flat removals on the upper face, cutting edge formation/rejuvenation (?)
- I. flat and semi-flat removals on the lower face, edge angle formation
- K. flat removals on the lower face derived from the transversal breakage at the base, surface thinning
- L. transversal breakage at the base
- G, H. flat removals on the lower face, edge angle formation, surface thinning
- F. flat, broad removals on the lower face, surface formation
- B. semi-flat, broad removals on the upper face, surface formation
- A. single, semi-steep removal on the upper face, earlier stages of manufacturing process

# Plate 183 Wahlen WH\_130

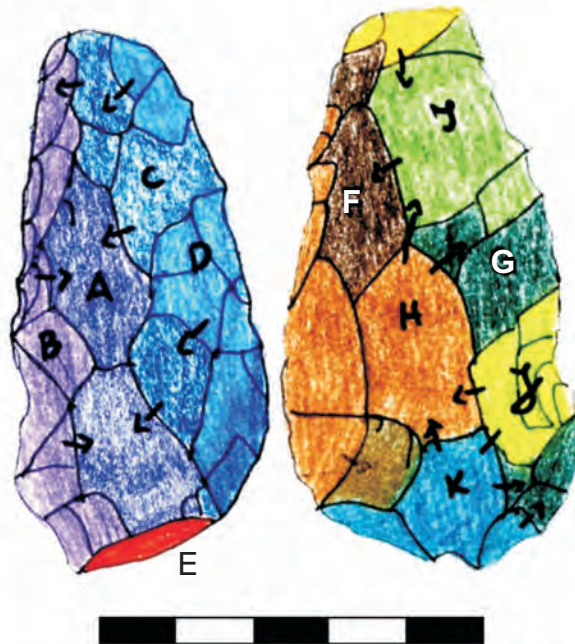


Tool broken in the middle with unexposed, but retouched tip and near-the-tip parts of edges.

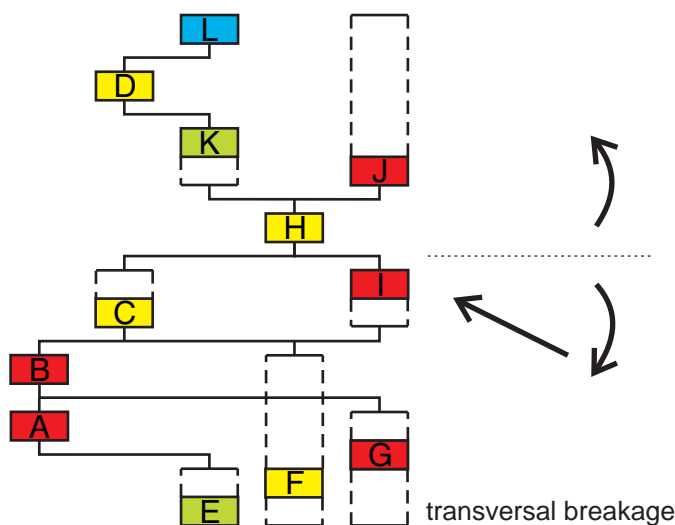


- I. transversal breakage located angularly to vertical axis, was caused by one of removals belonging to sequence D
- D. steep removals on the lower face, probably caused transversal breakage
- E. semi-steep, marginal retouch on the lower face near breakage, edge correction
- C. flat, precise removals on the lower face near the tip, edge sharpening, thinning
- H. flat removals on the upper face and semi-steep, marginal retouch near the tip, analogical to sequence C, edge sharpening
- F. flat removals, probably two separate sequences, first of flat, broad and far going removals, second of flat, more marginal retouch, surface and edge formation
- G. flat, broad removals on the upper face, surface formation
- B. semi-flat removals on the lower face, edge thinning
- A. flat, broad removals on the lower face, analogical to sequence G, surface formation

# Plate 184 Wahlen WH\_141



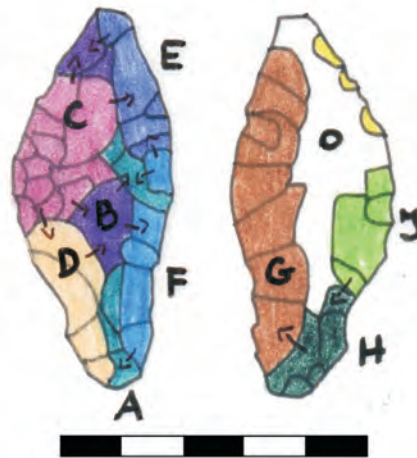
Plano-convex tool with unexposed tip and base formed by transversal breakage. Cutting edge was resharpened several times and opposite edge was blunted by series of hinged removals. Lower face was used for edge angle correction.



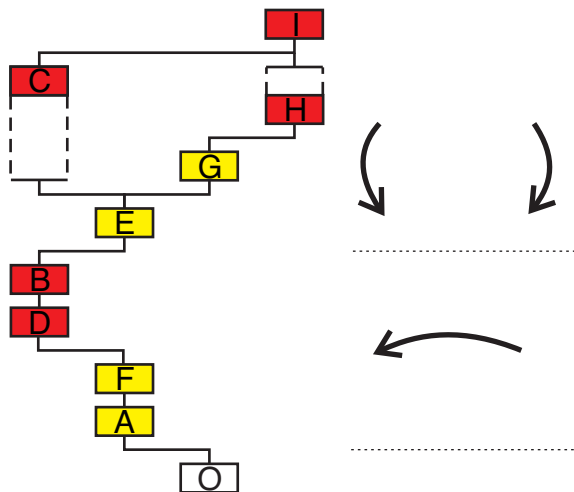
- L. removals on the lower face at the tip
- D. semi-flat, hinged removals on the upper face, edge rejuvenation
- K. flat removals on the lower face, derived from the base, thinning
- J. flat, hinged removals, all derived in one place, created a notch at the back
- H. flat removals on the lower face, edge angle correction, thinning
- I. flat removals on the lower face near the tip, near-the-tip part thinning
- C. semi-flat removals on the upper face, edge formation, sharpening
- B. semi-flat, hinged removals on the upper face, unsuccessful edge formation/rejuvenation or intentional edge blunting
- A. flat, broad removals on the upper face, surface thinning
- G. flat removals on the lower face, surface formation
- F. semi-flat removals on the lower face, edge angle formation, surface formation
- E. transversal breakage or natural surface at the base



# Plate 185 Wahlen WH\_142



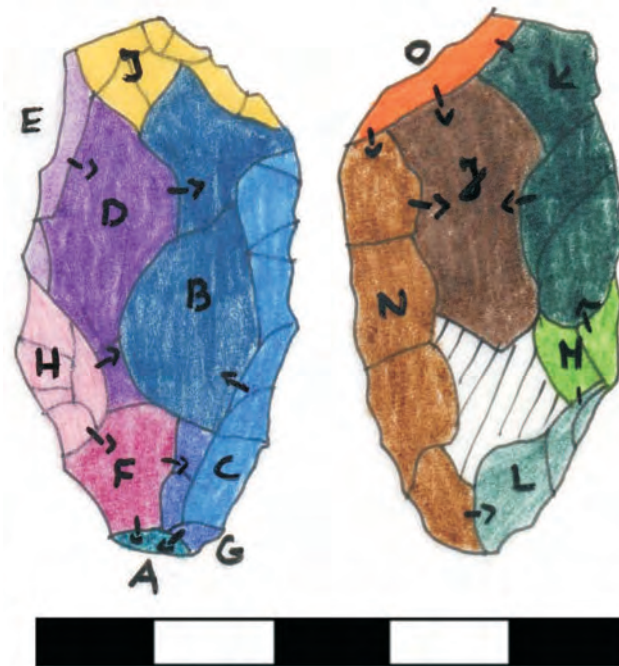
Exhausted, plano-convex tool made of flake, with both edges blunted near the base. Probably, its orientation was changed during rejuvenation stages; both edges were resharpened.



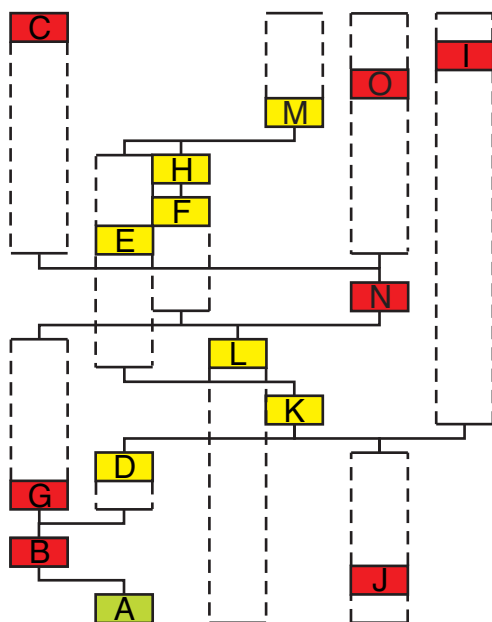
- I, H. flat removals on the lower face, edge angle correction, rejuvenation
- C. retouch on the upper face, edge rejuvenation
- G. semi-flat removals on the lower face, edge angle correction, rejuvenation
- F. semi-steep removals on the upper face near the base, edge rejuvenation
- E. retouch on the upper face near the tip, edge sharpening
- D. steep removals on the upper face near the base, together with sequence F create kind of tang
- B, A. flat removals on the upper face, earlier stages of manufacturing process
- O. ventral surface of a flake



# Plate 186 Wahlen WH\_149

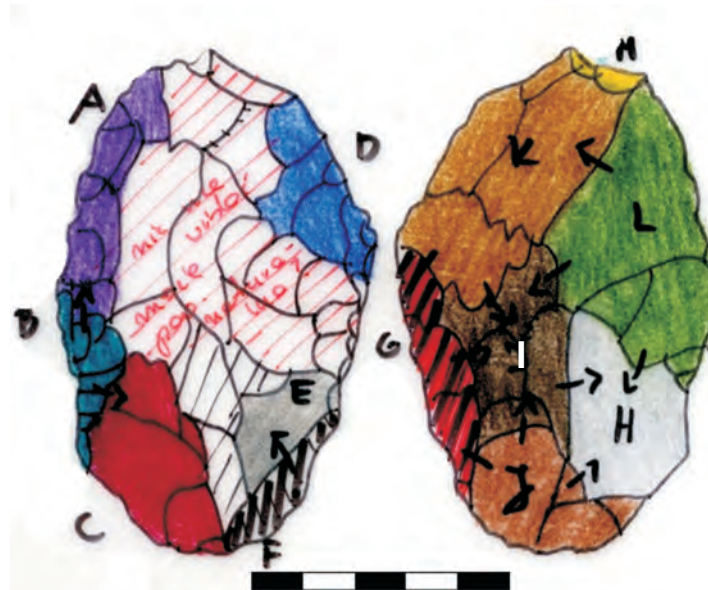


Heavily exhausted, small tool with unexposed tip, blunted base, both edges rejuvenated several times. Edges are heavily, postdepositionally eroded near the tip.

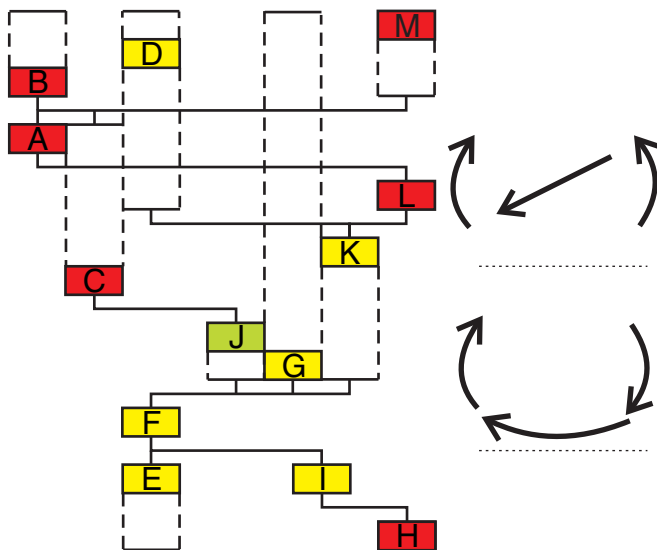


- I, O. eroded sequences of marginal retouch near the tip
- C. semi-steep, marginal removals on the upper face, more steep near the base, edge resharpener
- G. single, steep removals on the upper face near the base, edge rejuvenation, blunting (?)
- M. steep removals on the lower face, edge blunting
- H. flat removals on the upper face, edge angle correction
- F. semi-flat removals on the upper face near the base, edge rejuvenation
- L. steep removals on the lower face near the base, edge blunting
- E. semi-steep removals on the upper face near the tip, edge rejuvenation
- N. flat removals on the lower face, edge angle correction
- K. flat removals on the lower face, edge angle correction (?)
- J. single, flat removal on the lower face, earlier stages of manufacturing process
- D, B. flat removals on the upper face, earlier stages of manufacturing process, probably resharpener
- A. steep removals created the tool base

# Plate 187 Wahlen WH\_1969

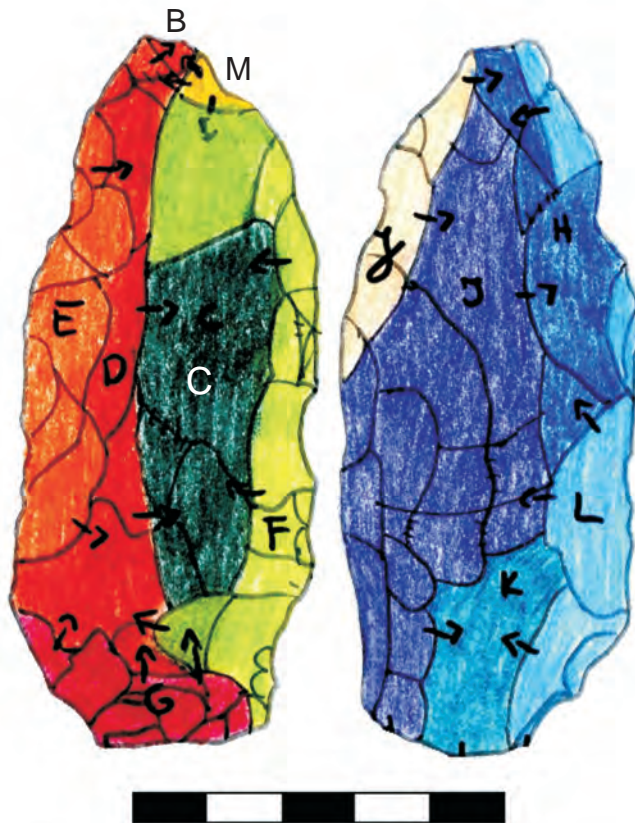


Plano-convex tool with unexposed tip, blunted back edge and single cutting edge. Eroded upper face makes the scars invisible on part of surface.

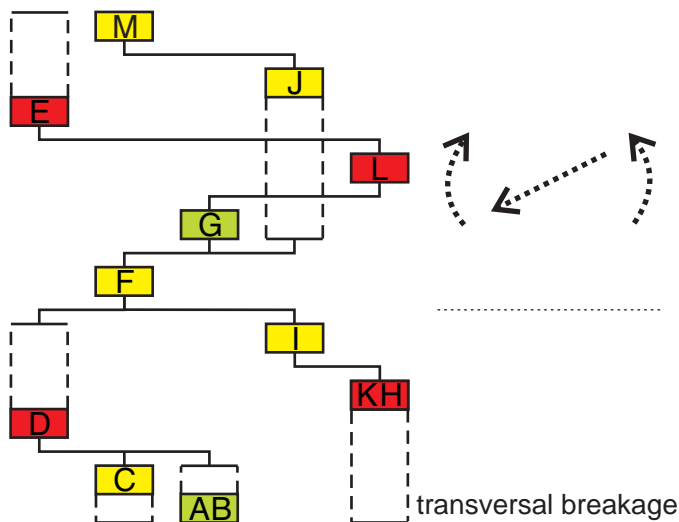


- M. marginal truncations on the lower face near the tip, probably postdepositional
- D. semi-flat retouch on the upper face, edge sharpening
- B. semi-steep and steep, marginal removals on the upper face, edge resharpener
- A. semi-flat removals on the upper face near the tip, edge sharpening
- C. semi-steep removals on the upper face near the base, edge formation
- L, K. flat removals on the lower face, edge angle formation, thinning
- J. semi-steep removals on the lower face, base formation
- G. steep removals on the lower face, back formation, edge blunting
- F. steep removals on the upper face, back formation, edge blunting
- E. flat removals on the upper face, surface thinning
- I, H. flat removals on the lower face, surface formation, thinning

# Plate 188 Wahlen WH\_A827-3

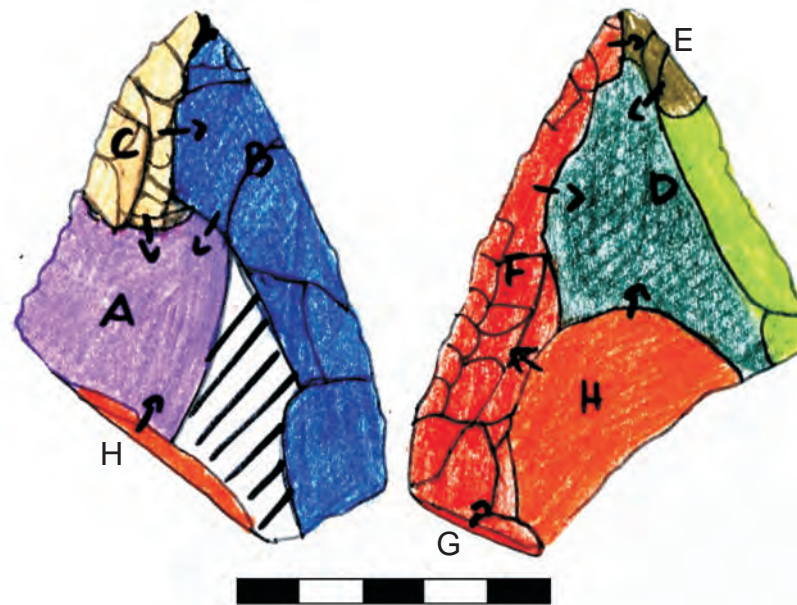


Plano-convex tool with transversal breakages at the base and the tip. Both breakage scars were not totally removed during manufacturing process. Both edges were roughly shaped. Cutting edge was probably resharpened and opposite edge (II) blunted near the base.

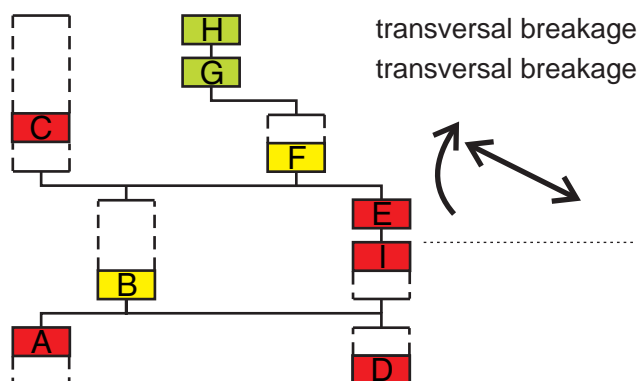


- M. single, semi-steep removal on the upper face near the tip, edge rejuvenation
- J. semi-flat removals on the lower face near the tip, edge rejuvenation
- E. semi-steep removals on the upper face along the edge, edge rejuvenation/formation (?)
- L. semi-steep removals on the lower face, back formation
- G. flat, partly hinged removals on the upper face at the base, base formation, thinning
- F. semi-flat/semi-steep retouch on the upper face, edge sharpening/resharpening (?)
- I. flat, removals on the lower face, partly hinged near the base, a few phases starting from surface formation until edge angle formation
- K, H. flat and semi-flat removals on the lower face, surface formation
- D. semi-flat removals on the upper face, edge/surface formation
- C. semi-flat, broad removals on the upper face, surface formation, thinning
- A. transversal breakage at the base
- B. transversal breakage at the tip

## Plate 189 Wahlen WH\_C16



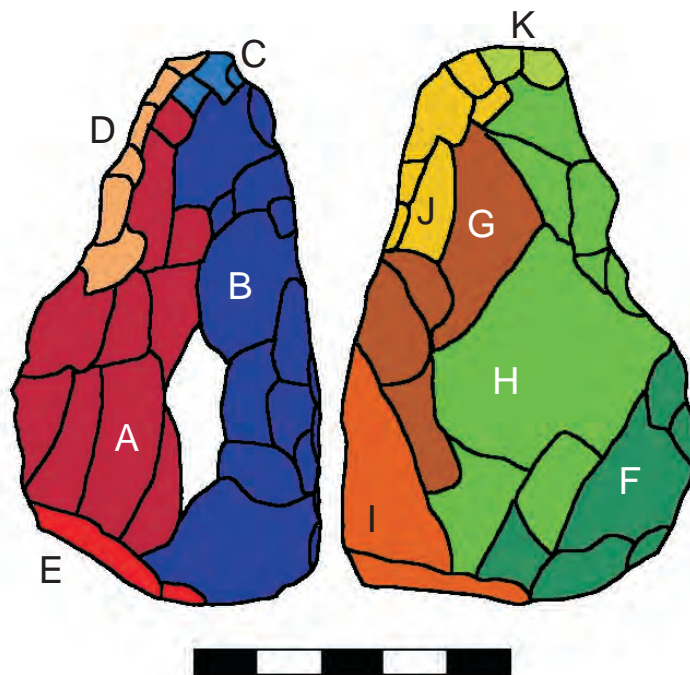
Big, triangular tool with both edges straight and convergent at the exposed tip. Edges were retouched alternately, and base was formed by two transversal breakages. Edge I was retouched and probably resharpened at its whole length, but edge II only near the tip.



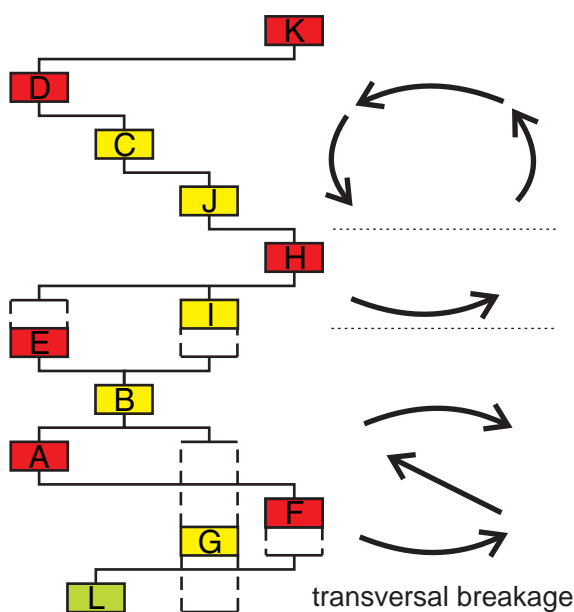
- H. transversal breakage at the base, overpassed on the lower face, caused probably by one of removals belonging to sequence I
- G. transversal breakage or natural surface at the base
- F. semi-steep removals on the lower face, edge sharpening, can consist of a few stages of edge rejuvenation
- C. flat, marginal retouch on the upper face near the tip, edge sharpening
- E. small removals on the lower face near the tip, edge angle correction before sequence C
- I. flat, broad removals on the lower face- surface thinning and single, steep removals causing the transversal breakage (H)
- B, A. flat, broad removals on the upper face, surface formation, decortication
- D. flat, broad removals on the lower face, surface formation, decortication



# Plate 190 Wahlen WH\_II79



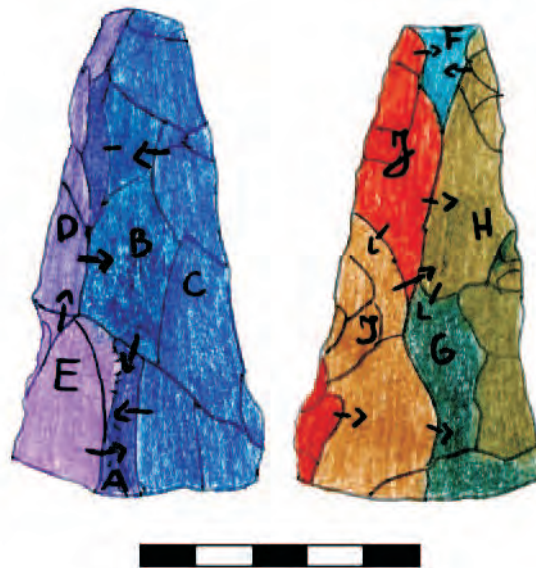
Plano-convex knife with unexposed tip, but the near-the-tip part narrower than the base. Base was blunted, whereas cutting edge and near-the-tip part were resharpenered and rejuvenated. Lower face was used for edge angle correction only.



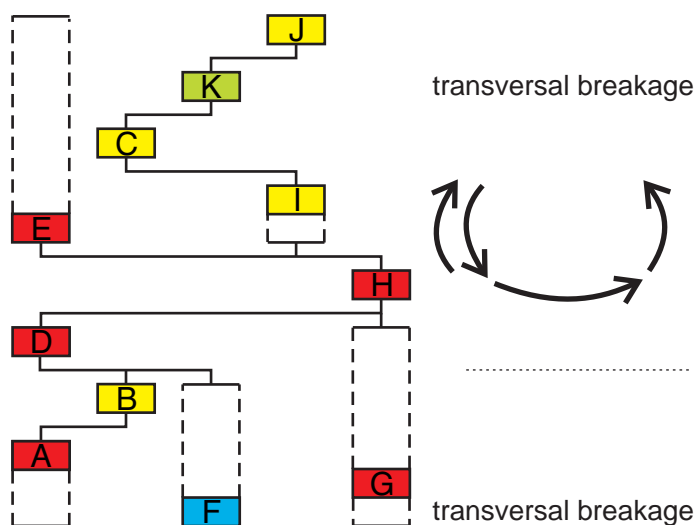
- K. marginal removals on the lower face at the tip
- D. steep, marginal retouch on the upper face near the tip, edge rejuvenation
- C. marginal removals on the upper face near the tip, edge rejuvenation
- J. semi-flat retouch on the lower face near the tip, cutting edge rejuvenation, edge angle correction
- H. flat removals on the lower face, surface and edge thinning, near-the-tip part thinning
- I. flat removals on the lower face near the base, edge angle correction, surface flattening
- B. semi-steep, partly hinged retouch on the upper face, probably a few phases of cutting edge resharpenering
- A. semi-steep/semi-flat removals on the upper face, surface thinning/edge formation
- F. flat removals on the lower face, surface formation
- G. flat removals on the lower face, surface formation, edge angle formation
- L. transversal breakage at the base
- E. steep removals on the upper face, base



## Plate 191 Wahlen WH\_Illa

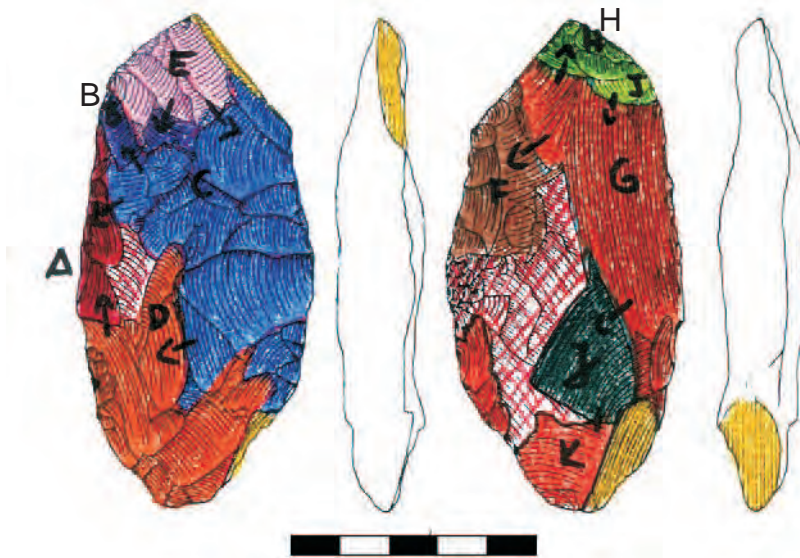


Tool with tip broken at the beginning of manufacturing process. Edges were remodeled after breakage, but tip remained blunted and unretouched. There are sequences showing care for tool symmetry and edge line. Edges were worked in steep-flat, alternate manner. The tool was also broken near the base and remodeled afterwards.



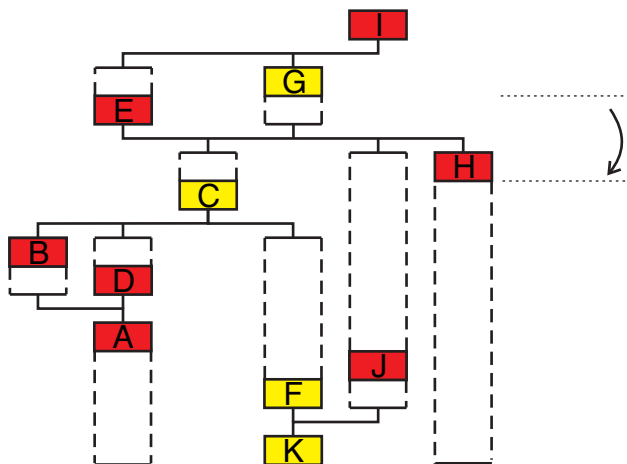
- J. semi-steep retouch near the tip and near the breakage on the lower face, edge line correction
- K. transversal breakage, probably caused by sequence C
- C. semi-steep, deep removals on the upper face, edge thinning
- B, A. flat and semi-flat removals on the upper face, surface formation
- E. semi-flat removals near the breakage on the upper face, edge formation and steep truncations blunting the edge
- I. flat removals on the lower face, surface formation
- H. semi-flat removals on the lower face, edge formation
- G. flat, broad removals on the lower face, surface formation
- D. flat removals on the upper face near the tip
- F. steep surface of breakage at the tip.

## Plate 192 Wahlen WH\_IIc

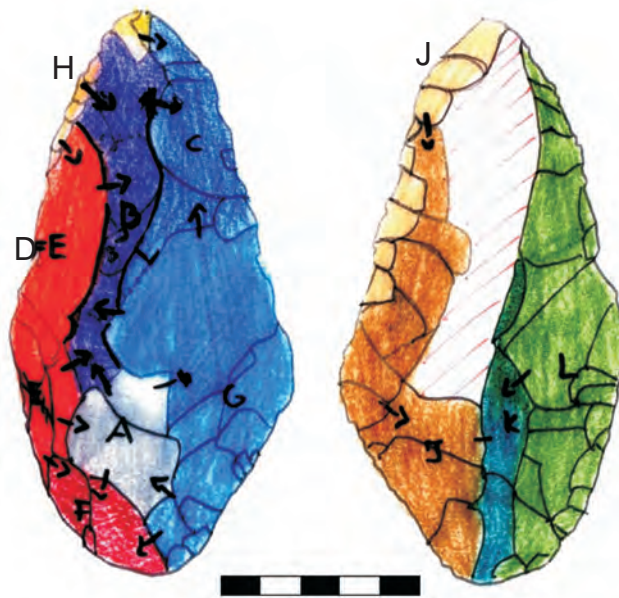


Knife with cutting edge damaged by big, overpassed removal, which took almost the whole of cutting edge on the upper face. The tool has natural, transversal surface on distal posterior part which prevented it from tip exposure; near-the-base part was worked roughly, only the near-the-tip part was precisely knapped.

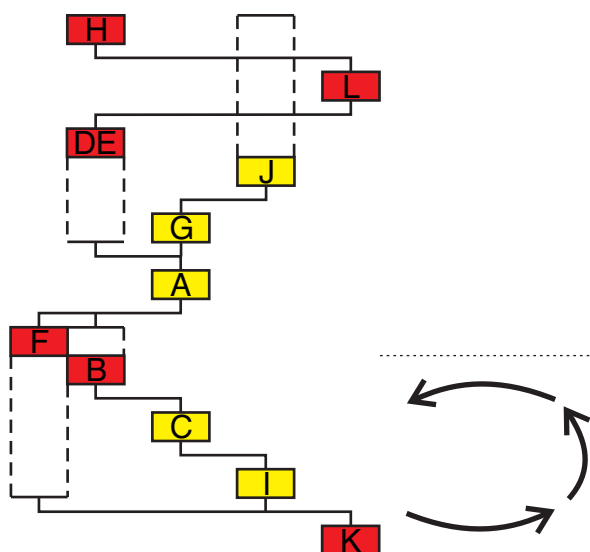
- I. single small removal on the upper face, edge rejuvenation, remodeling after sequence G
- G. flat, overpassed removal on the upper face derived from edge II reached the cutting edge and removed almost the whole cutting edge, and damaged the tool
- E. flat, precise, far going removals on the lower face near the tip, cutting edge rejuvenation
- H. semi-flat, marginal retouch on the upper face near the tip, cutting edge sharpening
- C. flat, broad removals on the lower face, surface thinning, formation
- B. flat, angular removals on the lower face near the tip, edge thinning, edge angle formation (?)
- D. flat, broad removals on the lower face near the base, surface thinning, base formation
- A. unsuccessful removals on the lower face, aimed at decorticating, surface formation
- J. single, flat removal on the upper face, surface formation, decortication
- F. flat removals on the upper face, edge angle formation before sequence C, back edge formation
- K. flat removals on the upper face near the base, base formation



# Plate 193 Wahlen WH\_WA

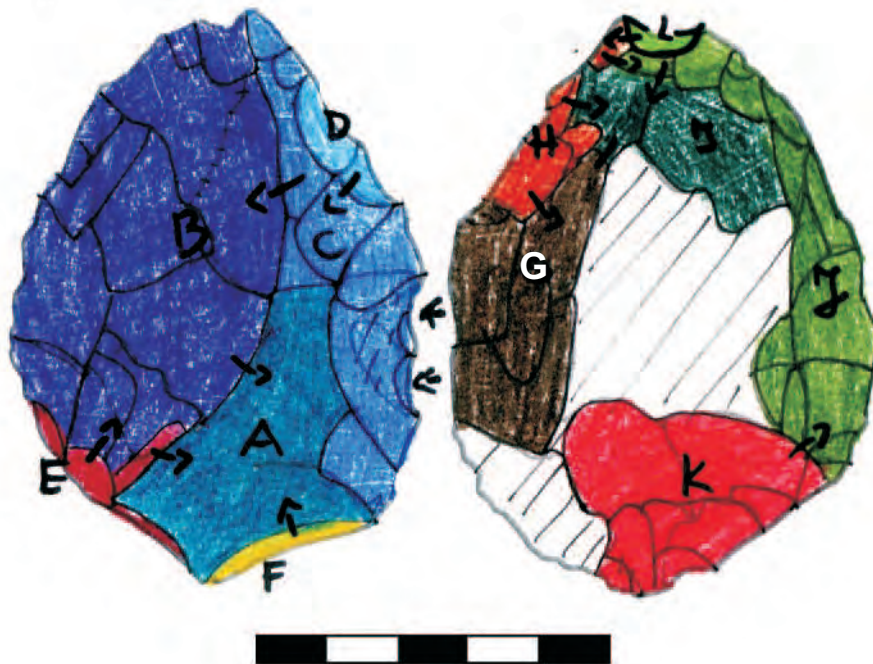


Thick tool with poorly exposed tip and near-the-tip part narrower than near-the-base part. Unsuccessfully thinned on the lower face. Near-the-tip part was more precisely worked and retouched. Both edges were retouched alternately near the tip.

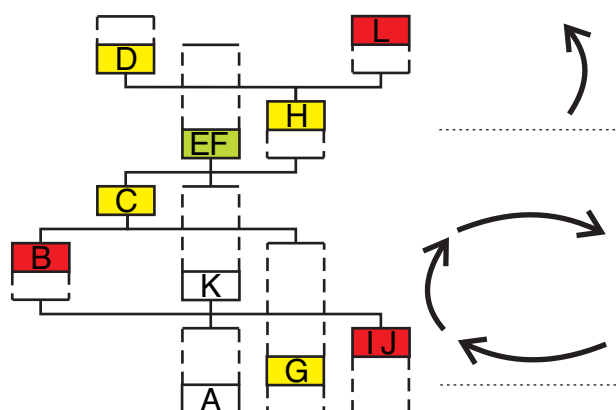


- H. steep, marginal retouch on the upper face, edge reshaping
- L. semi-flat, invasive, partly hinged removals on the lower face, thinning, edge formation, analogical to sequence G but unsuccessful
- E, D. steep and semi-steep removals on the upper face, edge blunting, back formation (?)
- F. semi-steep removals on the upper face near the base, base formation
- J. flat, irregular retouch on the lower face near the tip, edge sharpening
- G. semi-flat and semi-steep removals on the upper face analogical to sequence L but successful
- A. flat removals on the upper face, surface formation, thinning
- C, B. flat, broad removals on the upper face, surface formation, thinning
- I, K. flat removals on the lower face, surface formation, thinning

# Plate 194 Wahlen WH\_Wahlen



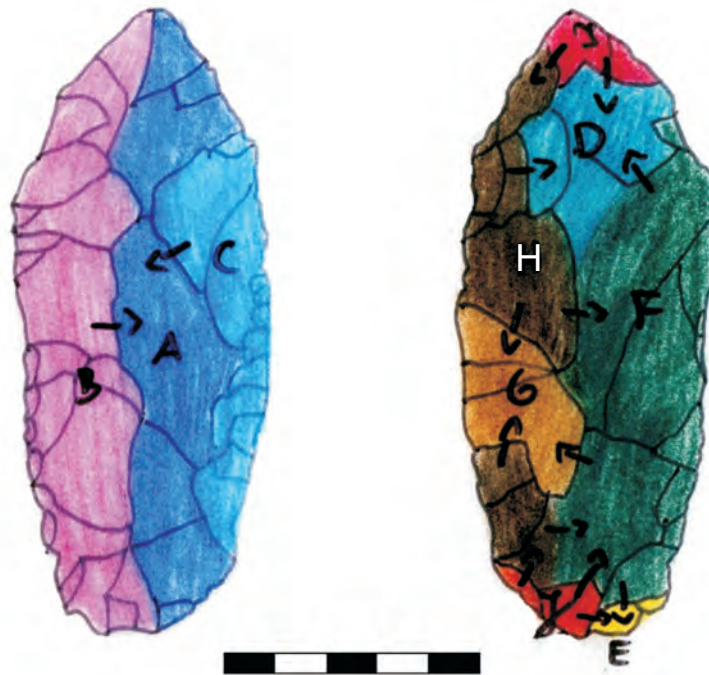
Plano-convex tool with unexposed tip, cutting edge rejuvenated and resharpened unsuccessfully, base blunted by abrupt removals, and notch created at the tip during last stage of chaîne opératoire.



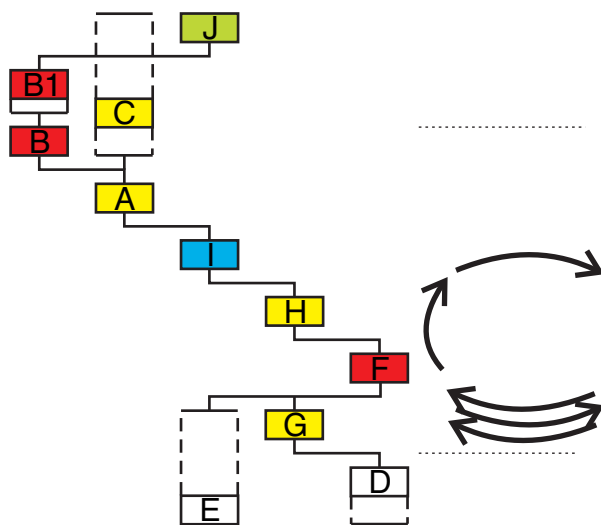
- L. single, semi-steep removal at the tip, created a notch at the tip
- D. deep, hinged, marginal removals on the upper face, unsuccessful edge rejuvenation
- H. semi-steep removals on the lower face, unsuccessful edge thinning near the tip
- C. semi-flat, partly hinged removals on the upper face, edge sharpening
- E, F. steep, blunting removals on the upper face at the base, base formation
- K. flat removals on the lower face at the base, surface thinning, decortication
- B. semi-flat, broad removals on the upper face, surface formation, thinning
- J. flat removals on the lower face, edge formation, thinning
- I, G. flat removals on the lower face, surface thinning, decortication
- A. flat, broad scar, can be a ventral surface of a flake or a removal from earlier stages of manufacturing process



# Plate 195 Wahlen WH\_X-3



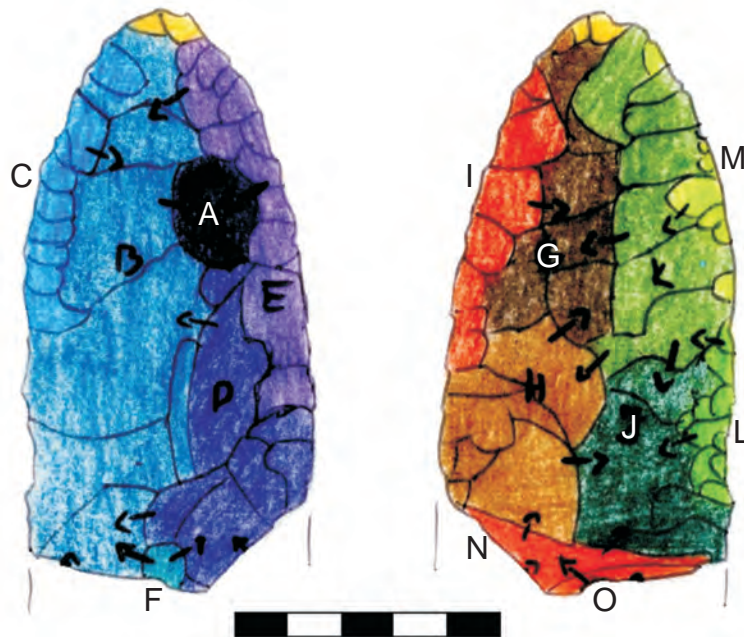
Plano-convex, thick tool made on a flake, with exposed, but unsuccessfully thinned tip. Orientation was probably changed at the last stage of chaîne opératoire-sharpening retouch of sequence B1. The tool was abandoned at the preform stage of production.



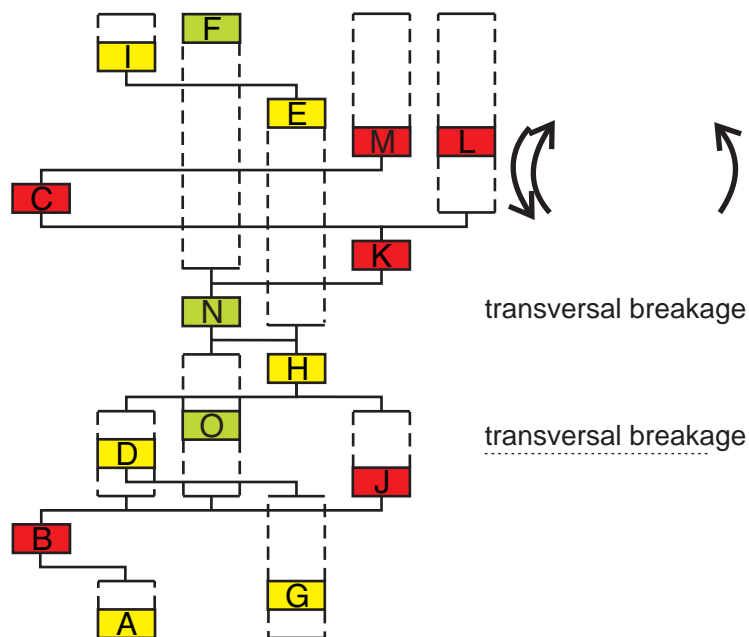
- B. semi-steep removals on the upper face, partly hinged near the tip, edge thinning, formation
- B1. semi-steep removals on the upper face near the base, edge thinning, formation
- C. hinged removals on the upper face, edge thinning
- A. semi-flat, broad removals on the upper face, surface formation
- I. thinning removals on the lower face, tip thinning
- J. steep removals on the lower face at the base, base formation, blunting
- H, G, F. flat removals on the lower face, surface thinning
- D. ventral surface of a flake
- E. remains of butt surface of a flake (?)



# Plate 196 Wahlen WH\_X608

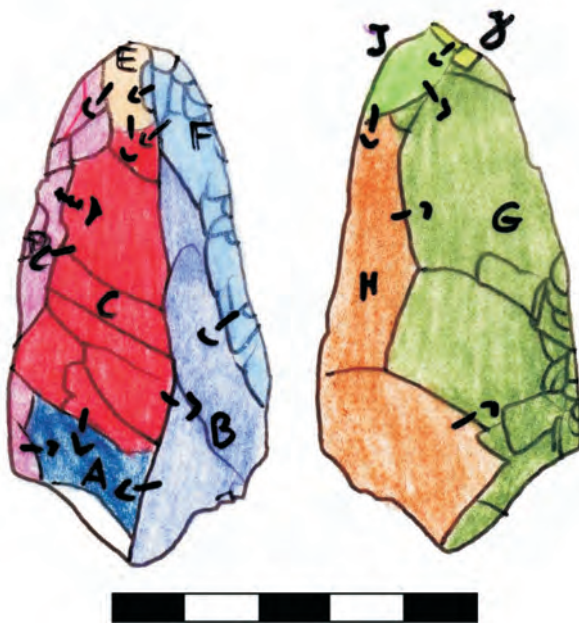


Tool with broken base, two breakage scars at the base, as well as unexposed and unretouched tip; precisely retouched both edges, probably resharpened.

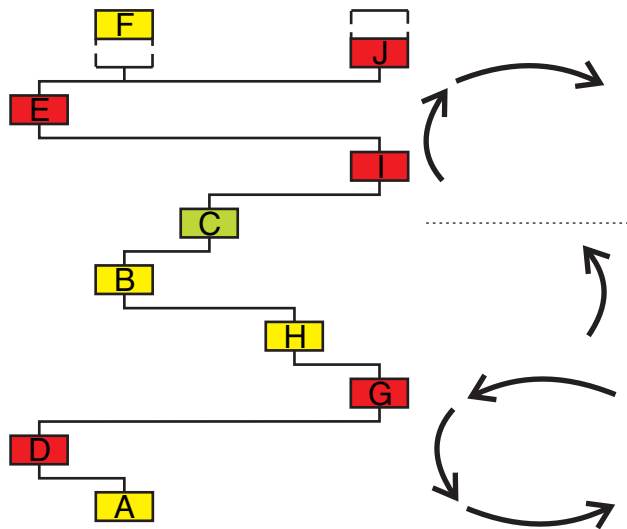


- F. single, flat, small removals on the upper face derived from the breakage scar
- E. semi-steep retouch on the upper face, edge sharpening
- C. flat, marginal retouch on the upper face, edge sharpening
- I. flat, marginal retouch on the lower face, edge angle correction
- M. marginal retouch on the lower face, edge resharpening
- L. semi-steep, marginal retouch on the lower face, created a notch on the edge
- K. flat removals on the lower face near the tip, edge formation, thinning
- N. transversal breakage caused by one of removals belonging to sequence H
- O. transversal breakage, earlier than sequence N
- H. flat removals on the lower face near breakage, edge thinning
- D. semi-flat removals on the upper face, surface formation
- G. flat removals on the lower face, surface formation
- J. semi-flat, broad removals on the lower face, surface formation
- B, A. flat, broad removals on the lower face, surface formation

Plate 197 Kokkinopilos 64.56.B:4

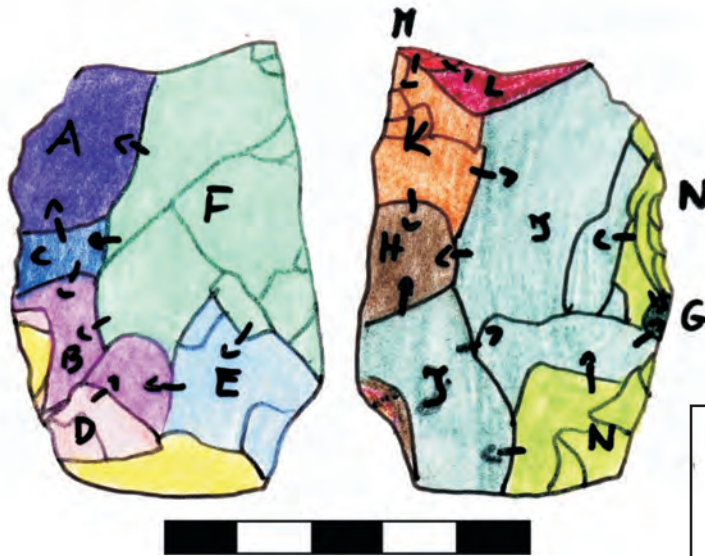


Plano-convex knife with single, resharpened cutting edge, flat lower surface and unexposed tip.

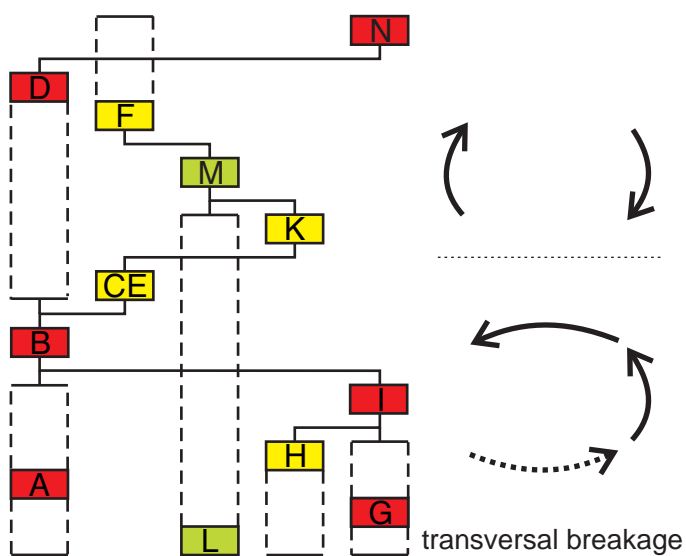


- F. semi-steep, marginal retouch on the upper face, edge resharpening
- J. flat, marginal removals on the lower face at the tip, tip correction
- E. semi-steep removals on the upper face at the tip, near-the-tip part thinning, rejuvenation
- I. single, semi-steep removal on the lower face at the tip, edge angle correction, near-the-tip part rejuvenation
- C. flat, long removals on the upper face derived from the tip, surface thinning, and surface rejuvenation
- B. semi-flat/semi-steep removals on the upper face, edge formation, thinning or rejuvenation (?)
- H. flat, broad removals on the lower face, edge angle formation, thinning
- G. flat removals on the lower face, surface formation, thinning, flattening
- D. semi-steep, marginal removals on the upper face, edge blunting, edge angle formation before sequence G
- A. single removal, semi-flat towards edge II, derived from edge I on the upper face, either overpassed from edge I or showing how much the tool was remodeled during subsequent resharpening sequences.

# Plate 198 Kokkinopilos 3622

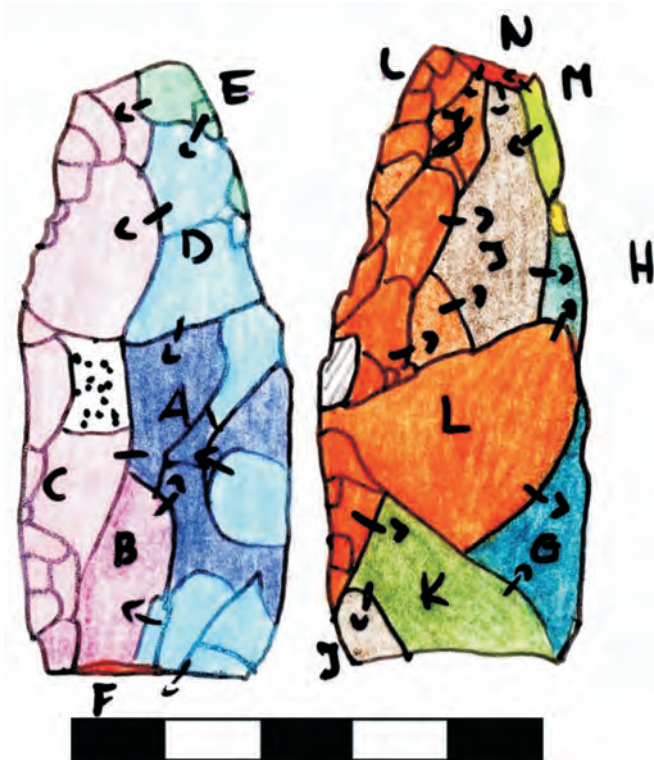


Middle part of biconvex tool with one of its ends broken during manufacturing process. The other end was broken postdepositionally (no patina). The tool was abandoned at thinning stage, probably due to unsuccessful thinning of sequence N. The tool has no traces of sharpening retouches or rejuvenation sequences, although its edges could be used as working edges.

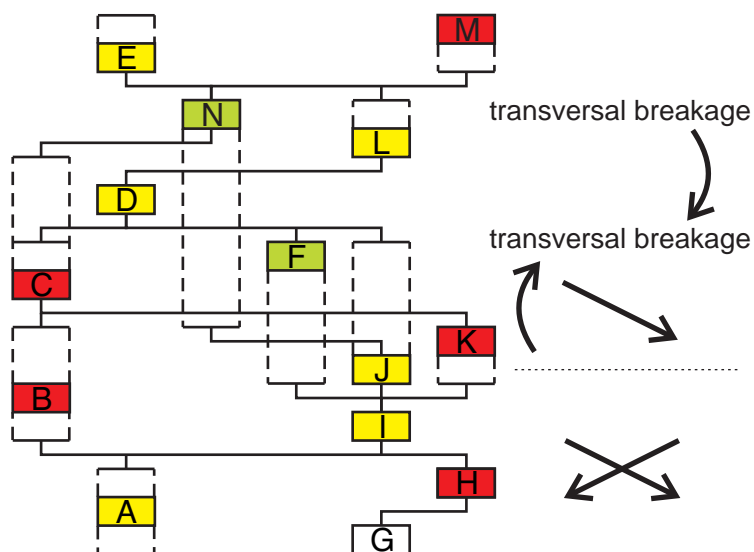


- N. flat, hinged removals on the lower face, unsuccessful edge thinning, probably aimed to be analogical to sequence F
- D. flat removals on the upper face, edge angle correction
- F. flat removals on the upper face, surface thinning after breakage
- M. single, semi-steep removal on the breakage scar, breakage scar remodeling
- L. transversal breakage or steep removals blunting the tip/base
- K. semi-flat removals, edge angle correction before deriving sequence F
- E. semi-flat and steep removals on the upper face, edge formation
- C. flat scar of a broad removal which reached the opposite edge, surface formation, thinning
- B. semi-flat removals on the upper face, edge formation
- A. single semi-flat, broad scar on the upper face, surface formation, thinning
- I. flat, broad removals on the lower face, reaching the opposite edge, analogical to sequence C, surface formation, thinning
- H. semi-flat removals on the lower face, surface formation, thinning
- G. single, semi-steep scar on the lower face, earlier stage of manufacturing process

# Plate 199 Kokkinopilos 3638



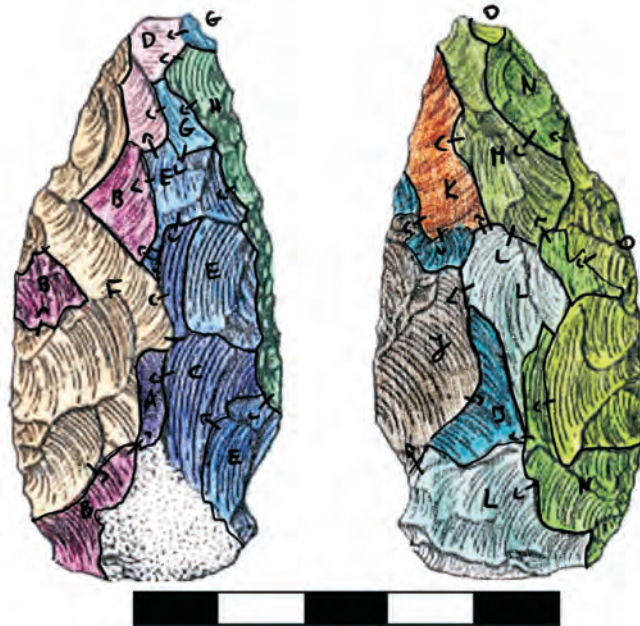
Plano-convex, middle part of preform with broken tip and base. The tool was rejuvenated after near-the-base breakage—traces of shaping (sequence D and L), and after near-the-tip breakage (sequence E and probably M). The tool has no sharpening retouches along edges, it is probably a leafpoint preform.



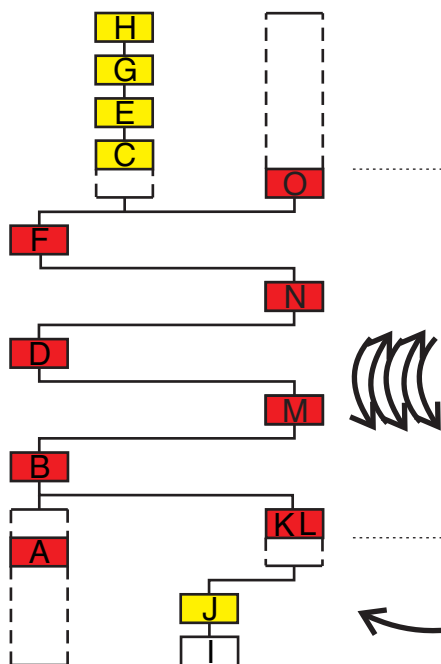
- M. single, semi-steep truncation on the lower face near the breakage, can be postdepositional
- E. marginal retouch on the upper face near the breakage
- N. transversal breakage at the tip
- L. flat removals on the lower face, surface thinning and formation, shaping near-the-tip part after base breakage
- D. semi-flat, partly hinged, near-the-base removals on the upper face, shaping after base breakage
- F. transversal breakage at the base
- C. removals on the upper face: flat near the tip and semi-steep near the base, edge formation, shaping, thinning
- K. single, flat, broad removal on the lower face, surface formation, thinning
- J. flat removals on the lower face, edge formation, thinning, shaping (?)
- I, H. flat removals on the lower face, surface formation, thinning
- B. flat, broad removals on the upper face, surface formation, thinning
- A. semi-steep removals on the upper face, surface formation
- G. ventral surface of a flake or very broad removal on the lower face



# Plate 200 Kokkinopilos 10013



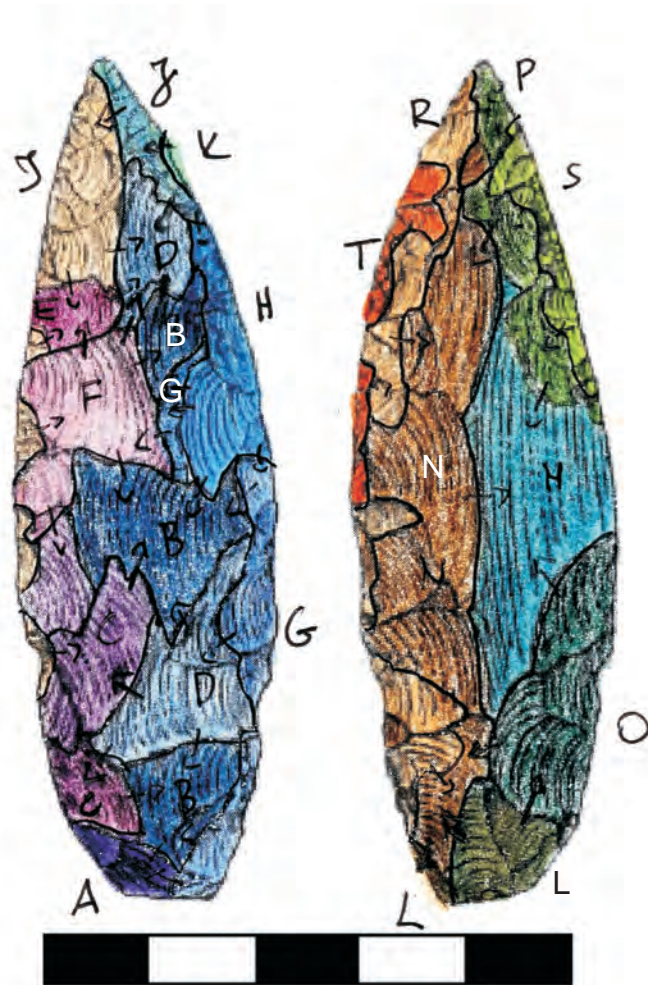
Biconvex tool with poorly exposed tip and cortical base; could be made on a flake. It has both edges retouched and resharpened by flat retouch sequences derived alternately several times. Edge II was retouched on the lower face and edge I on the upper face. Both edges were worked independently, and edge I was worked after edge II had been exhausted.



- H. flat and semi-flat, marginal retouch on the upper face, edge resharpening
- G, E, C. semi-steep removals on the upper face, edge resharpening
- O. single, flat, small, marginal removal on the lower face at the tip and flat removals along the edge, edge resharpening
- F. semi-flat, far going, long removals on the upper face, edge angle correction
- N, M. flat removals on the lower face, edge resharpening
- D. semi-steep removals on the upper face near the tip, near-the-tip part thinning, rejuvenation
- B, A. semi-flat removals on the upper face, earlier stages of manufacturing process
- L, J, K. flat, broad removals on the lower face, surface formation, thinning
- I. ventral surface of a flake or flat, very broad removals on the lower face

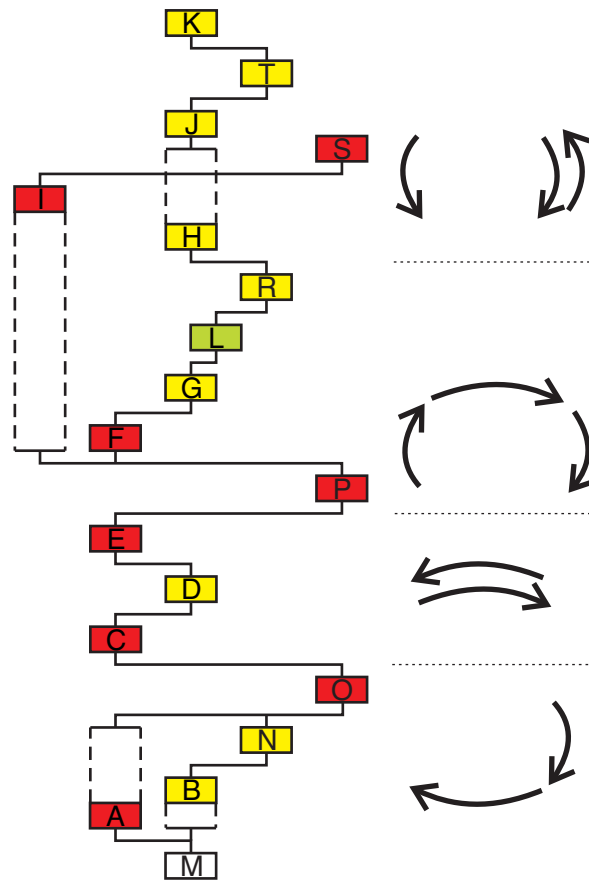


# Plate 201 Kokkinopilos 10014



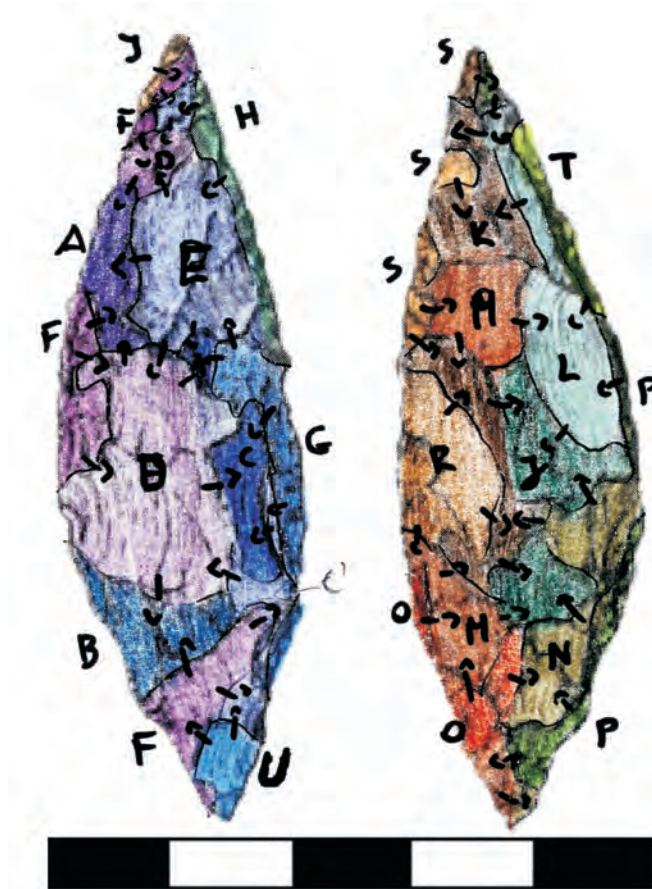
Plano-convex tool made on a flake with exposed and precisely worked tip. One edge (edge I) was worked and resharpened more precisely. Opposite edge was resharpened only near the tip and retouched less precisely, lower face was used for edge angle correction; retouches aimed at edge sharpening, not its shaping. Tip was moved out of vertical axis due to resharpening sequences. The tool was shaped only at first stages of manufacturing process. Further chaîne opératoire was focused on edges sharpening.

## Plate 201 Kokkinopilos 10014



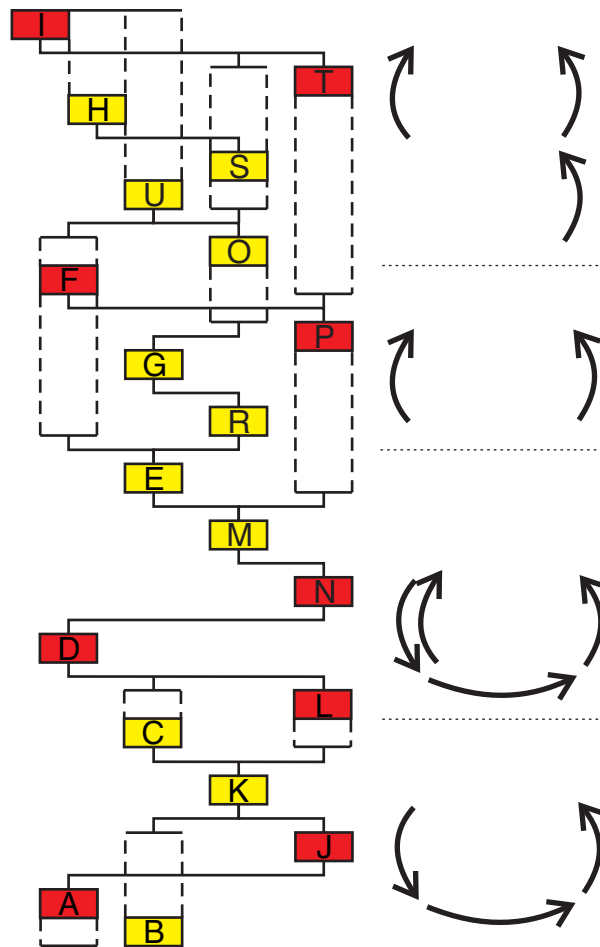
- K. steep, marginal retouch on the upper face, probably usewear retouch
- T, S. flat, marginal retouch on the lower face, edge correction
- J. semi-steep, precise, marginal retouch on the upper face near the tip, edge resharpening, tip exposure
- I. semi-flat retouch on the upper face near the tip and irregular, marginal retouch along the edge created notches, edge resharpening, less precise than sequence J
- H. flat, partly hinged, marginal retouch on the upper face, edge resharpening
- R, P. flat removals on the lower face near the tip and along the edge, edge angle correction
- L. semi-steep removals on the lower face, derived from the base, base formation
- G. flat removals on the upper face, edge resharpening
- F, E. semi-flat removals on the upper face, surface thinning, rejuvenation, shaping (?)
- D. semi-flat removals on the upper face, surface thinning, shaping (?) or edge sharpening
- C. flat removals on the upper face, edge formation, thinning
- O. flat and semi-flat removals on the lower face near the base, aimed at bulb removing and surface thinning
- N. flat, broad removals on the lower face, surface formation, thinning, surface flattening
- M. ventral surface of a flake
- A. semi-flat removals on the upper face near the base, earlier stages of manufacturing process
- B. semi-flat and flat, broad removals on the upper face, surface formation, thinning

Plate 202 Kokkinopilos 10015



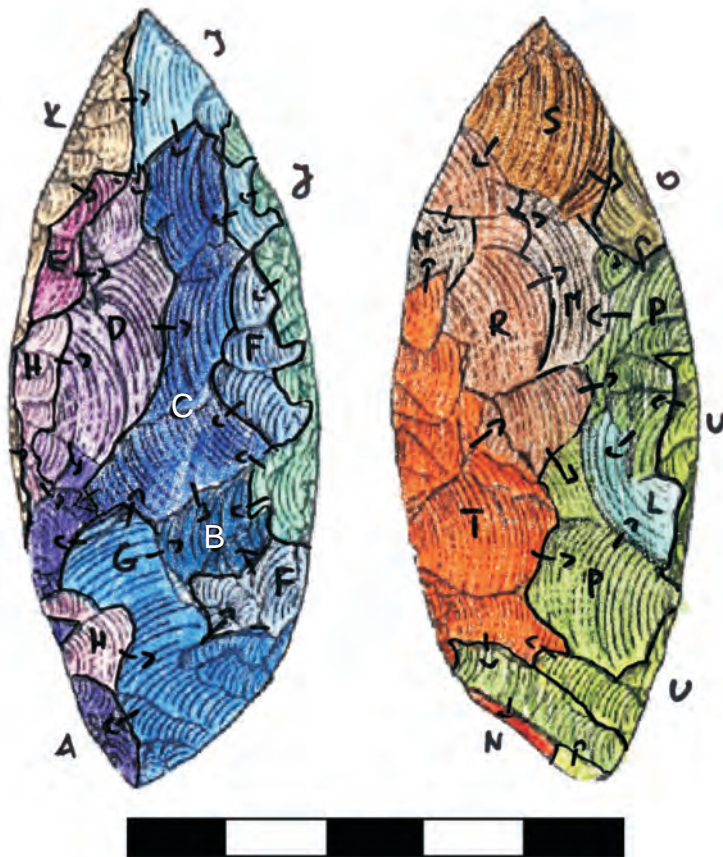
Biconvex asymmetrical leafpoint with exposed tip and base, intensively shaped during the whole manufacturing process, both edges bear no traces of sharpening or reshaping sequences.

## Plate 202 Kokkinopilos 10015



- I. flat, very small, marginal retouch on the upper face near the tip, edge correction
- T. flat, hinged retouch on the lower face along the edge, edge correction, analogical to H
- S. semi-flat, marginal removals on the lower face, edge angle correction
- H. flat, partly hinged removals on the upper face analogical to sequence T, edge correction
- U. flat removals on the upper face near the base, edge correction, and near-the-base part thinning
- O. semi-flat and semi-steep, hinged removals on the lower face, edge correction
- F. flat removals on the upper face near the tip, the base and in the middle part of the edge, shape correction
- P. flat, intensive, marginal removals on the lower face, edge shaping
- G. flat, partly hinged removals on the upper face, shaping, edge thinning
- R. flat and semi-flat removals on the lower face, edge angle correction
- E. semi-flat, far going removals on the upper face near the tip and the base, shaping, surface thinning
- M. removals on the lower face: semi-steep near the base and flat near the tip, edge angle correction, near-the-base part shaping
- N. semi-flat removals on the lower face, near-the-base part shaping
- D. flat, far going removals on the upper face, surface thinning
- J, L, K. flat removals on the lower face, surface formation, thinning
- C. flat removals on the upper face, surface thinning
- A. semi-flat/semi-steep removals on the upper face, surface formation
- B. flat, broad, reaching the opposite edge removals on the upper face, surface formation, thinning

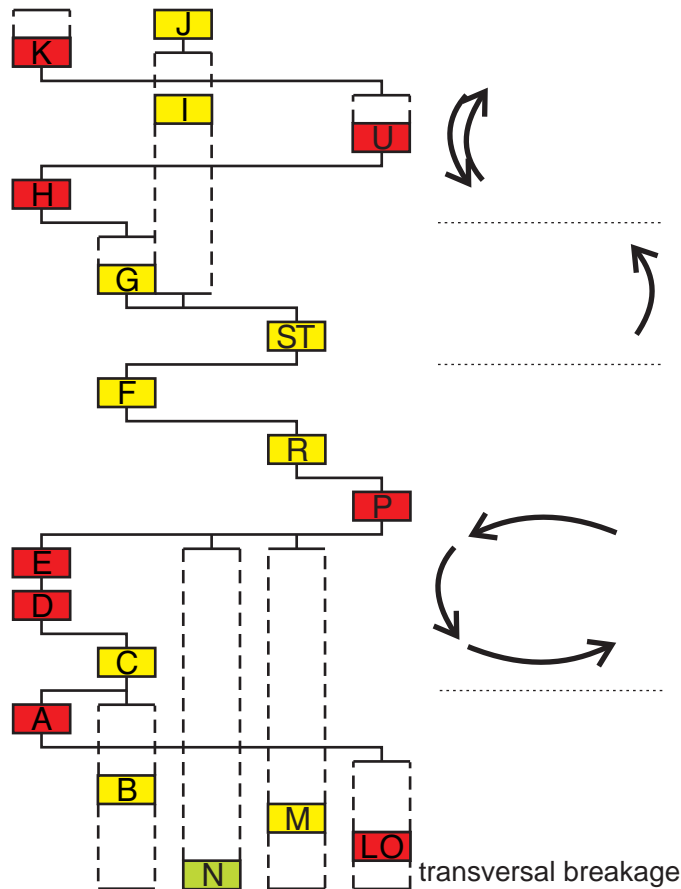
Plate 203 Kokkinopilos 10016



Plano-convex leafpoint with base formed by angularly located transversal breakage. The upper face at the tip was unsuccessfully thinned near the tip (edge E) which prevented it from further thinning. Therefore, further work was focused on near-the-base part due to removing breakage scar and orientation change. The aim was not fulfilled; therefore, intensive thinning was done near the tip (sequences S, I), aimed at maximal thinning and shaping. The whole manufacturing process was focused on obtaining symmetrical, thin tool.

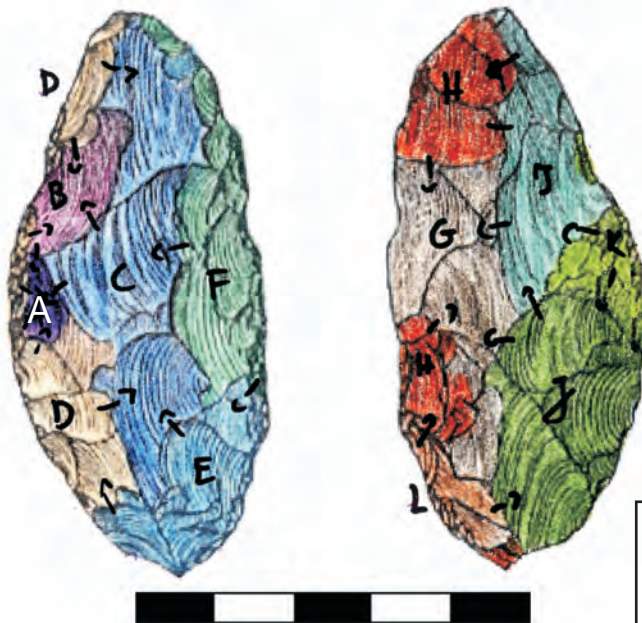


## Plate 203 Kokkinopilos 10016

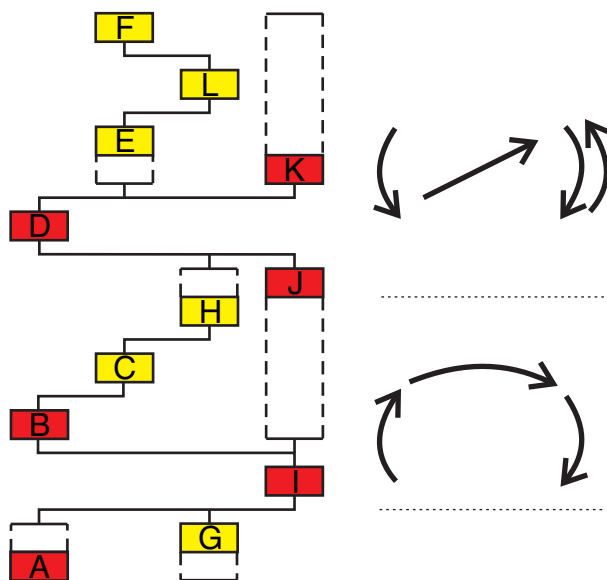


- K. semi-steep, partly hinged retouch on the upper face near the tip, shaping
- J. semi-flat, marginal retouch on the upper face, edge correction
- I. semi-flat removals on the upper face near the tip, aimed at thinning near-the-tip part and shaping
- U. flat, long, far going removals on the lower face near the base and marginal removals along the edge, thinning, shaping
- H. semi-flat removals on the upper face, edge correction, shaping
- G. flat, far going, long, angular removals on the upper face near the base, shaping, thinning, analogical to sequence P
- S. flat removals on the lower face at the tip, near-the-tip part thinning
- T, R. flat, far going removals on the lower face, surface thinning, shaping, edge angle correction
- F. semi-flat removals on the upper face, edge formation, thinning
- P. flat, far going, long, angular removals on the lower face near the base and along the edge, shaping, thinning, analogical to sequence G
- E. semi-flat, hinged removals on the upper face near the tip, unsuccessful thinning which damaged the upper face near the tip
- D, C, B, A. semi-flat, far going, broad removals on the upper face, surface thinning
- L, O. flat removals on the lower face, surface formation
- M. flat, broad removals on the lower face, surface formation, thinning
- N. transversal breakage at the base

## Plate 204 Kokkinopilos 10031

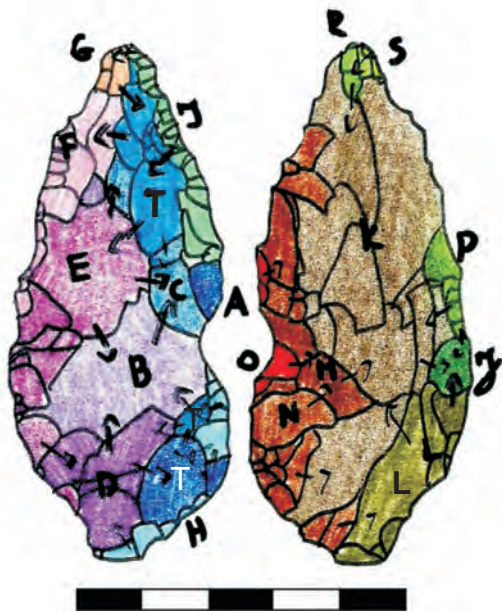


Biconvex tool without exposed tip, with both edges rejuvenated by series of flat, hinged removals derived alternately. Rejuvenation was focused on edges, not on shape or tip exposure.



- F. flat, partly hinged retouch on the upper face, edge resharpening
- L. flat, marginal removals on the lower face near the base, edge correction
- E. semi-flat and semi-steep removals on the upper face near the base and along the edge, near-the-base part rejuvenation, edge resharpening
- K. flat, marginal removals on the lower face, edge correction
- D. semi-flat removals on the upper face, edge rejuvenation
- J. flat, angular removals on the lower face near the base, surface thinning, edge angle correction, thinning
- H. flat and semi-flat removals on the lower face, edge correction, sharpening (?)
- C. flat, far going removals on the upper face, edge formation/rejuvenation (?)
- B. flat removals on the upper face, edge formation
- A. single, steep scar on the upper face, earlier stages of manufacturing process
- G. semi-flat, broad removals on the lower face, surface formation, thinning or already edge formation
- I. flat, broad removals on the lower face, surface formation, and near-the-tip part thinning

## Plate 205 Jankovich Pb559



Biplan, elongated tool with irregular line of both edges and exposed tip. Both edges were resharpended subsequently on the upper face. Lower face was used for edge angle correction. Very high hinged scar damaged one of edges (sequence M) on the lower face, and created a notch on the edge. Base was formed alternately.

- O. steep removals on the lower face, deepening the notch at the edge
- I. semi-steep, marginal retouch on the upper face, edge resharpening
- S. semi-steep, marginal truncations on the lower face near the tip, edge resharpening
- G. semi-steep, marginal retouch on the upper face near the tip, edge resharpening, tip exposure
- T. semi-steep removals on the upper face near the tip, edge resharpening
- H. semi-steep, marginal retouch on the upper face near the base, edge resharpening
- N. semi-flat and semi-steep removals on the lower face, edge angle correction
- F. semi-steep and semi-flat retouch on the upper face near the tip, edge resharpening
- R. flat, marginal removals on the lower face at the tip, edge angle correction, thinning
- P. semi-flat and semi-steep, marginal removals on the lower face, edge angle correction
- E, D. semi-flat removals on the upper face, edge formation/rejuvenation/shaping (?)
- L. semi-flat removals on the lower face near the base, edge angle correction
- B. single, flat, broad removal on the upper face, surface formation
- C. flat removals on the upper face, edge formation/rejuvenation/shaping (?)
- A. flat removals on the upper face, earlier stages of manufacturing process
- M. flat, high (>7mm) hinged removals on the lower face, edge damaging, unsuccessful thinning,
- K. flat, broad removals on the lower face, surface formation, thinning
- J. single, flat scar on the lower face, earlier stage of manufacturing process

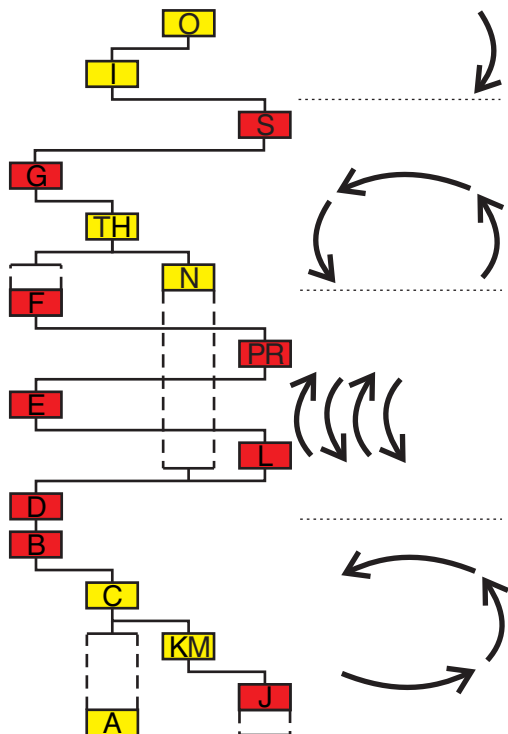
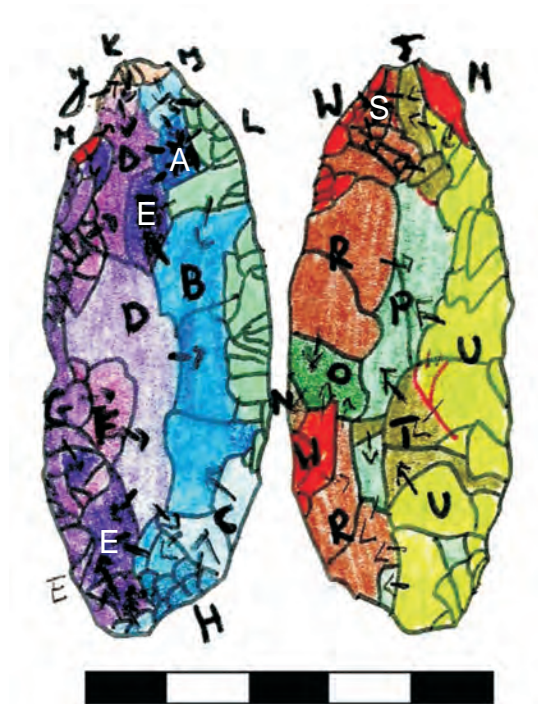
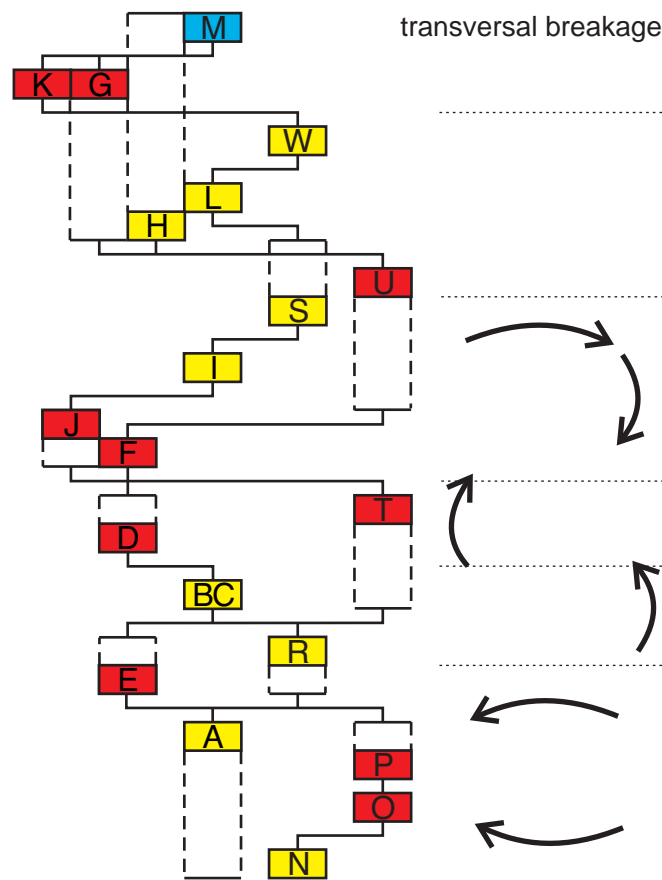


Plate 206 Jankovich Pb560



Biconvex, flat, elongated tool without exposed tip. Both edges were resharpened subsequently on the upper face. Lower face was used for edge angle correction. Edge II had blunting retouch which created notches along the edge. At last stage of rejuvenation base was retouched, probably to create working edge there. Tip was blunted. The pradnik, spall-like removal can be a postdepositional truncation.

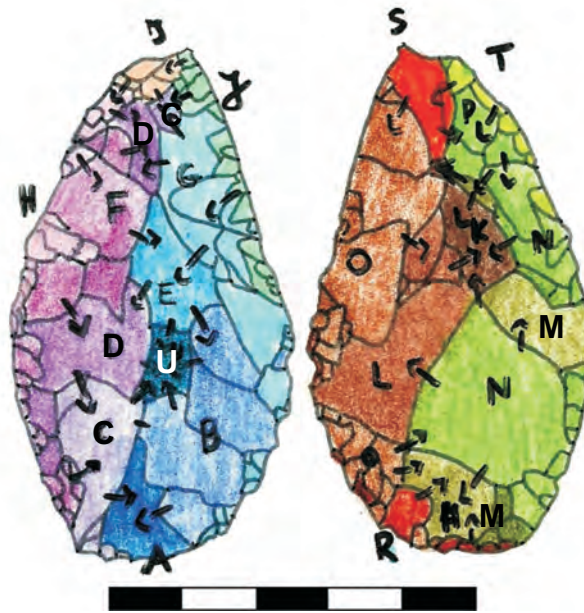
## Plate 206 Jankovich Pb560



- M. twisted, pradnik spall-like removal derived on the lower face from the tip
- K. steep removals on the upper face at the tip, tip blunting
- G. semi-flat and steep irregular, marginal retouch created notches
- W. semi-steep, marginal retouch on the lower face, edge correction, resharpening
- L. semi-steep and semi-flat, regular, marginal retouch on the upper face, edge resharpening
- I. semi-flat removals on the upper face near the tip, edge resharpening, thinning
- S. semi-flat removals on the lower face near the tip, edge angle correction, thinning
- H. steep, marginal retouch on the upper face at the base, edge resharpening, created the working edge (?)
- U. semi-flat removals on the lower face, edge angle correction, thinning
- J. flat, small removals on the upper face near the tip, edge resharpening, near-the-tip part thinning, analogical to sequence I
- F. semi-flat removals on the upper face, edge rejuvenation
- T. flat removals on the lower face, edge angle correction, thinning
- D. semi-flat, broad removals on the upper face, surface rejuvenation, thinning
- B, C. semi-flat removals on the upper face, edge resharpening
- R. flat removals on the lower face, edge angle correction
- E. semi-flat removals on the upper face, semi-steep near the tip, earlier stages of manufacturing process
- A. single, flat scar on the upper face, earlier stages of manufacturing process
- P. flat, broad removals on the lower face, surface formation, thinning
- O, N. semi-steep scars on the lower face, earlier stages of manufacturing process

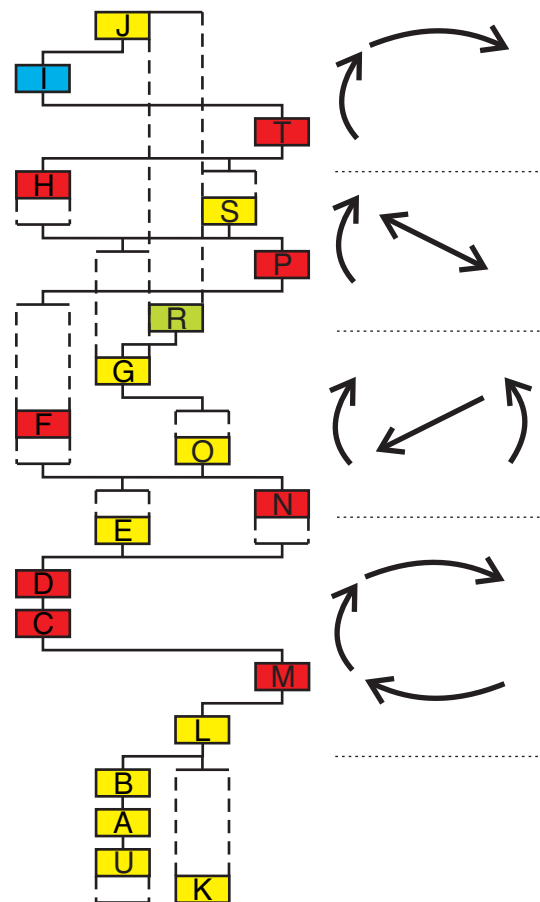


Plate 207 Jankovich 13.917.1



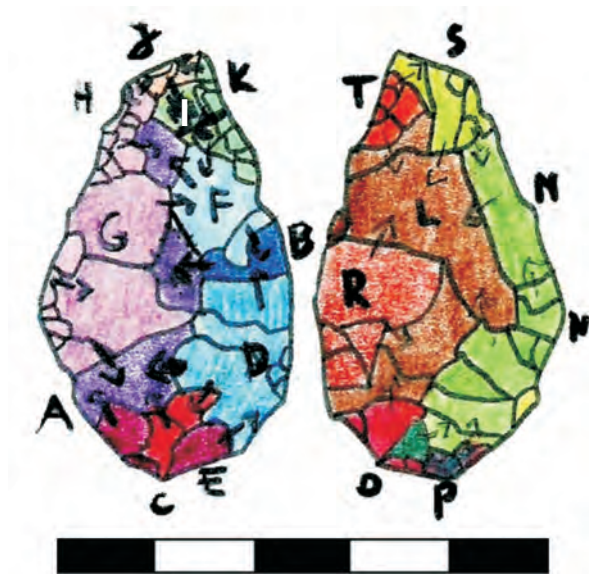
Flat tool with straight cutting edge and concave distal posterior edge, resharpened several times and rejuvenated onat both edges. Tip was moved from vertical axis by rejuvenating sequences, and was blunted at last stage of distal posterior edge rejuvenation. Base was formed precisely and thinned.

# Plate 207 Jankovich 13.917.1



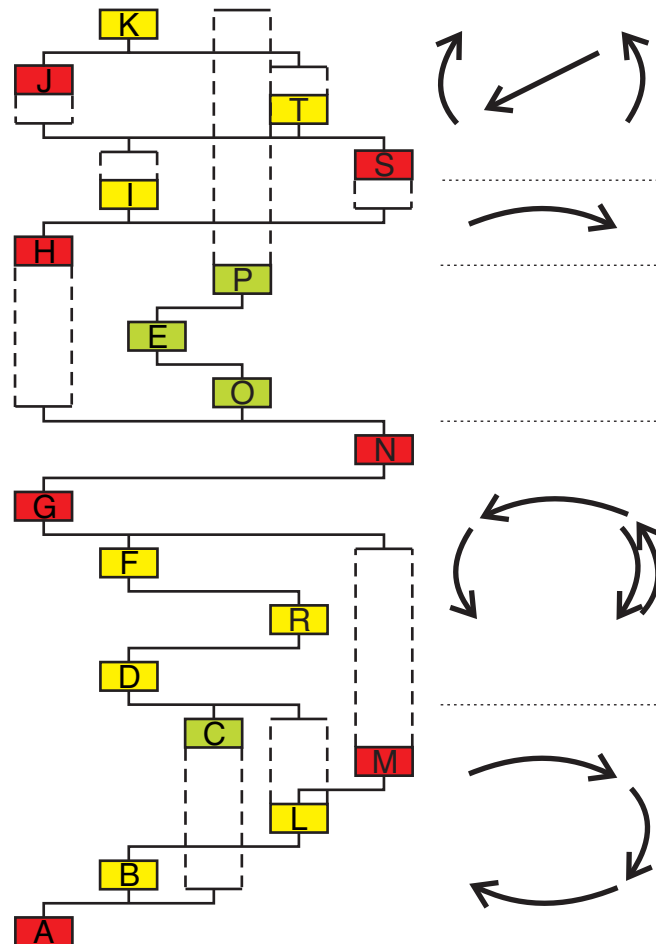
- I. steep, marginal removals on the upper face at the tip, distal posterior edge rejuvenation, thinning
- J. semi-flat, marginal retouch on the upper face near the tip; cutting edge resharpening
- T. small, deep truncation on the lower face near the tip, distal posterior edge correction
- H. semi-flat, marginal retouch on the upper face, less regular than sequence J, edge resharpening
- S. single, flat removal on the lower face near the tip, near-the-tip part thinning
- P. semi-flat removals on the lower face near the tip, edge angle correction, and near-the-tip part thinning
- F. semi-flat removals on the upper face near the tip, edge rejuvenation
- R. steep, marginal retouch on the lower face at the base, edge rejuvenation
- G, E, B. semi-flat removals on the upper face, cutting edge resharpening
- O, L. flat removals on the lower face, edge angle correction, analogical to sequences F and D
- M, N. semi-flat removals on the lower face, edge angle formation, thinning
- D, C. flat removals on the upper face, edge formation, thinning, rejuvenation (?)
- A, U. flat scars on the upper face, earlier stages of manufacturing process
- K. flat scars on the lower face, earlier stages of manufacturing process

Plate 208 Jankovich 13.917.2



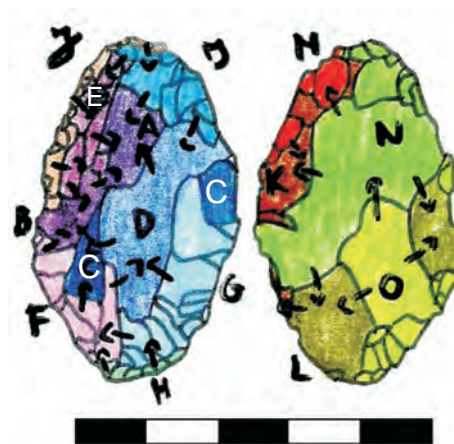
Biconvex tool with straight cutting edge and concave distal posterior edge, resharpened several times and rejuvenated on both edges, tip was moved from vertical axis by rejuvenating sequences and was blunted at last stage of distal posterior edge rejuvenation. Base was formed precisely and thinned.

# Plate 208 Jankovich 13.917.2

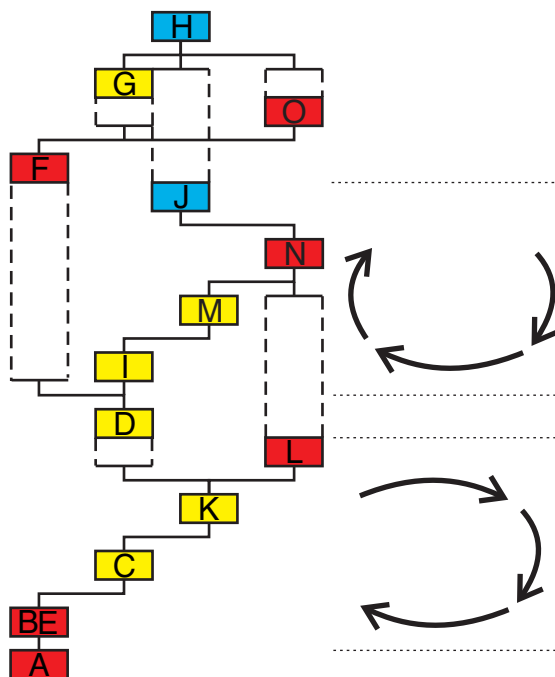


- K. flat, regular, hinged, marginal retouch on the upper face near the tip, edge resharpening
- J. semi-steep, marginal removals on the upper face at the tip, distal posterior edge rejuvenation, tip blunting
- T, S. semi-flat removals on the lower face near the tip, edge angle correction
- I. flat removals on the upper face near the tip, edge resharpening
- H. semi-flat, marginal retouch on the upper face, edge resharpening
- P, O. flat removals on the lower face, base edge rejuvenation, thinning
- E, C. flat removals on the upper face, base edge rejuvenation, thinning
- N, M. semi-flat removals on the lower face near the base, edge angle correction
- G, D. semi-flat removals on the upper face, edge thinning, resharpening
- F. semi-steep removals on the upper face, edge thinning, resharpening
- L, R. flat removals on the lower face, edge angle correction, thinning
- A, B. semi-flat removals on the upper face, earlier stages of manufacturing process (rejuvenation?)

Plate 209 Jankovich 13.917.3



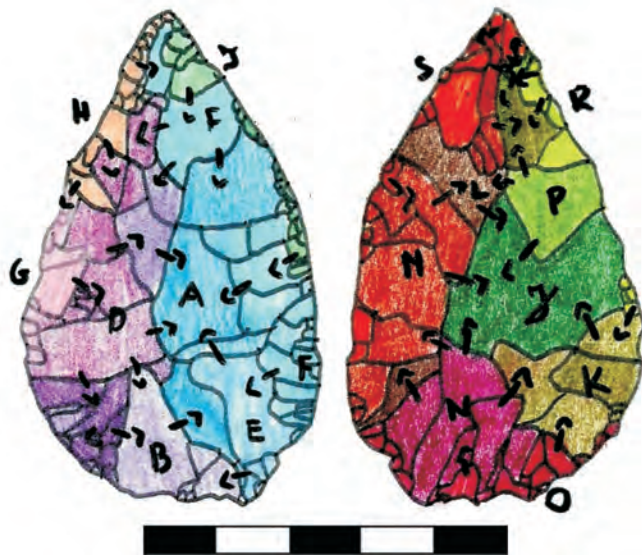
Plano-convex tool with both edges resharpended several times. Working edge was created at the tip edge and at the end of chaîne opératoire; also at the base edge. Lower face was used for edge angle correction.



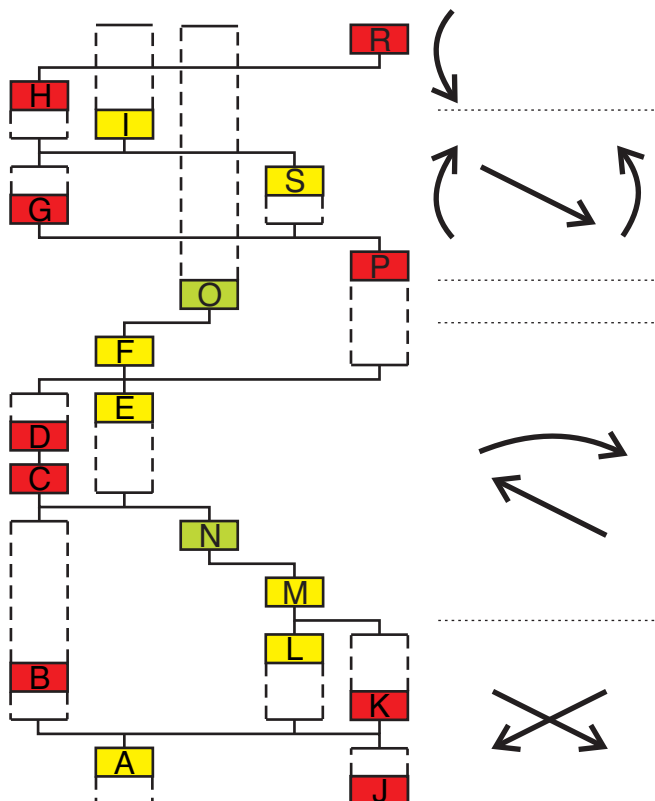
- H. steep, marginal retouch on the upper face at the base, edge resharpening
- O. semi-flat removals on the lower face, edge angle correction, thinning
- G, F. semi-steep removals on the upper face near the base, edge resharpening, thinning
- J. steep, marginal retouch on the upper face at the tip and along the edge, edge resharpening
- N. flat, far going removals on the lower face, edge angle correction, thinning
- M, K. semi-flat removals on the lower face, edge angle correction
- I, E. flat, partly hinged retouch on the upper face near the tip, edge resharpening
- D. single, flat, broad removal on the upper face, edge thinning, rejuvenation (?)
- L. semi-flat removals on the lower face, edge angle correction, surface thinning
- A, C. flat removals on the upper face, earlier stages of manufacturing process
- B. semi-steep removals on the upper face, earlier stages of manufacturing process



# Plate 210 Jankovich 61.925.2

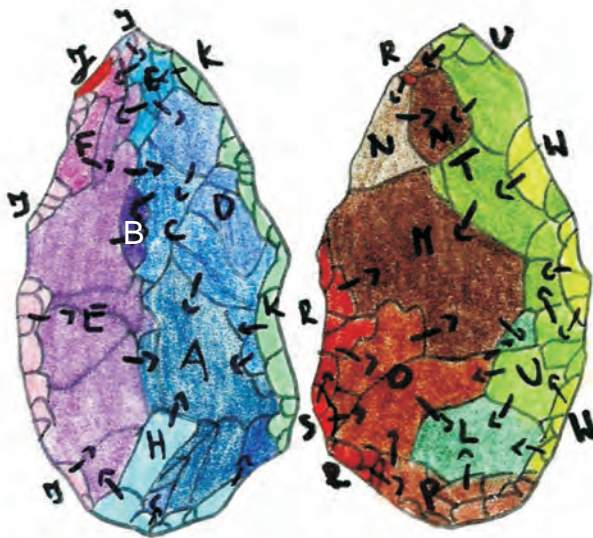


Biconvex, very thin tool with exposed tip and rounded base. Both edges were resharpened subsequently. Base was formed precisely on the lower face. Lower face was used for edge angle correction. Sequences C, D, M could be aimed at shaping.

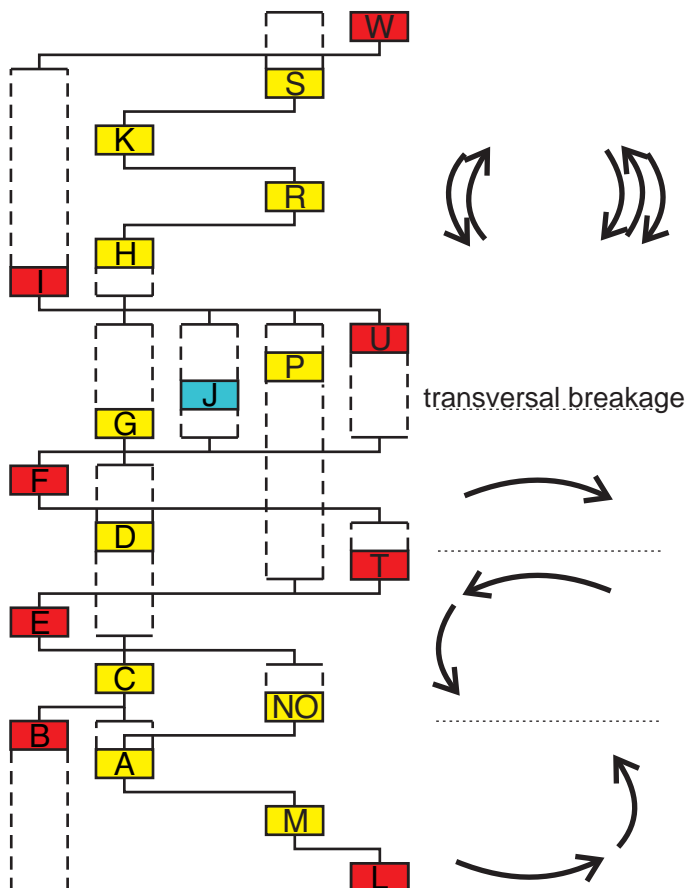


- R. semi-flat, deep, marginal removals on the lower face, edge correction
- H, G. semi-flat, marginal retouch on the upper face, edge resharpening
- I. flat, marginal retouch on the upper face, edge resharpening
- S. semi-flat removals on the lower face, edge angle correction, and near-the-tip part thinning
- P. flat removals on the lower face, edge angle correction
- F. semi-flat removals on the upper face, edge resharpening
- E. flat removals on the upper face, edge resharpening
- C, D. semi-flat/flat removals on the upper face, edge thinning, analogical to M, shaping (?)
- O. steep, marginal removals on the lower face, base edge formation
- N. flat removals on the lower face derived from the base, surface thinning, and near-the-base part formation
- M. semi-flat removals on the lower face, edge angle correction, surface thinning, shaping (?)
- K. flat removals on the lower face, edge angle correction, surface thinning
- L, J. flat, broad removals on the lower face, surface formation, thinning
- A, B. flat, broad removals on the upper face, earlier stages of manufacturing process, surface formation, or already rejuvenation

# Plate 211 Jankovich 94.915.8

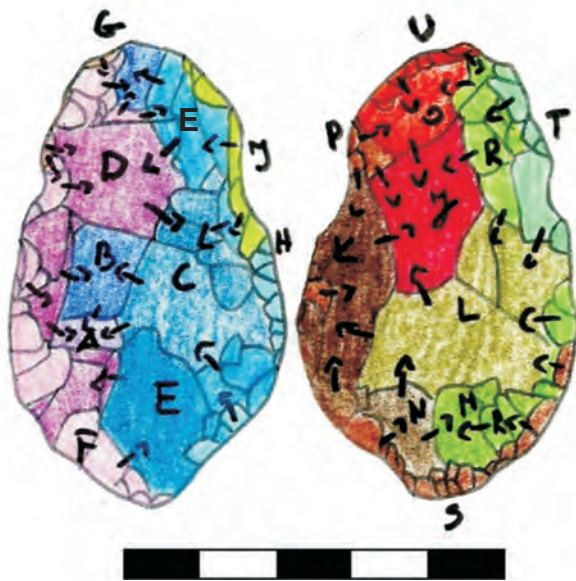


Plano-convex, thin tool with poorly exposed tip and both edges blunted due to subsequent resharpening sequences. At last stages of rejuvenation, resharpening retouch was derived on both faces and also at the base.

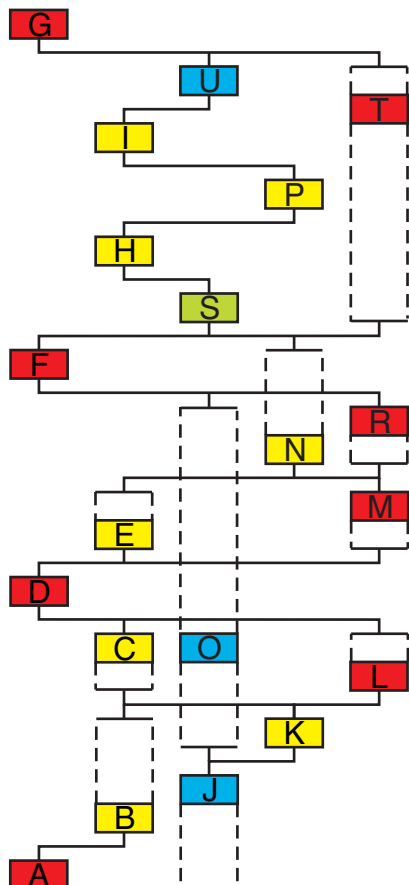


- W, S, R. steep, marginal removals on the lower face, edge resharpening
- K, I. steep, marginal removals on the upper face, edge resharpening, created notches
- H. steep and semi-steep, marginal removals on the upper face at the base, edge resharpening
- U, T, N, O. flat removals on the lower face, edge angle correction
- P. semi-steep retouch on the lower face at the base, edge resharpening
- J. transversal breakage at the edge near the tip, located angularly to vertical axis
- G. semi-steep removals on the upper face near the tip, edge resharpening
- F. semi-flat removals on the upper face near the tip, edge resharpening
- D. semi-flat/semi-steep removals on the upper face, edge resharpening
- C. semi-flat removals on the upper face, edge sharpening/rejuvenation (?)
- E. flat removals on the upper face, edge thinning/sharpening/Rejuvenation (?)
- A, B. flat removals on the upper face, earlier stages of manufacturing process
- M, L. flat, broad removals on the lower face, surface formation, thinning

Plate 212 Jankovich 94.915.9

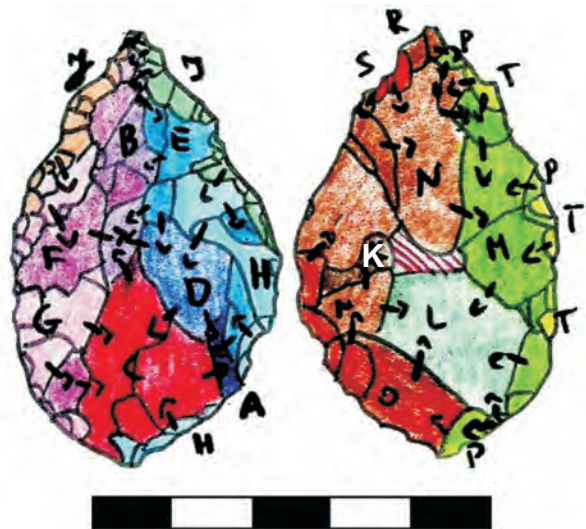


Plano-convex, heavily exhausted tool with blunted edges, tip and base. All edges were retouched and resharpened subsequently. There were separate working edges created by semi-steep retouch at the tip and at the base.

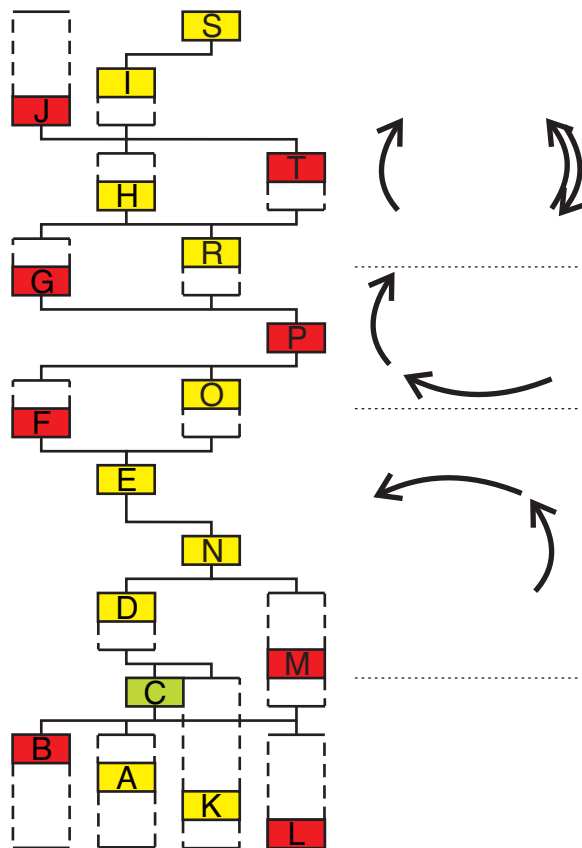


- G. steep truncations on the upper face at the tip, edge blunting
- U. steep, marginal retouch on the lower face, edge rejuvenation
- T. flat and semi-flat, marginal retouch on the lower face, edge angle correction
- I. steep, marginal retouch on the upper face, edge resharpening
- P. flat removals on the lower face, edge angle correction
- H. semi-steep, marginal retouch on the upper face, edge resharpening
- S. steep, marginal retouch on the lower face at the base, edge sharpening, created a working edge at the base
- F. semi-flat, marginal retouch on the upper face, edge resharpening
- R. flat removals on the lower face, edge angle correction
- M, N. flat and semi-flat removals on the lower face, edge angle correction, probably also notches preparation at the base
- E. semi-flat removals on the upper face, shaping, surface thinning, rejuvenation
- D. flat removals on the upper face, edge formation, thinning
- C. flat removals on the upper face, edge formation
- O, J. flat removals on the upper face derived from the tip, surface formation, thinning
- K, L. flat, broad removals on the lower face, surface formation, thinning
- A, B. flat scars on the upper face, earlier stages of manufacturing process

Plate 213 Jankovich 94.915.13



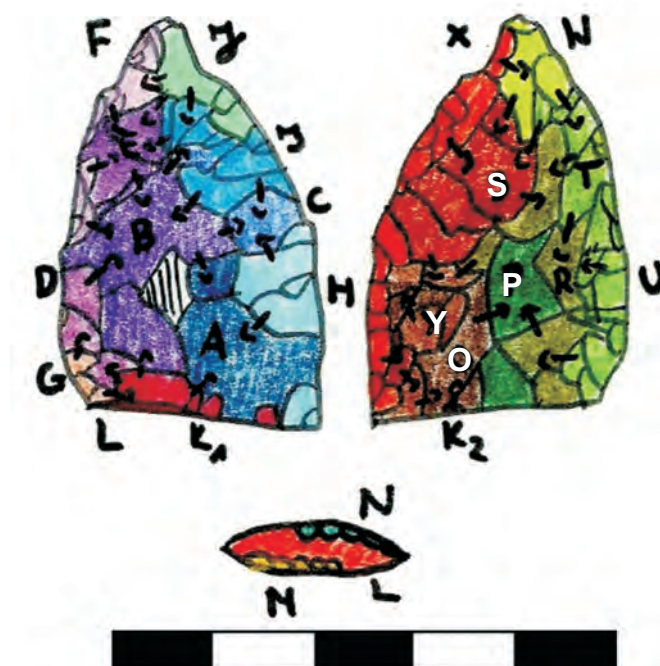
Plano-convex tool with exposed tip and concave rounded base, both edges were retouched and resharpener subsequently on the upper face. Lower face was used for edge angle correction.



- S. semi-steep truncations on the lower face near the tip, edge correction
- I, J. semi-steep, hinged, marginal retouch on the upper face near the tip, edge resharpener
- T. semi-flat truncations on the lower face, edge angle correction
- H. semi-flat near the tip and semi-steep near the base, marginal retouch on the upper face, edge resharpener
- G, E. semi-steep, marginal retouch on the upper face, edge resharpener
- R, P. flat removals on the lower face, edge angle correction
- O. flat removals on the lower face near the base, edge angle correction, thinning
- N, M. flat removals on the lower face, edge angle correction
- D, F. semi-flat removals on the upper face, earlier stages of edge resharpener (?)
- B. flat scars on the upper face, earlier stages of edge resharpener (?)
- A. semi-steep scar on the upper face, earlier stages of manufacturing process
- C. semi-flat removals on the upper face derived from the base, thinning, and base formation/rejuvenation (?)
- K, L. flat, broad scars on the lower face, earlier stages of manufacturing process



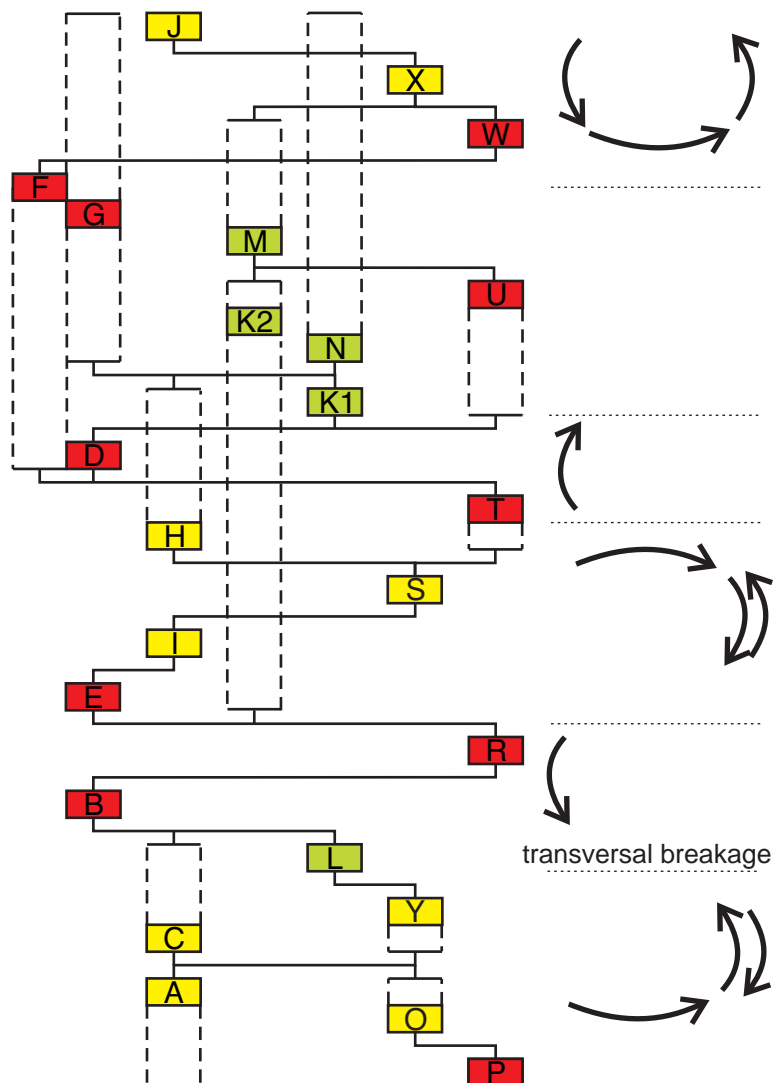
Plate 214 Jankovich 94.915.15



Biconvex tool with base broken transversally in the middle of chaîne opératoire, probably during rejuvenation phases. Both edges were retouched and subsequently resharpened before and after breakage. At last stage of rejuvenation, a kind of borer was created at the tip.

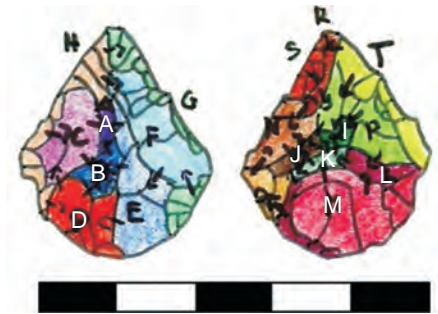


# Plate 214 Jankovich 94.915.15



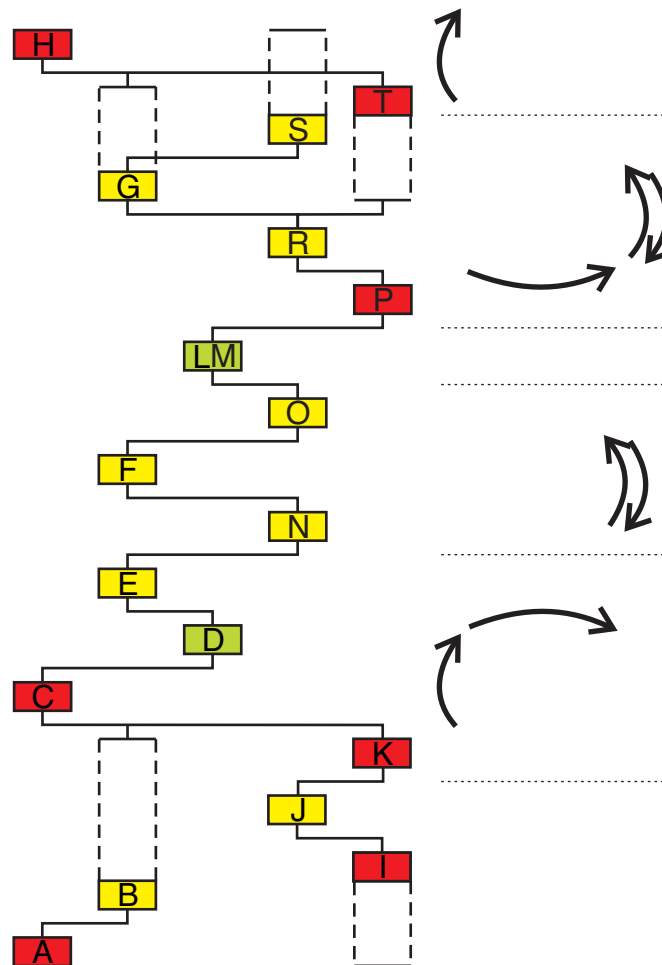
- J. steep removals on the upper face near the tip, created a borer at the tip
- F. semi-steep removals on the upper face near the tip, created a borer at the tip
- X. semi-flat, marginal removals on the lower face, edge resharpener
- W. flat, marginal removals on the lower face, edge correction, and near-the-tip part thinning
- G. semi-steep, marginal retouch on the upper face near the breakage, edge correction
- M, N. flat, marginal removals on the breakage scar, scar flattening
- K1, K2. flat, marginal removals derived from the breakage scar onto the lower and upper face, edge correction
- U. semi-steep, marginal removals on the lower face, edge correction after breakage
- D. flat retouch on the upper face, edge resharpener
- T. semi-flat removals on the lower face, edge angle correction
- H, I, C, E. semi-flat removals on the upper face, edge resharpener
- S, Y, R. flat removals on the lower face, edge angle correction
- B. flat removals on the upper face, earlier stages of rejuvenation (?)
- A. semi-flat removals on the upper face, earlier stages of rejuvenation (?)
- L. transversal breakage
- O, P. flat removals on the lower face, earlier phases of manufacturing process (rejuvenation?)

Plate 215 Jankovich 94.915.16



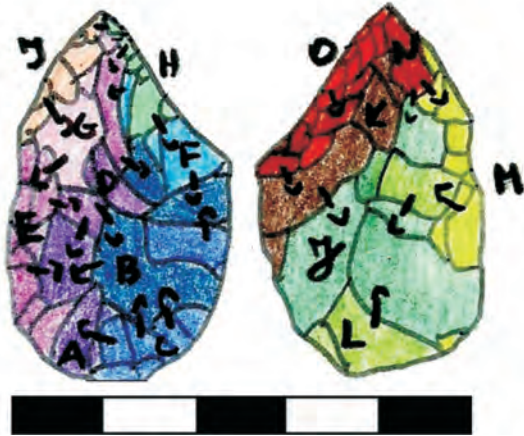
Biconvex, heavily exhausted, small tool with exposed tip and both edges subsequently resharpened on the upper face. Lower face was used for edge angle correction. Flat removals derived from the base, aimed at base part thinning.

# Plate 215 Jankovich 94.915.16

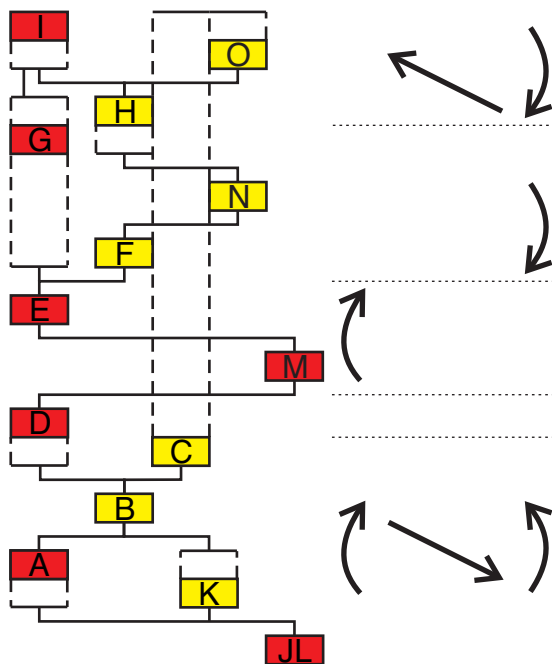


- H. semi-steep, precise, regular marginal retouch on the upper face, edge resharpening
- T. flat, marginal removals on the lower face, edge angle correction
- S. flat, marginal removals on the lower face, edge correction
- G. semi-flat, marginal retouch on the upper face, edge resharpening, partial blunting
- P. flat/semi-flat, marginal removals on the lower face, edge angle correction, and near-the-tip part thinning
- R. flat, hinged removals on the lower face, edge angle correction, and near-the-tip part thinning
- L, M. semi-flat removals on the lower face, derived from the base, surface thinning and rejuvenation
- D. flat removals on the upper face, derived from the base, surface thinning, rejuvenation
- O. semi-flat removals on the lower face, edge angle correction
- N. flat removals on the lower face, edge angle correction
- J, K, I. flat scars on the lower face, earlier stages of manufacturing process
- F, E, C. semi-flat removals on the upper face, edge resharpening
- A, B. flat scars on the upper face, earlier stages of manufacturing process

Plate 216 Jankovich 94.915.40

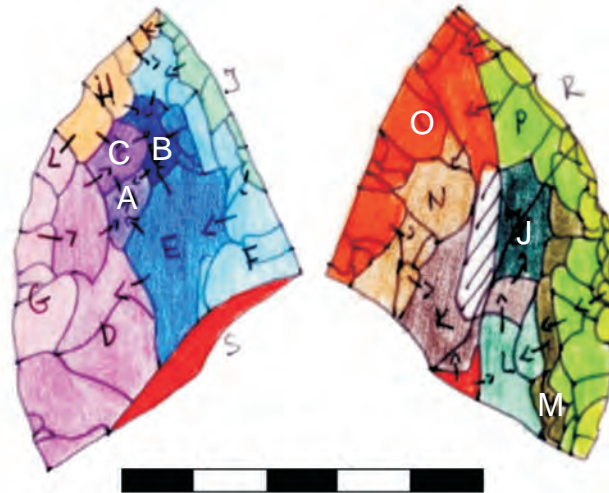


Plano-convex, exhausted, small, inverted knife with single cutting edge located on the left side of the upper face. Distal posterior edge was rejuvenated by flat removals derived on the lower face, whereas the upper face was used on this edge for edge angle correction. Cutting edge was retouched on the upper face, and its lower face was used for edge angle correction. Tip is exposed but located out of vertical axis. Base is concave, rounded and precisely worked.

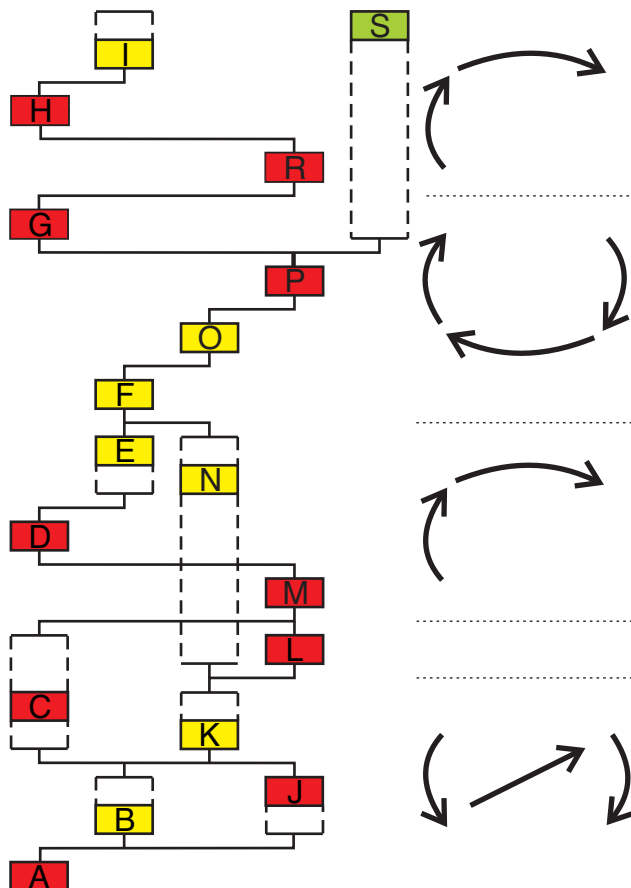


- I. semi-flat, marginal retouch on the upper face, edge resharpening
- E. semi-flat, hinged removals on the upper face, edge resharpening
- G. semi-flat removals on the upper face near the tip, aimed at removing near-the-tip, hinged scars
- O, N. flat, marginal removals on the lower face near the tip, edge thinning, rejuvenation
- H, F. semi-steep, marginal retouch on the upper face near the tip, edge angle correction, edge rejuvenation
- M. flat removals on the lower face, edge angle correction
- D. semi-flat removals on the upper face, edge resharpening
- C. marginal retouch on the upper face at the base, edge formation
- A, B. semi-steep removals on the upper face, earlier stages of manufacturing process, probably rejuvenation
- K. flat removals on the lower face, edge angle correction, thinning
- J, L. flat, broad removals on the lower face, surface thinning, earlier stages of manufacturing process

Plate 217 Sajóbabony Mész-tető 91.257.1



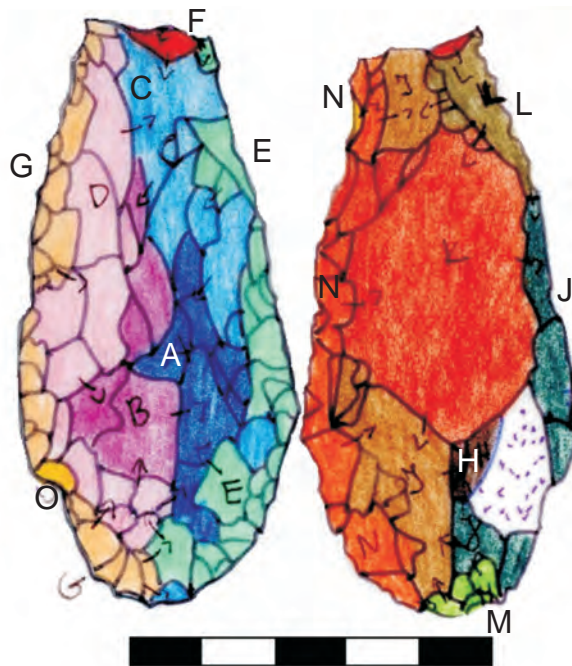
Tool with exposed tip and broken base. One of edges is flat and the second is semi-steep on the lower face; therefore; removals were derived semi-steeply onto the edge (sequences M, P, R). Both edges were intensively resharpened and the upper face was intensively thinned.



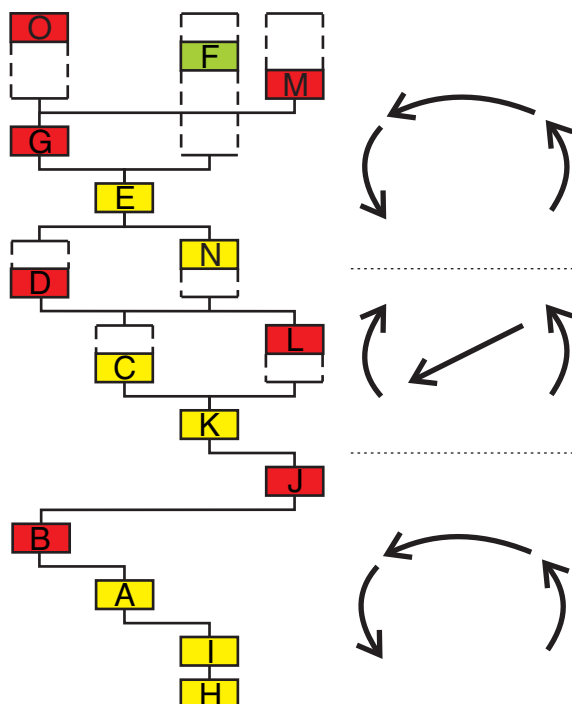
- I. flat, small, marginal retouch on the upper face near the tip, edge resharpening
- H. flat, partly hinged, marginal retouch on the upper face near the tip, edge resharpening
- R. semi-steep, marginal retouch on the lower face, near the tip more flat and hinged, edge angle correction
- G. flat, hinged removals on the upper face, edge resharpening
- P. semi-steep removals on the lower face, edge angle correction
- O, N. flat removals on the lower face, edge angle correction
- S. transversal breakage
- F. flat removals on the upper face, edge resharpening
- E. semi-flat removals on the upper face, edge resharpening
- D. flat removals on the upper face, edge formation, sharpening (?)
- M. semi-flat, partly hinged scars, earlier stages of edge angle formation
- L. flat, hinged removals on the lower face, surface formation
- J, K. flat removals on the lower face, surface formation
- C. single, flat, hinged removal on the upper face near the tip, surface formation, thinning
- A, B. flat and semi-flat scars, earlier stages of manufacturing process



# Plate 218 Sajóbáony Mész-tető 91.258.1

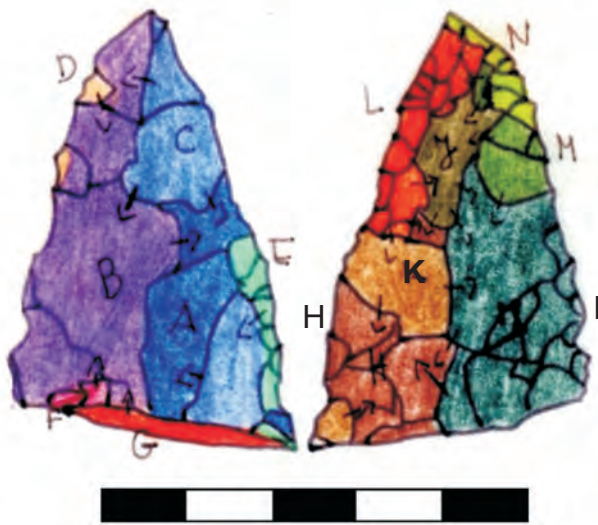


Plano-convex tool with blunted, probably broken tip and both edges reshaped several times. At the end of chaîne opératoire, its orientation was probably changed and the tool was retouched at the base. Lower face was used for edge angle correction.

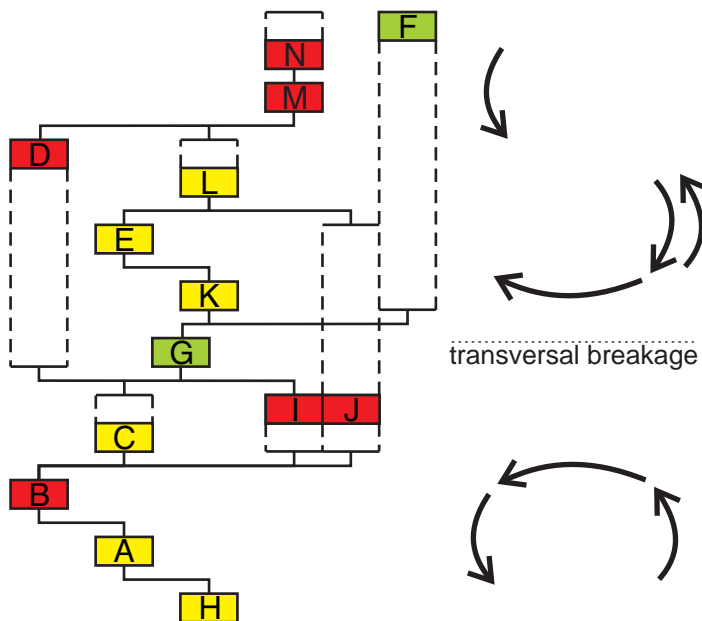


- O. postdepositional truncation
- F. steep, blunting retouch at the tip
- M. flat, marginal removals on the lower face at the base, edge correction
- G. semi-steep, marginal retouch on the upper face along the edge and at the base, edge reshaping
- E. semi-steep/semi-flat, partly hinged, marginal retouch on the upper face along the edge and at the base, edge reshaping
- N. semi-flat removals on the lower face, edge angle correction
- D, C. semi-steep, partly hinged removals on the upper face, edge formation, sharpening (?)
- L. flat, partly hinged removals on the lower face near the tip, edge angle formation
- K. flat, broad removals and single hinged removal on the lower face, surface flattening, thinning, edge angle formation
- J, I. flat removals on the lower face, surface formation, thinning
- A, B. semi-steep removals on the upper face, surface formation, thinning, unsuccessful thinning near the base
- H. flat scar, earlier stages of manufacturing process

# Plate 219 Sajóbáony Méhész-tető 91.258.2

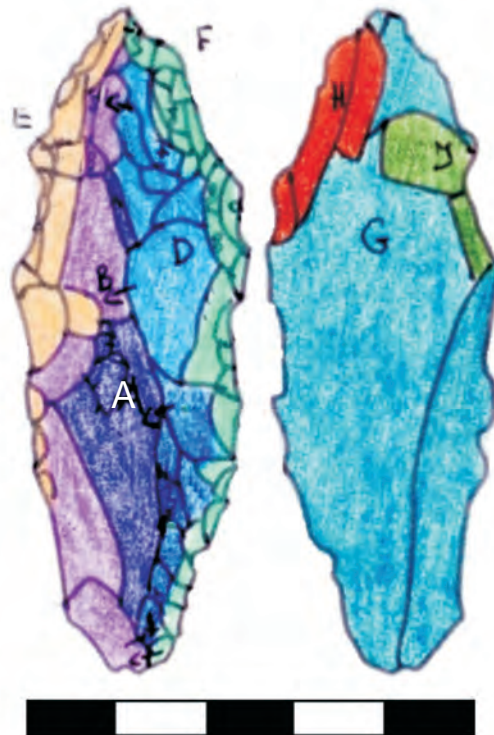


Plano-convex tool with transversally broken base and exposed tip located out of vertical axis. Both edges were retouched and resharpened also after breakage; near-the-tip part was thinned on the lower face.

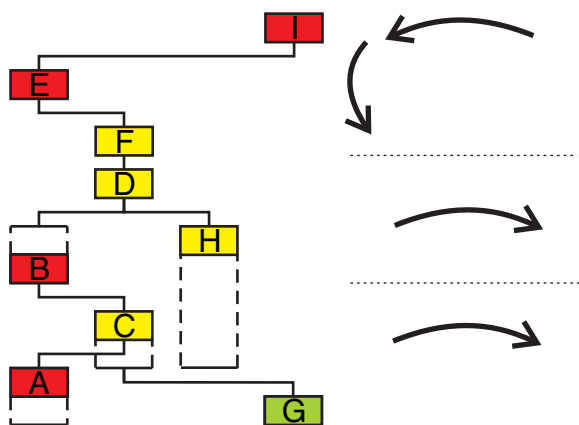


- N. marginal retouch on the lower face near the tip, edge resharpening, partly usewear
- M. flat, marginal retouch on the lower face near the tip, edge resharpening, thinning
- D. semi-flat truncations on the upper face, edge correction
- L. semi-flat, partly hinged, marginal retouch on the lower face near the tip, edge resharpening, thinning
- F, E. semi-steep, marginal retouch on the upper face, edge resharpening
- K. semi-flat removals on the lower face, edge angle correction
- F. flat, small, marginal truncations on the upper face derived from the breakage scar
- G. transversal breakage, impact point in the middle of the lower face
- J. single, flat removals on the lower face, near-the-tip part thinning
- I. semi-steep/semi-flat removals on the lower face, edge formation
- C. semi-steep removals on the upper face, edge formation
- A, B. semi-steep, broad removals on the upper face, surface formation
- H. semi-flat removals on the lower face, surface formation, thinning

Plate 220 Sajóbabony Méhész-tető 91.258.3

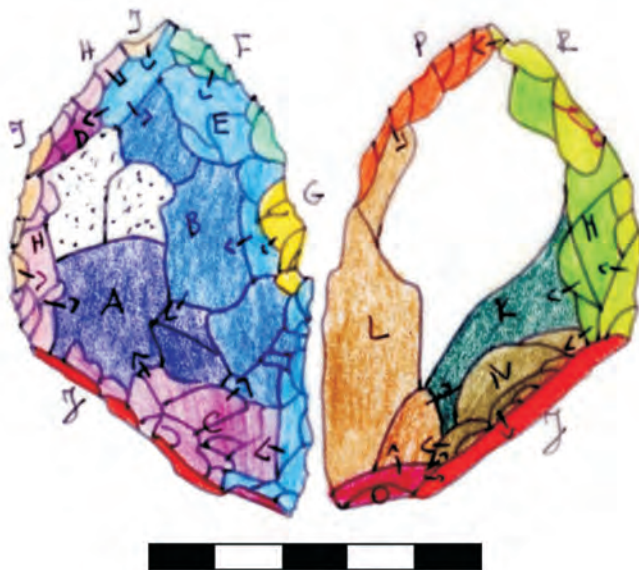


Plano-convex tool with subsequently resharpened both edges. Both edges were blunted due to rejuvenation sequences derived on the upper face. Small, flat, edge angle correcting removals were derived on the lower face; lower surface is irregular.

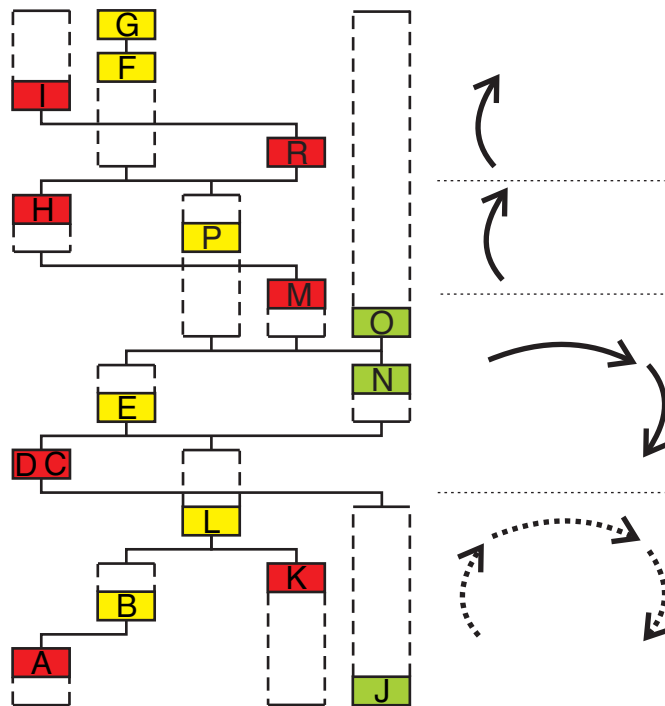


- I, H. flat removals on the lower face, edge angle correction
- E. steep, marginal retouch on the upper face, edge resharpening
- F. semi-steep, marginal removals on the upper face, edge resharpening
- D. steep removals on the upper face, edge resharpening
- B, C. semi-steep removals on the upper face, edge resharpening
- A. semi-flat, broad removals on the upper face, probably derived before obtaining the blank

# Plate 221 Sajóbáony Mész-tető 91.258.7



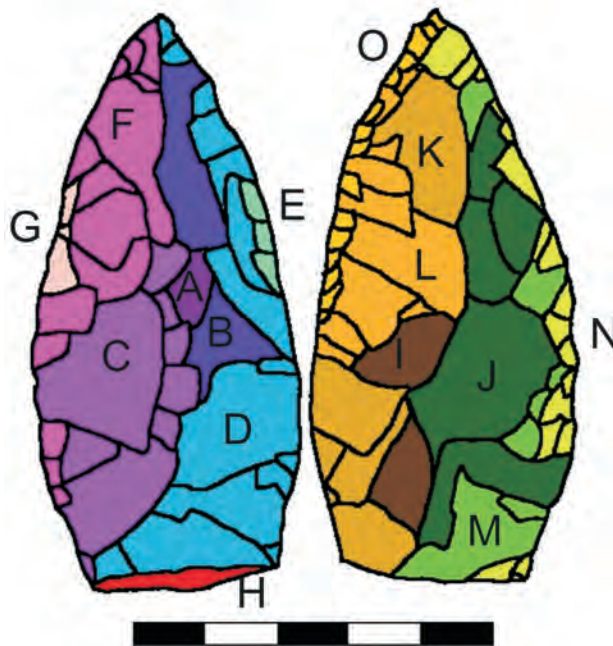
Plano-convex tool with poorly exposed tip and base formed by transversal breakage or natural surface. Both edges were subsequently resharpened.



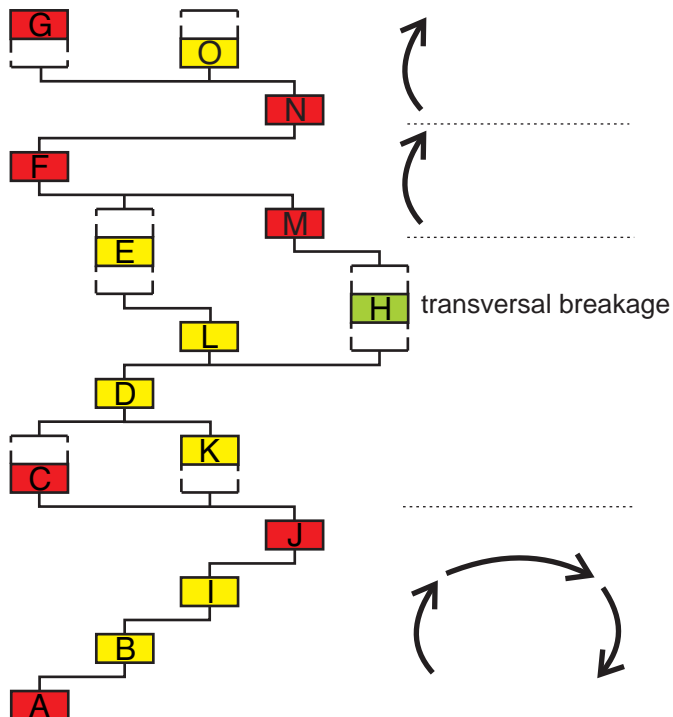
- G. flat truncations on the upper face, probably postdepositional
- F. flat, marginal retouch on the upper face near the tip, edge resharpening
- I. semi-steep and steep, marginal retouch on the upper face, edge resharpening
- P. semi-steep removals on the lower face, edge angle correction
- R, M. semi-flat removals on the lower face, edge angle correction
- H. semi-flat, marginal retouch on the upper face, more steep near the breakage, edge resharpening
- L. semi-flat, broad removals on the lower face, surface formation, edge angle formation and decortication
- E. semi-flat retouch on the upper face, edge resharpening
- C. flat removals on the upper face derived from the breakage scar, surface thinning, base correction
- N. semi-flat, hinged removals on the lower face derived from the breakage scar, surface thinning, base correction
- D. flat, hinged removals on the upper face, edge sharpening
- K. flat, broad removals on the lower face, surface formation, thinning, decortication
- B. flat removals on the upper face, edge formation, sharpening
- A. flat removals on the upper face, surface formation, thinning
- J. transversal breakage or natural surface on the base
- O. semi-steep removals on the lower face at the breakage scar, remove the acute angle near the cutting edge, base formation



Plate 222 Sajóbáony Mész-tető 97.2.1072



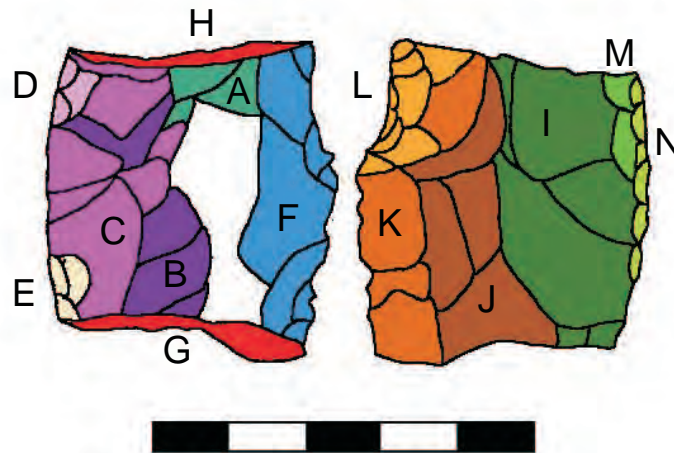
Biconvex leafpoint with broken base and exposed tip. Both edges were treated equally; no traces of intensive reshaping. The tool was shaped and its base was broken in the middle of manufacturing process.



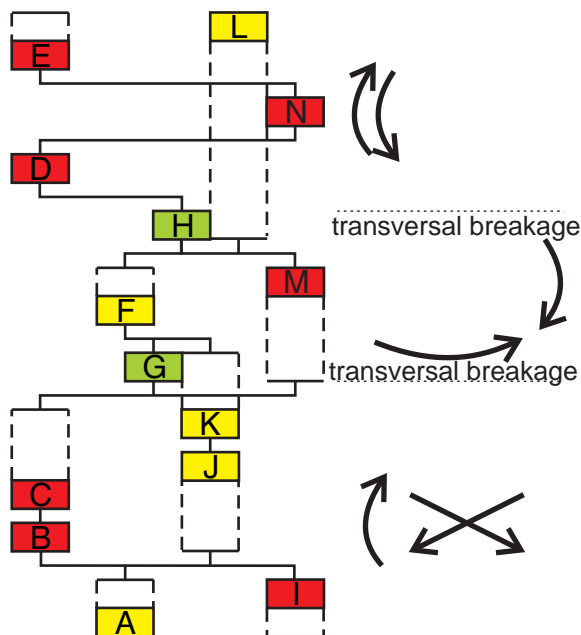
- G. flat, hinged truncations on the upper face, edge damaging,
- O, N. semi-flat, very fine, marginal retouch on the lower face, edge sharpening
- F. semi-flat removals on the upper face near the tip, shaping, thinning
- M. semi-flat removals on the lower face, edge angle correction, thinning
- H. transversal breakage
- E. small, marginal retouch on the upper face, edge correction
- L. semi-flat, removals going far on the lower face, thinning, edge angle correction
- D, C. semi-flat removals on the upper face, shaping, thinning
- K. semi-flat removals on the lower face, edge angle formation, shaping, thinning
- J, I. semi-flat removals on the lower face, surface formation, thinning
- A, B. semi-flat removals on the upper face, surface formation, thinning



Plate 223 Sajóbáony Mész-tető 97.2.1160

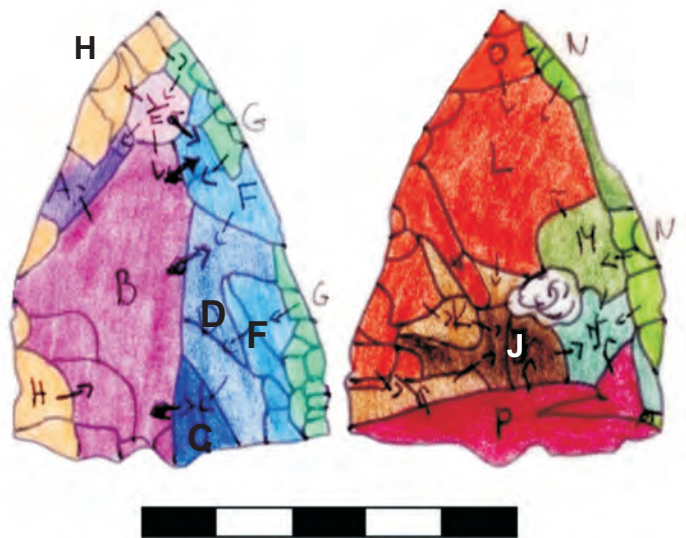


Biconvex, rectangular segment with both ends formed by transversal breakages and both edges straight. One was blunted after breakages, the second was sharpened and deep notch was created near the breakage.

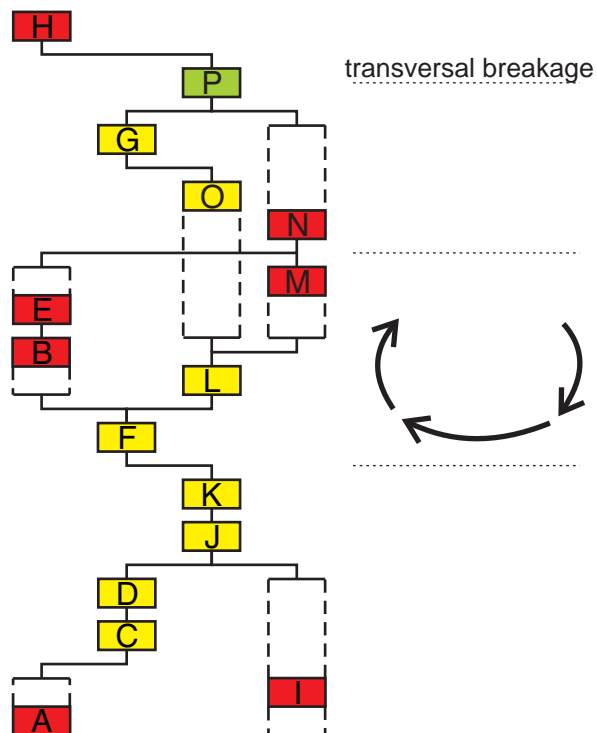


- E. semi-steep, marginal retouch on the upper face at the angle near breakage, edge correction
- D. semi-flat, marginal retouch on the upper face at the angle near breakage, edge correction
- L. semi-flat, marginal retouch on the upper face at the angle near breakage, edge correction, created a notch on the edge
- N. semi-steep, marginal retouch on the lower face, edge correction, blunting
- M. semi-flat removals on the lower face near breakage, edge correction
- F. semi-steep retouch on the upper face, edge sharpening (?)
- K. semi-flat removals on the lower face, edge formation, edge angle formation
- J. flat/semi-flat, broad removals on the lower face, surface formation
- C. semi-flat removals on the upper face, edge formation, thinning
- B. semi-flat removals on the upper face, surface thinning, decortication
- G, H. transversal breakage
- I. flat, broad removals on the lower face, surface formation
- A. flat scars, earlier stages of manufacturing process, decortication

Plate 224 Sajóbáony Mész-tető 97.2.1558

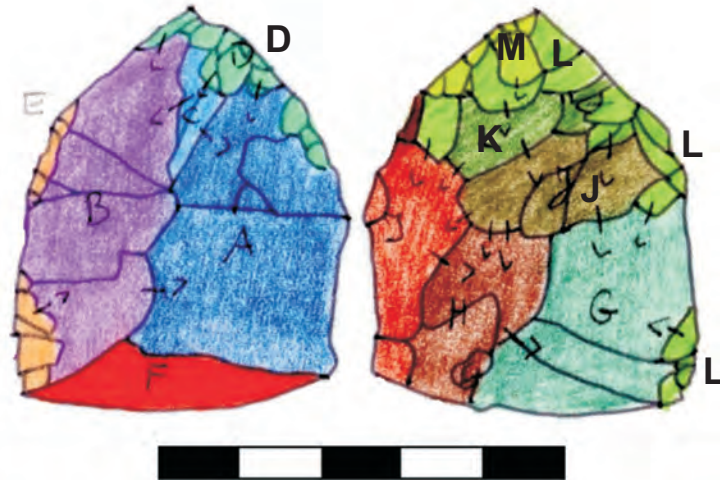


Plano-convex tool with broken base and exposed tip. One edge (edge I) was resharpened several times; edge II was retouched only after breakage.

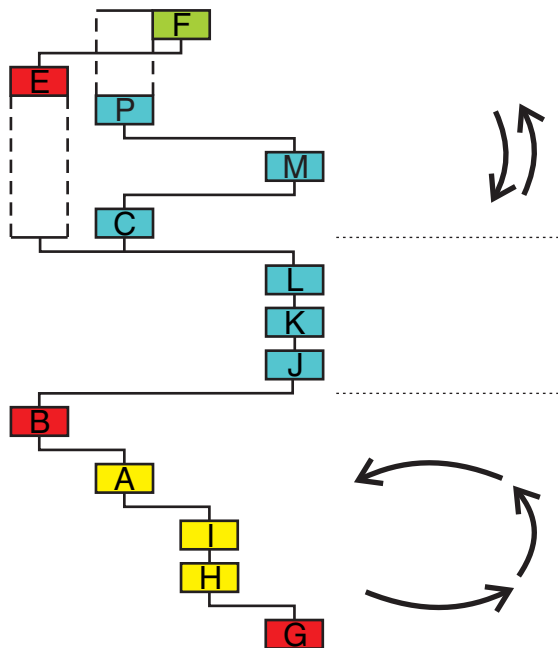


- H. semi-flat, marginal retouch on the upper face near the tip, steep near the breakage, edge sharpening
- P. transversal breakage
- G. semi-flat, marginal retouch on the upper face, edge sharpening
- O. flat removals on the lower face at the tip, edge angle correction, thinning
- N, M, I. semi-flat removals on the lower face, edge angle correction
- L. semi-flat removals on the lower face, edge angle correction, thinning
- F, D. semi-steep removals on the upper face, edge sharpening/resharpening (?)
- K, J. flat removals on the lower face, edge angle correction, surface thinning
- E. single, semi-flat removal on the upper face, near-the-tip part thinning, rejuvenation
- B. semi-flat, broad removals on the upper face, thinning, aimed at removing the hinged scar of sequence C, partly successful
- C. very high (>1cm) hinged removal on the upper face, unsuccessful thinning
- A. semi-steep scar, earlier stages of manufacturing process

Plate 225 Sajóbáony Mész-tető 97.2.1821

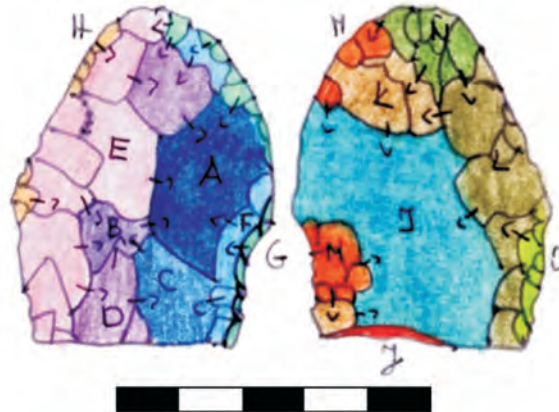


Plano-convex tool with broken base and poorly exposed tip. Retouch was limited only to near-the-tip part; tip was thinned several times on the lower face.

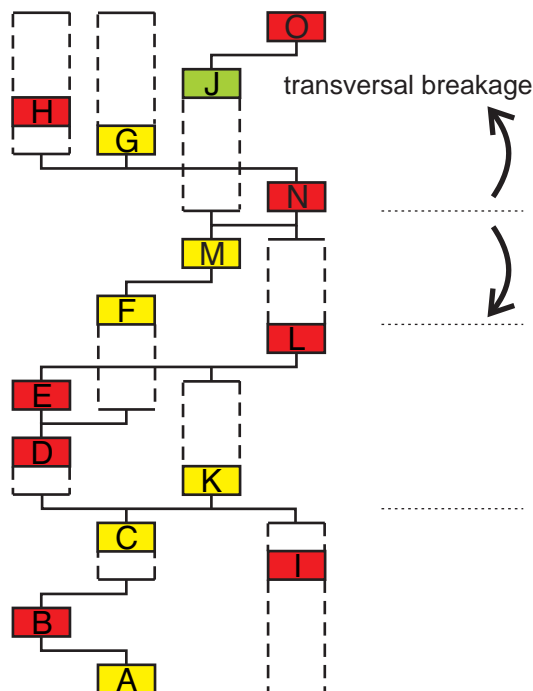


- F. transversal breakage, impact point in the middle of the upper face
- E. small, marginal retouch on the upper face
- M. flat removals on the lower face near the tip, edge angle correction
- L, K, J. flat removals on the lower face near the tip, near-the-tip part thinning
- D. semi-flat, marginal retouch on the upper face, edge sharpening
- C. semi-flat, far going removals on the upper face, near-the-tip part thinning
- G, H, I. flat removals on the lower face, surface formation, thinning
- A, B. semi-flat removals on the upper face, edge formation

Plate 226 Sajóbáony Mész-tető 97.2.1970

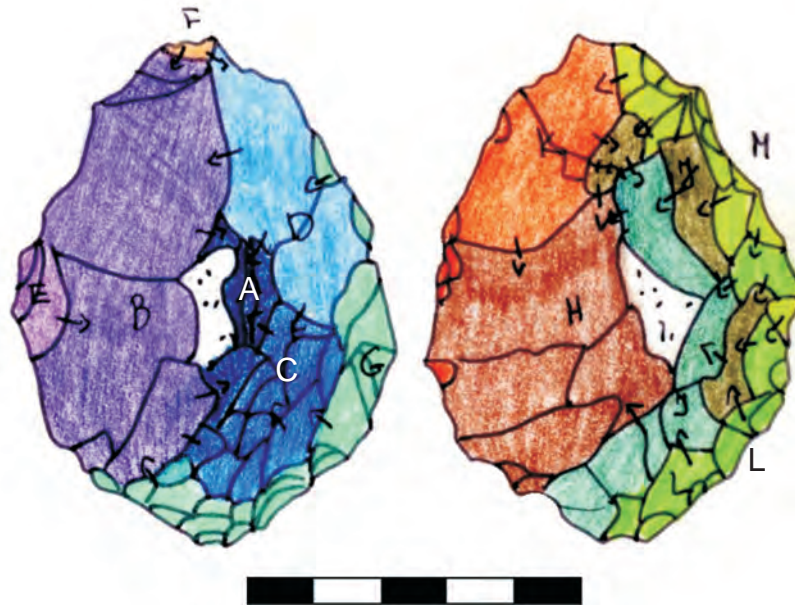


Plano-convex tool made on a flake, with transversally broken base and unexposed tip. The edges were sharpened and resharpened several times. At least one of edges was rejuvenated also after breakage (sequence O). A kind of tang was created near the breakage.

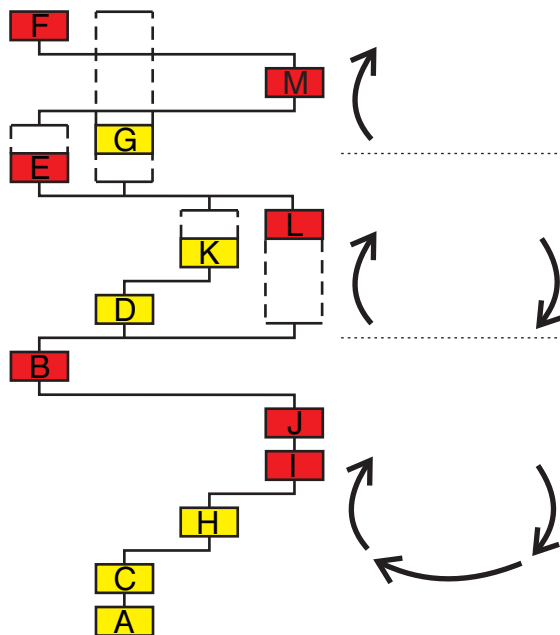


- O. semi-steep, marginal retouch on the lower face, created a notch near the breakage
- J. transversal breakage
- I. ventral surface of a flake
- H. small, marginal retouch on the upper face, edge correction, profile line straightening
- G. steep, marginal retouch on the upper face near the breakage, more flat along the edge, created a notch
- N. semi-flat removals on the lower face near the tip, thinning
- M. flat, marginal removals on the lower face, edge correction
- F. semi-flat, marginal retouch on the upper face, edge sharpening
- L. semi-flat removals on the lower face, edge thinning, formation
- K. flat removals on the lower face, edge thinning, formation
- E. semi-flat, removals going far on the upper face, surface thinning, edge formation
- D, C. flat and semi-flat removals on the upper face, surface formation, thinning
- B, A. semi-flat scars, derived probably before obtaining the flake

Plate 227 Sajóbáony Mész-tető 97.10.16



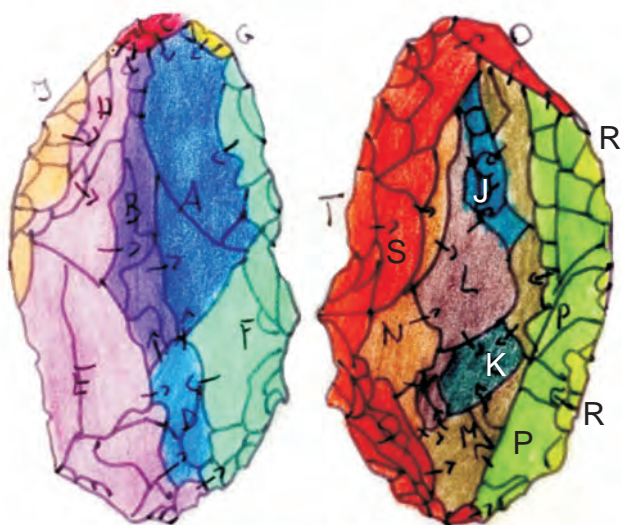
Biconvex, very thick,  
unsuccessfully thinned preform.



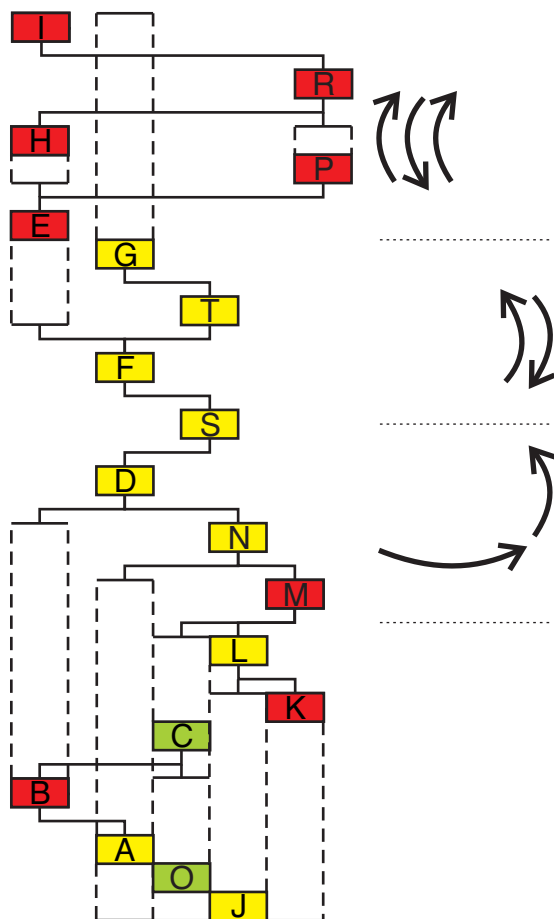
- F. single, semi-steep removal on the upper face at the tip, tip blunting, probably postdepositional
- L, M. semi-steep, marginal removals on the lower face, edge thinning, sharpening
- E. semi-flat removals on the upper face, edge angle correction
- G. semi-flat, hinged removals on the upper face at the base, base formation, unsuccessful thinning
- K. semi-steep removals on the lower face near the tip, edge thinning
- D. semi-steep removals on the upper face near the tip, edge angle formation before sequence K, near-the-tip part thinning
- B. semi-steep removals on the upper face, surface thinning, edge formation
- C. semi-steep, hinged removals on the upper face near the base, unsuccessful base thinning
- A. semi-flat removals on the upper face, surface formation, thinning, decortication
- I, J. semi-steep removals on the lower face, surface formation, thinning, analogical to sequence A and C but not hinged
- H. semi-steep removals on the lower face, surface formation, thinning



# Plate 228 Sajóbáony Mész-tető 97.10.50

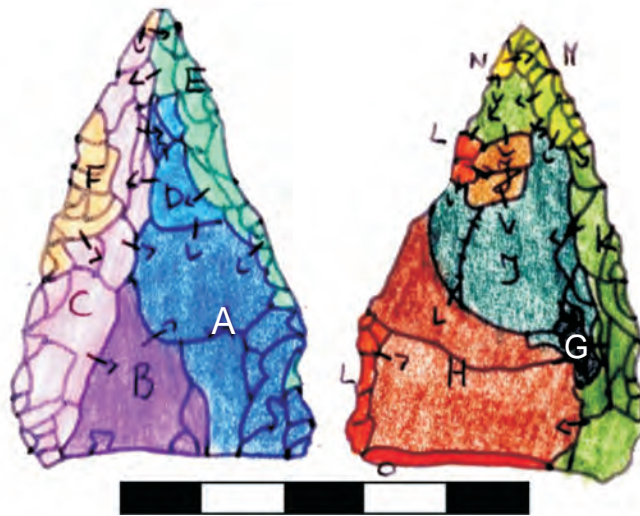


Irregular tool with both edges retouched and resharpened intensively, one edge was worked and resharpened first, and only after that the second edge was worked.

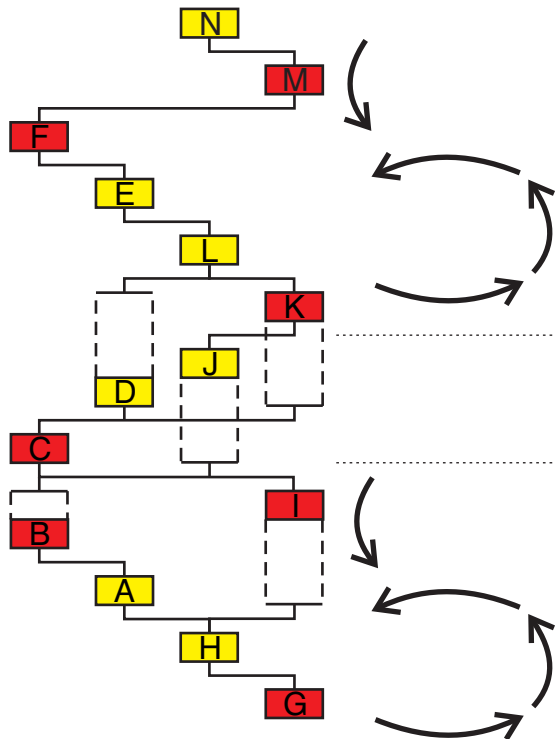


- I, H. flat, small, marginal retouch on the upper face near the tip, edge thinning, rejuvenation
- R. flat, marginal retouch on the lower face, edge rejuvenation
- P. flat, partly hinged removals on the lower face, edge thinning, rejuvenation, edge angle correction
- E. semi-flat removals on the upper face, partly hinged near the tip and deep near the base, edge formation
- G. single marginal removals on the upper face near the tip, probably usewear or postdepositional
- T. semi-steep and steep, marginal removals on the lower face, edge rejuvenation
- F. semi-steep removals on the upper face, edge rejuvenation, thinning
- S. semi-steep, partly hinged removals on the lower face, more flat near the tip, edge formation/thinning/rejuvenation (?)
- D. semi-flat removals on the upper face, edge rejuvenation
- N. flat removals on the lower face, earlier stages of edge rejuvenation
- M. flat, partly hinged removals on the lower face, edge rejuvenation/thinning
- L, K. semi-flat removals on the lower face, earlier stages of manufacturing process
- J. flat scar or natural surface on the lower face
- O. steep natural surface or transversal breakage located angularly to vertical axis near the tip
- C. semi-steep removals on the upper face, derived from the tip, unsuccessful near-the-tip part thinning
- A, B. semi-flat, broad removals on the upper face, surface formation or earlier phases of rejuvenation

Plate 229 Sajóbáony Mész-tető 97.10.63

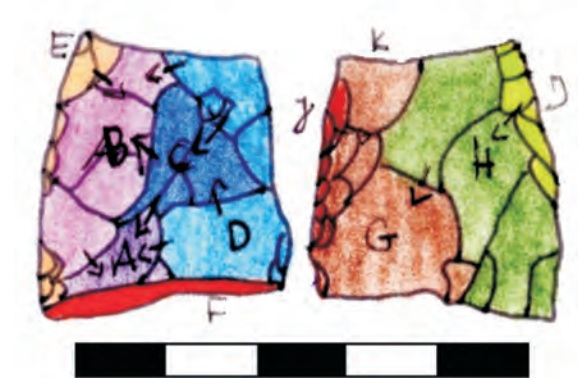


Plano-convex tool with exposed tip and broken base. Both edges were intensively resharpened on the upper face. Lower face was used for edge angle correction. It is not exactly known if edges were resharpened also after breakage.

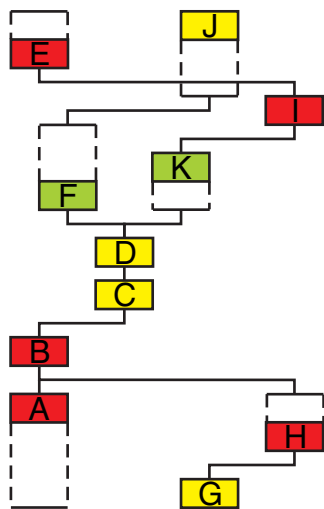


- N. single, marginal truncation on the lower face near the tip, probably postdepositional
- M. flat, marginal retouch on the lower face near the tip, edge resharpening
- F. semi-flat, marginal retouch on the upper face, edge resharpening
- E. semi-steep, marginal retouch on the upper face, edge resharpening
- L. semi-steep marginal retouch on the lower face, edge resharpening
- K. semi-flat, hinged removals on the lower face and flat, far going removal near the tip, edge angle correction
- J. flat removals on the lower face near the tip, edge angle correction, thinning
- C, D. semi-flat removals on the upper face, edge resharpening
- I. flat removals on the lower face, edge angle correction, near-the-tip part thinning
- G, H. flat removals on the lower face, surface formation, thinning
- A. semi-flat removals on the upper face, edge formation, sharpening
- B. flat removals on the upper face, surface formation
- O. transversal breakage

Plate 230 Sajóbáony Mész-tető 97.10.64

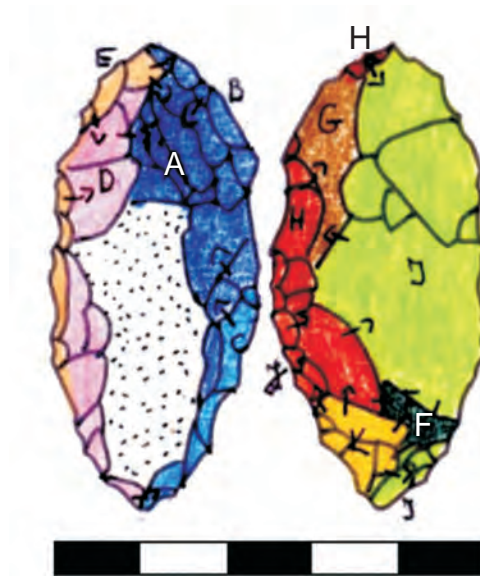


Biconvex, rectangular segment with both ends formed by transversal breakages. Both edges are straight and were marginally retouched; both were also retouched after breakages. The tool was very precisely knapped.

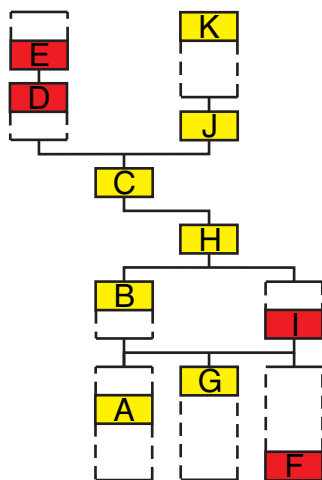


- J. semi-flat, marginal retouch on the lower face
- E. semi-flat, marginal retouch on the upper face
- I. semi-flat, marginal retouch, edge angle correction, edge correction
- F. transversal breakage, impact point in the middle of the lower face
- K. transversal breakage, impact point in the middle of the upper face
- G, H. flat removals on the lower face, surface and edge formation, thinning
- A, C, D, B. semi-flat removals on the upper face, edge and surface formation, thinning

Plate 231 Sajóbáony Mész-tető 97.10.71

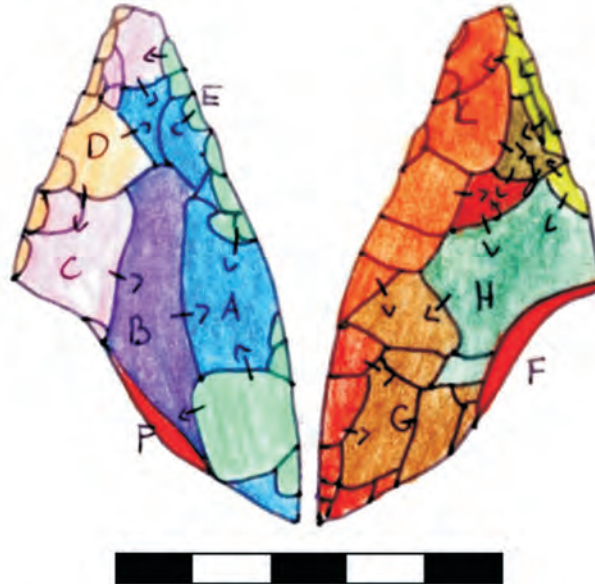


Plano-convex tool with flat and partly cortical lower face, convex upper face and unexposed tip. Both edges bear traces of resharpening. Lower face was used for edge angle correction. Tool orientation was probably changed at last rejuvenation stage.

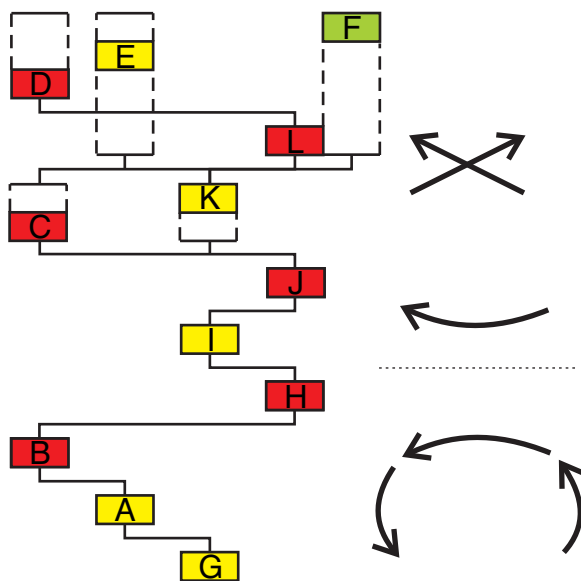


- K. flat, marginal removals on the lower face near the base, edge correction (might be postdepositional)
- E. steep, marginal retouch on the upper face, edge resharpening
- D, B. semi-steep removals on the upper face, edge resharpening
- C. steep, marginal retouch on the upper face near the base, orientation change (?), edge resharpening
- J. flat, marginal removals on the lower face, edge angle correction
- H. flat removals on the lower face, edge angle correction
- I, G. flat, broad removals on the lower face, edge angle correction, surface thinning
- A. semi-steep removals on the upper face, edge formation/sharpener
- F. ventral surface of a flake or earlier stages of manufacturing process

Plate 232 Sajóabony Méhész-tető 97.10.74



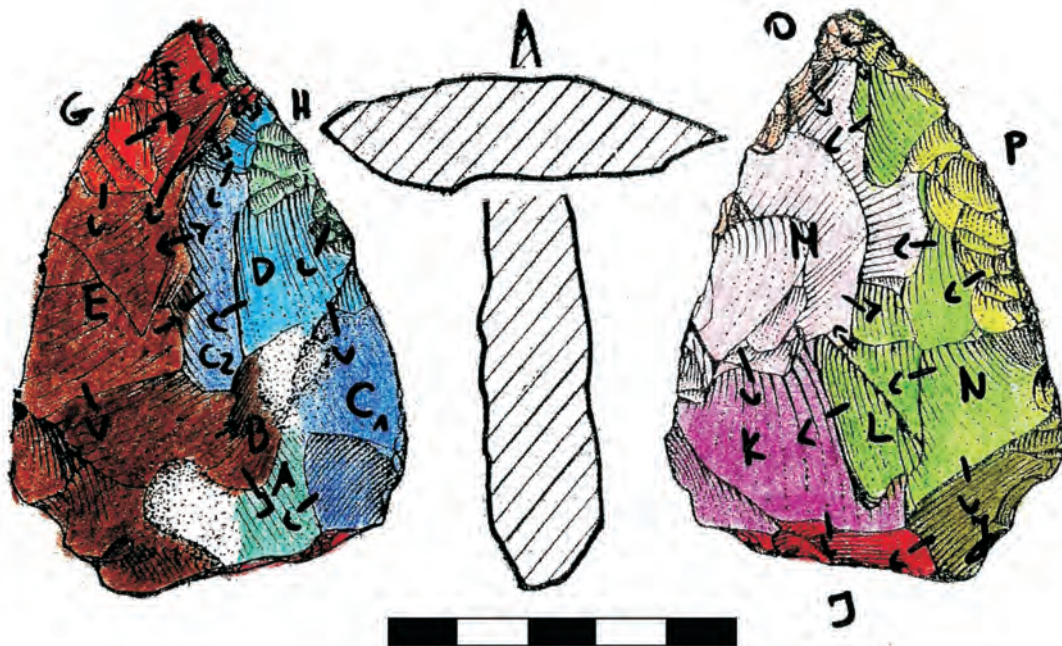
Plano-convex tool with broken base and exposed tip. Both edges were resharpened several times.



- F. transversal breakage
- E. semi-steep, marginal retouch on the upper face, edge resharpening
- D. semi-flat, marginal retouch on the upper face, edge resharpening
- L. flat, marginal retouch on the lower face, edge angle correction
- K. semi-flat removals on the lower face, edge angle correction
- C, A. semi-flat removals on the upper face, edge sharpening
- B. single, flat, broad removal on the upper face, surface formation
- I, J. flat and semi-flat removals on the lower face, edge angle correction, near-the-tip part thinning
- G, H. semi-flat removals on the lower face, surface formation, thinning

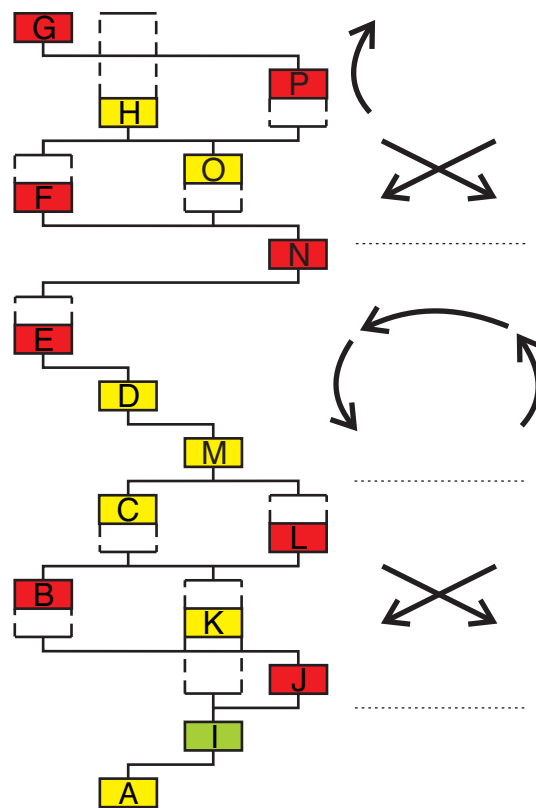


Plate 233 Ripiceni Izvor MV.2259



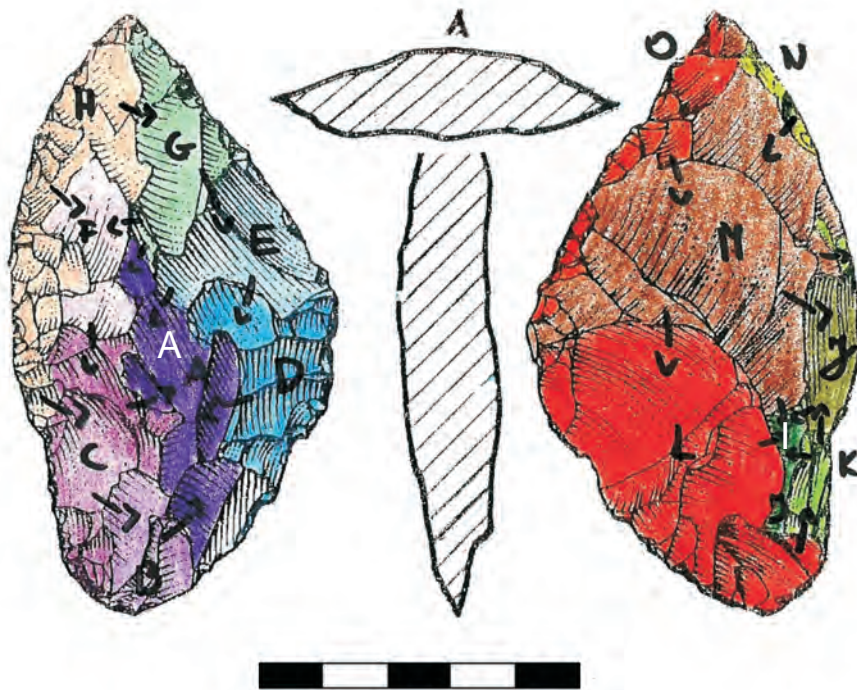
Nearly biconvex knife with alternate retouch of both edges and base formed abruptly; probably made on a flake. Cutting edge was more carefully retouched and was rejuvenated several times. The second edge was rejuvenated only near the tip. Tip is exposed but was not retouched; it is also not located in vertical axis.

# Plate 233 Ripiceni Izvor MV.2259



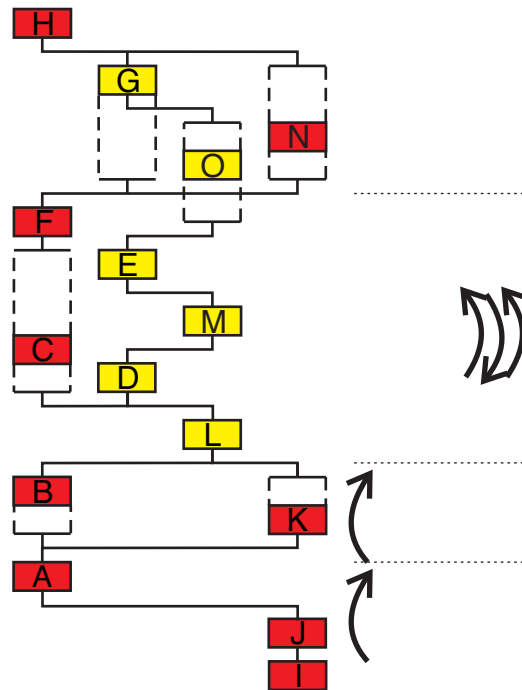
- H. flat removals on the lower face, semi-steep–near the tip, edge correction
- G. flat removals on the lower face, analogical to sequence H, edge correction and thinning
- P. flat and semi-flat retouch on the lower face and usewear
- F. flat removals derived angularly from the tip on the lower face, edge angle correction
- O. flat, hinged removals on the upper face near the tip, edge thinning
- N. flat removals, edge rejuvenation
- L. flat, broad removals, edge formation/rejuvenation (?)
- J. semi-steep removals near the base, base surface formation
- E. flat removals on the lower face, edge angle correction, surface flattening
- D. flat removals on the lower face, analogical to sequence N, edge formation
- M. semi-flat removals, analogical to sequence E, surface correction
- C. flat near the tip and semi-flat near the base removals, surface formation
- B. flat, broad removals on the lower face, surface formation
- A. flake ventral surface or natural surface
- I. steep, blunting removals, base formation
- K. flat, broad removals on the upper face, surface formation

Plate 234 Ripiceni Izvor MV.2266



Plano-convex, inverse knife with cutting edge on the left side of the upper face. Flat retouch was derived on the lower face of distal posterior edge. The tool bears traces of multiple rejuvenation stages: edge angles corrections on the lower face and precise cutting edge retouch on the upper face. Base was formed by semi-steep, natural surface and blunting removals of sequence D. It might have undergone orientation change during manufacturing process, which would explain flat removals on the lower face derived from the back near the base. Orientation was changed due to hinged removals of sequence K, which prevented further cutting edge rejuvenations in its near-the-tip part.

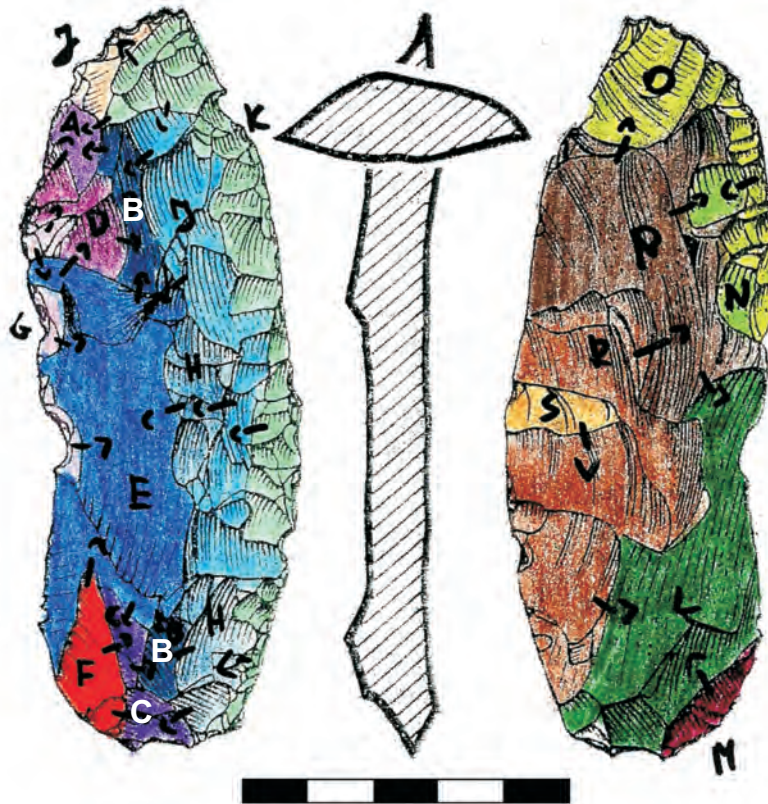
## Plate 234 Ripiceni Izvor MV.2266



- H, F, C. semi-flat, far going removals on the upper face, cutting edge resharpening
- B. semi-flat retouch of cutting edge near the base, perhaps the sequence covered the whole edge but was removed by further rejuvenation sequences
- A. flat, broad removals on the upper face, surface formation
- G. semi-flat removals near the tip; distal posterior edge rejuvenation
- E. semi-flat removals near the tip, distal posterior edge rejuvenation
- O. flat removals near the tip on the lower face, edge angle correction
- M. flat, broad removals on the lower face, derived from the back, rejuvenation, surface formation
- L. flat removals on the lower face, the formation of surface and back near the base, tool rejuvenation/remodeling
- N. flat removals on the lower face near the tip, edge angle correction
- D. semi-flat removals and partly steep retouch on the upper face, back formation
- K, J. flat, partly hinged removals on the lower face, edge angle correction
- I. flat scar on the lower face, perhaps ventral surface of a flake



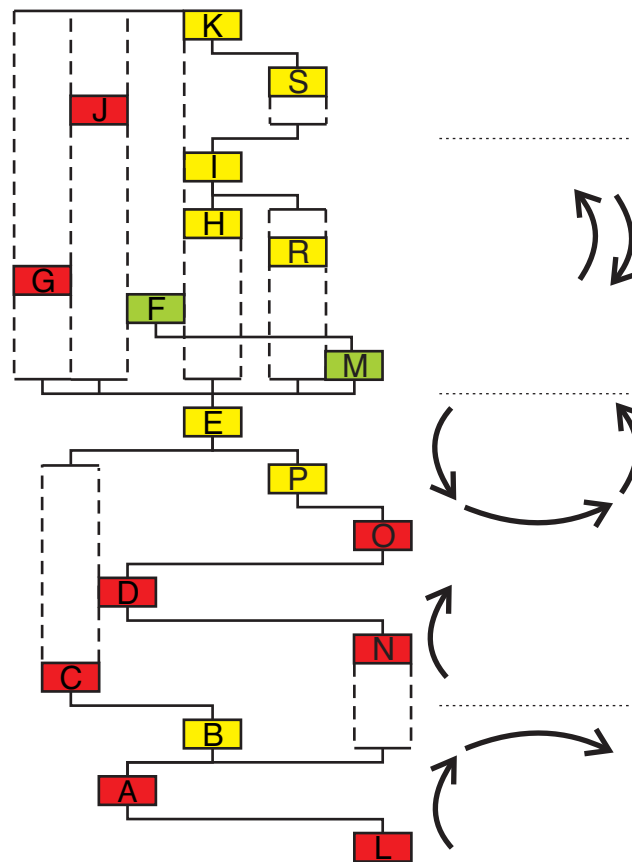
Plate 235 Ripiceni Izvor MV.2276



Plano-convex knife with multiple cutting edge rejuvenation phases. Lower face is flat; angular removals were derived from distal posterior edge on the lower face, aimed at edge angle correction. Overpassed removal derived on the upper face from cutting edge caused tool thinning and back removing. After the overpassed removal (sequence E), the tool was remodeled.

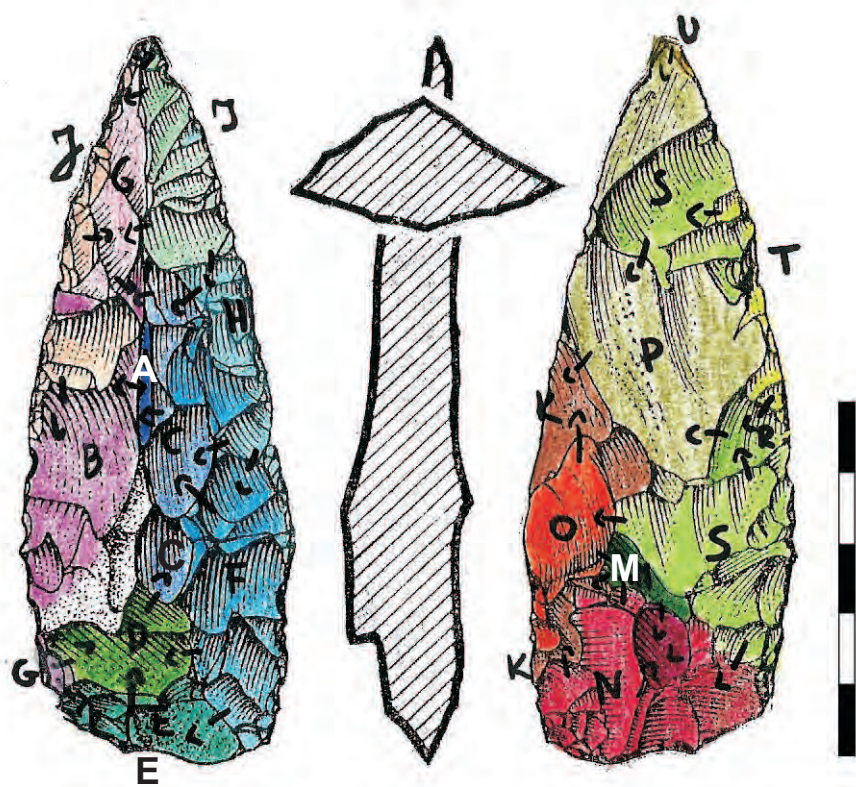


## Plate 235 Ripiceni Izvor MV.2276



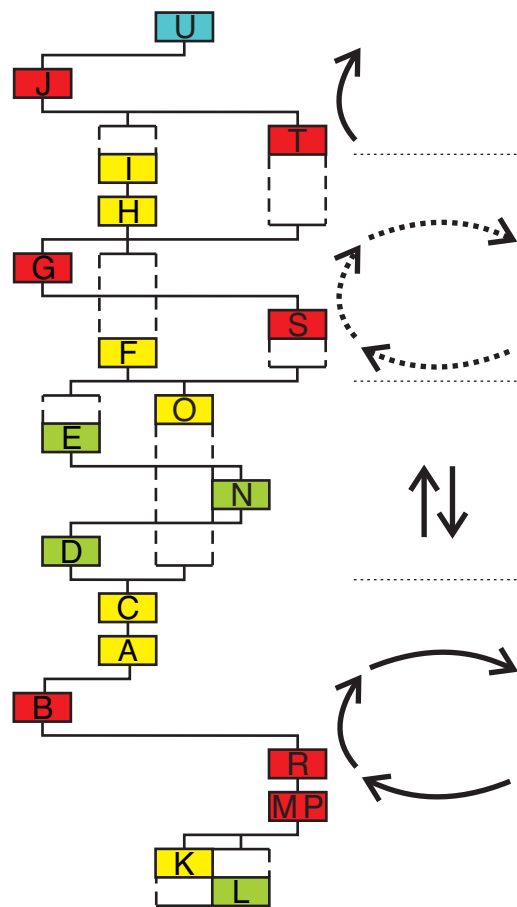
- K. semi-steep, precise retouch near the tip, cutting edge resharpener
- S. flat removal on the lower face, edge angle correction
- P, R. flat removals on the lower face, edge angle correction
- O, N. flat, angular removals on the lower face derived from distal posterior edge near the tip, cutting edge angle correction
- L. flat, very broad removals on the lower face, surface formation
- M. semi-steep removals on the lower face, base formation
- I, H. semi-steep removals, cutting edge rejuvenation
- G. steep retouch created notches on the upper face of back edge
- F. flat, hinged removals on the upper face, derived from the base, unsuccessful thinning
- E. flat, very broad, overpassed removals on the upper face, reaching the opposite edge, removing the back surface, thinning
- D. semi-flat removals on the upper face, distal posterior edge formation
- C. semi-flat removals, surface and base formation
- B. removals from earlier phases of manufacturing process, flat near the tip, semi-steep near the base
- J. semi-steep retouch on the upper face, distal posterior edge rejuvenation

Plate 236 Ripiceni Izvor MV.2277



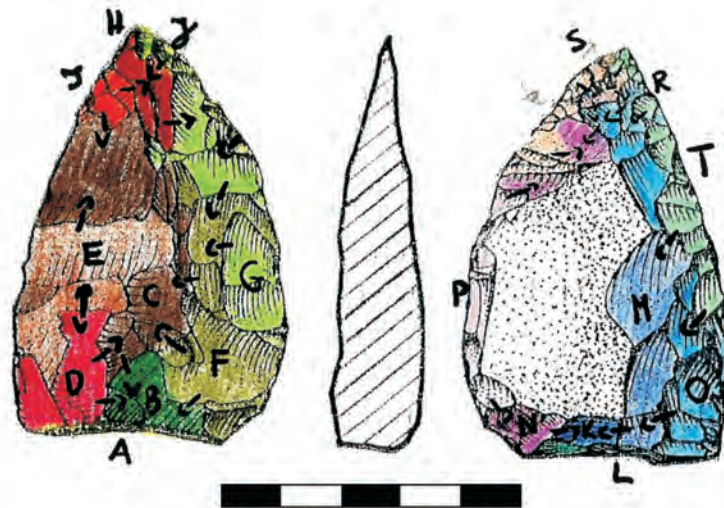
Symmetrical tool with semi-steep retouch of both edges, convergent at the tip. Lower face is flat; convex only near the base. Both edges are straight; tip is well exposed and located in vertical axis. The tool was unsuccessfully thinned by deriving flat removals from the base on the upper face. The tool was highly reduced during rejuvenation. Cutting edge is more straight in profile than the opposite edge. There are no removals correcting edge angle on the lower face of cutting edge. Rejuvenation was concentrated near the tip. Each edge was rejuvenated at least two times.

## Plate 236 Ripiceni Izvor MV.2277



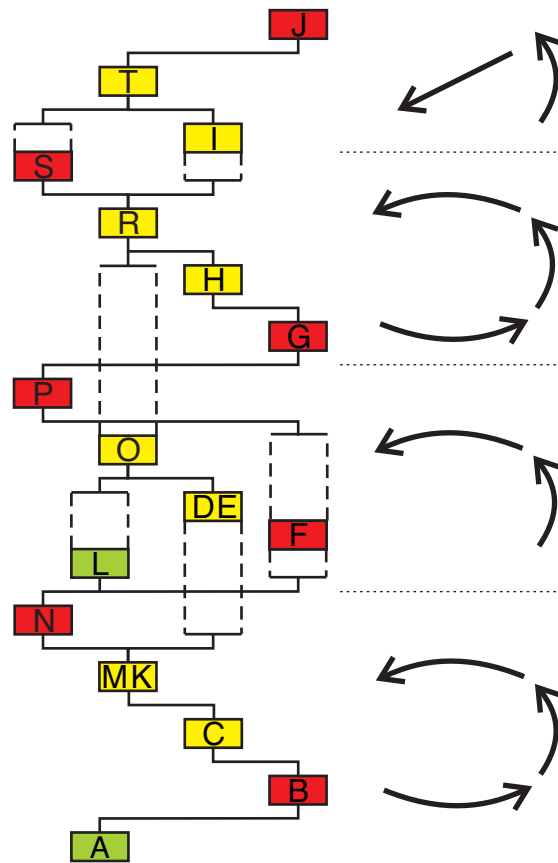
- U. perhaps a breakage scar, impact point in the middle of the upper face, the breakage scar goes onto the lower face and along the edge, removing part of edge near the tip
- J. semi-steep/steep, marginal retouch near the tip, distal posterior edge correction
- T. flat, partly hinged removals on the lower face, edge angle correction
- I. semi-steep retouch near the tip
- H. semi-steep retouch, edge sharpening and usewear
- G, B, F, C. semi-steep, far going removals, edge retouch
- A. flat removals, earlier stages of edge formation
- S. flat removals on the lower face, near the base semi-flat retouch bending the edge towards the upper face, edge angle correction
- O. flat removals on the lower face, edge angle correction, thinning
- E. semi-flat removals, base formation
- N. semi-flat removals on the lower face, base formation
- D. high hinged removals derived from the base, unsuccessful thinning
- L. flat scar of removal derived on the lower face, probably from the base, earlier phases of manufacturing process
- R, P, M, K. flat, broad removals, surface formation or subsequent edge angle correction

Plate 237 Ripiceni Izvor MIV.3573



Biconvex knife with one edge retouched, base formed by single, abrupt removal or natural surface. Back edge is convex and semi-steep on the lower face.

# Plate 237 Ripiceni Izvor MIV.3573



- J. small, semi-flat truncation on the lower face of distal posterior edge
- T. semi-flat retouch of cutting edge
- I. flat, small removals, edge angle correction on the lower face
- S. semi-flat, very fine removals on the distal posterior edge near the tip
- R. flat retouch of cutting edge
- H. flat removals on the lower face, edge angle correction
- G. semi-steep and semi-flat removals, distal posterior edge and back formation
- P. semi-flat removals, back formation or edge retouch
- O. semi-flat retouch of cutting edge, partly hinged near the base
- K, M. semi-flat retouch of cutting edge, partly hinged near the base
- D. flat removals derived from the base on the lower face, surface formation
- E. flat removals on the lower face, cutting edge angle correction
- F. semi-flat/semi-steep removals on the back, perhaps it was a cutting edge before
- L. steep removals derived from the base, base formation
- N. semi-steep removals near the base and semi-flat near the tip, edge decortication
- C. flat, broad removals on the lower face, surface formation
- B. semi-flat, broad removals on the lower face, surface formation
- A. single, steep removal or a natural surface forming the base

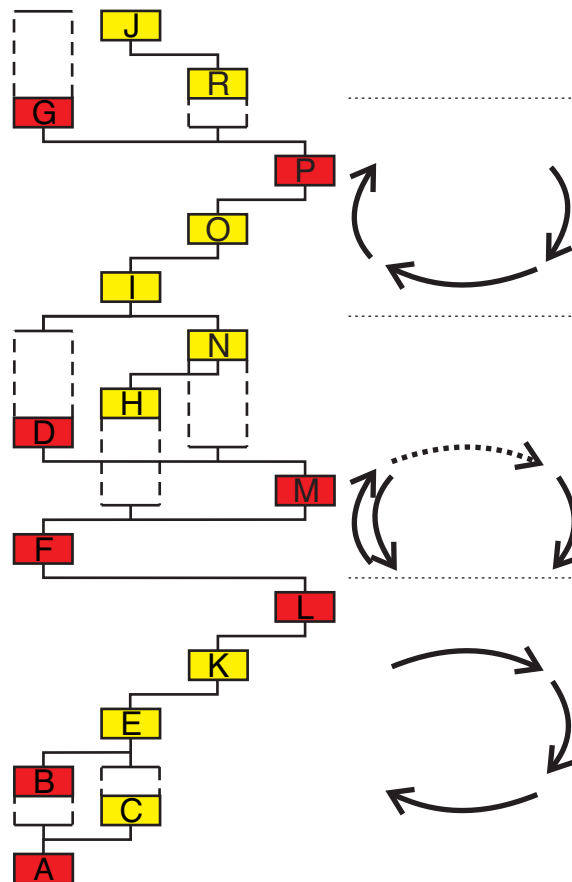


Plate 238 Ripiceni Izvor MIV.3827



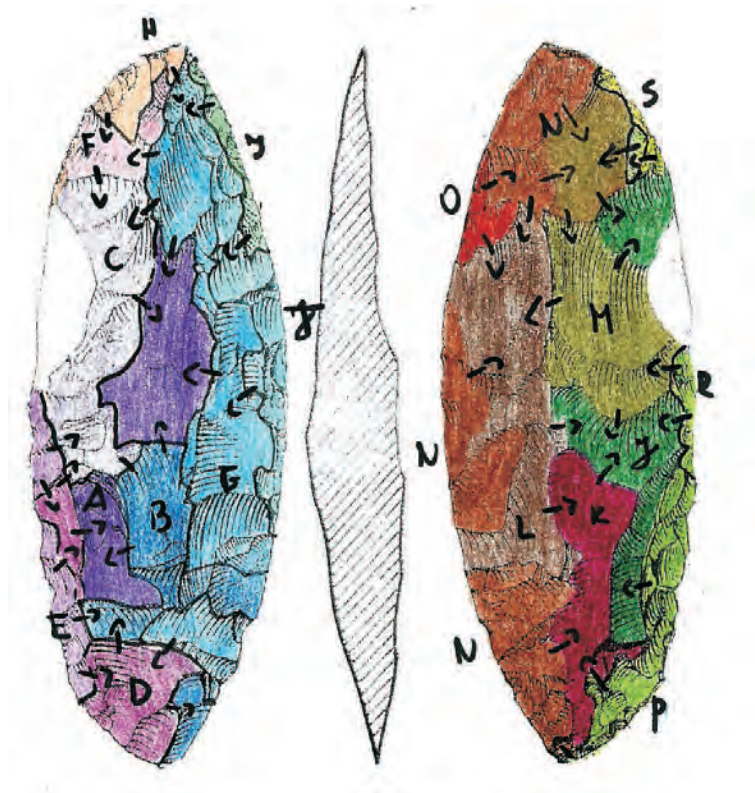
Very big, biconvex knife with one edge partly retouched. The tool was abandoned at early stage of using; no traces of intensive rejuvenation; single retouch sequences. Most sequences come from the thinning and shaping stage of manufacturing process.

## Plate 238 Ripiceni Izvor MIV.3827



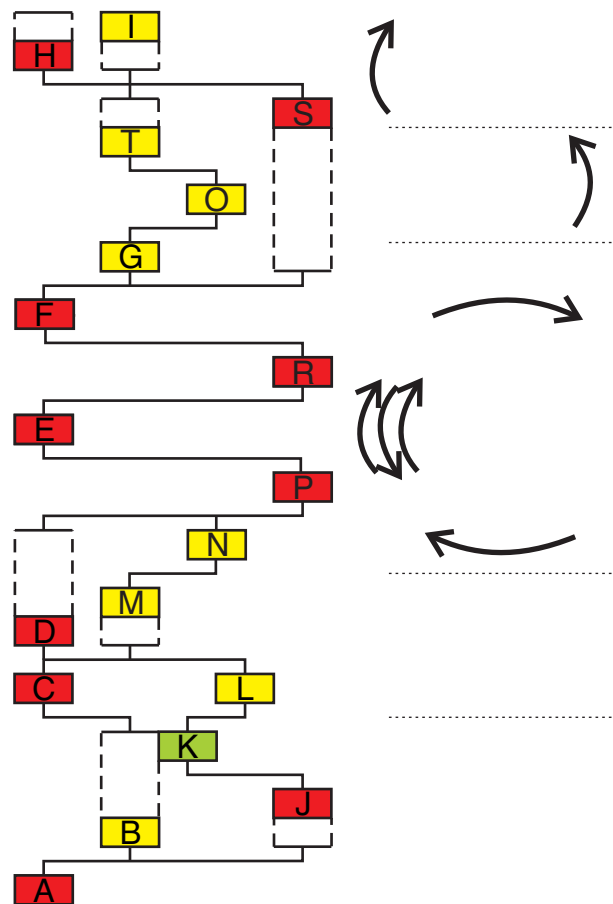
- J. flat, small removals on the lower face, derived from the tip, tip resharpener
- R. flat removal derived from the tip on the upper face, edge angle correction before sequence J
- G. flat, fine removals on the lower face, edge correction
- P. semi-flat, irregular, long removals, cutting edge two-stage retouch/resharpener
- O. semi-flat, regular retouch near the tip
- I. flat removals on the lower face near the tip, edge angle correction before sequence O
- N. semi-flat removals near the tip and denticulated retouch forming notches along the edge
- H. flat removals on the lower face, edge angle correction before sequence N
- D. semi-flat, long, broad, angular removals on the lower face, near-the-tip part thinning, surface formation
- M. flat, long, broad, angular removals on the upper face, near-the-tip part thinning, surface formation and smaller removals near the base- edge formation
- F. flat, long, broad, angular removals on the lower face, thinning and surface formation near the base, partly successful—partly high hinged removals
- L. flat, long, broad, angular removals, near-the-base part thinning, surface formation
- K. semi-flat removals on the upper face, surface formation
- E. flat, broad, partly hinged removals on the lower face along the whole edge, surface formation, thinning, decorticating
- B. semi-flat removals on the lower face, surface formation
- A. flat removals from early phase of manufacturing process, perhaps even from decorticating phase
- C. single, semi-flat, long, angular removal on the lower face, surface formation

Plate 239 Ripiceni Izvor MIV.3832



Plano-convex knife with nearly vertical cutting edge and curved/convex, very precisely retouched and rejuvenated distal posterior edge. Cutting edge was rejuvenated several times. Base was very precisely formed and retouched, analogically to the tip. Perhaps the tool was reoriented during manufacturing process.

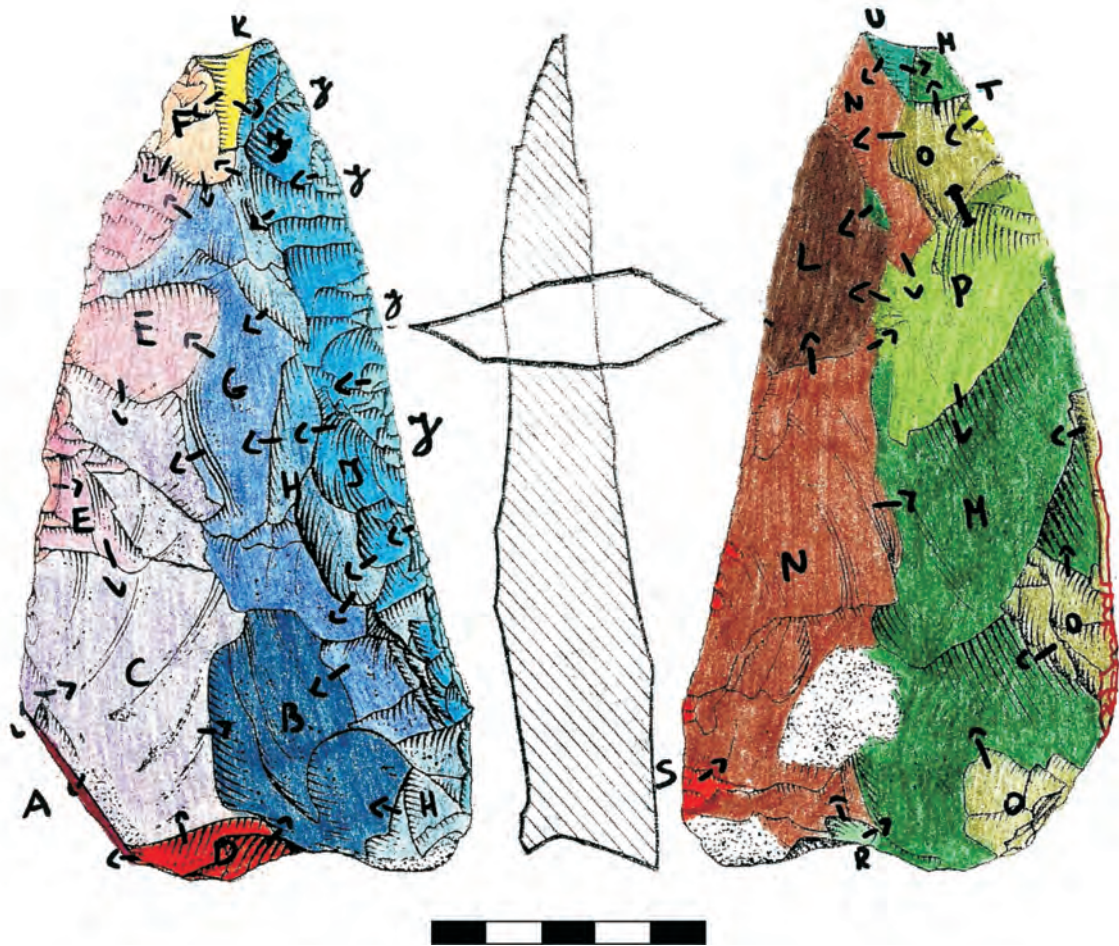
# Plate 239 Ripiceni Izvor MIV.3832



- I. semi-flat, marginal retouch of cutting edge
- H. semi-flat, very precise, marginal retouch of distal posterior edge
- S. flat, small truncations on the distal posterior edge on the lower face
- T. semi-flat retouch of cutting edge
- G. semi-flat/semi-steep retouch of the whole cutting edge, edge rejuvenation
- F. semi-flat retouch of distal posterior edge
- O. flat removals on the lower face, edge correction
- R. flat, hinged removals on the lower face, derived from the back, partly unsuccessful thinning
- E. semi-flat, partly hinged removals, back formation
- P. semi-flat removals on the lower face, back or distal posterior edge formation—if derived before orientation change
- D. flat, hinged removals on the lower face, derived from the back, surface formation, unsuccessful thinning, perhaps caused the orientation change
- N. flat removals on the lower face, near the base removals are more precise and can be treated as a flat retouch, edge correction
- M. flat, broad removals on the lower face, surface flattening
- C. flat removals on the upper face, surface formation
- L. flat, broad removals on the lower face, surface formation
- K. flat, broad removals on the lower face, derived from the base, surface formation
- J. flat, broad removals on the lower face, surface formation
- B, A. flat, broad removals on the upper face, surface formation



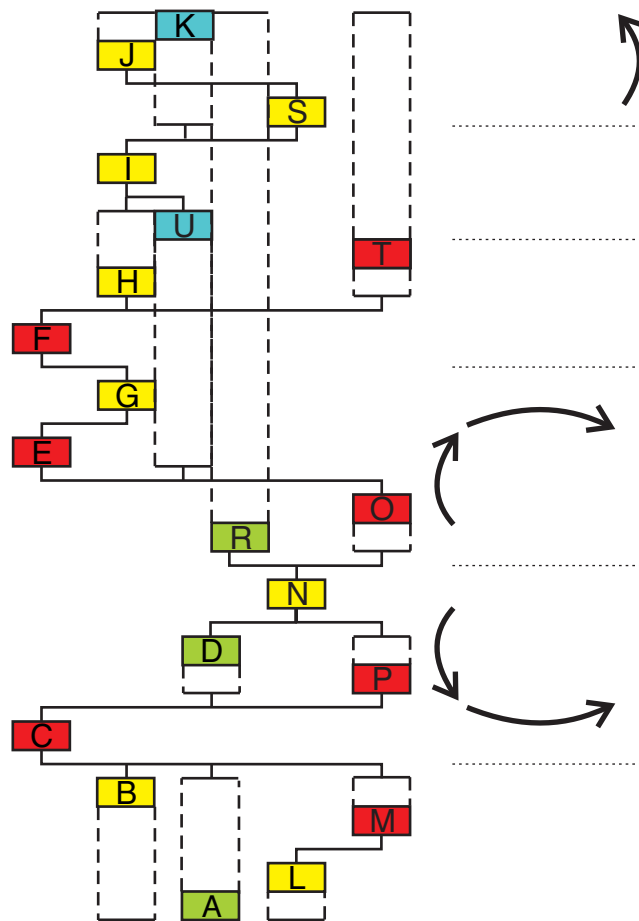
Plate 240 Ripiceni Izvor MIV.3855



Plano-convex knife with broken tip and multiple cutting edge resharpening phases. Both: back and base were formed abruptly.

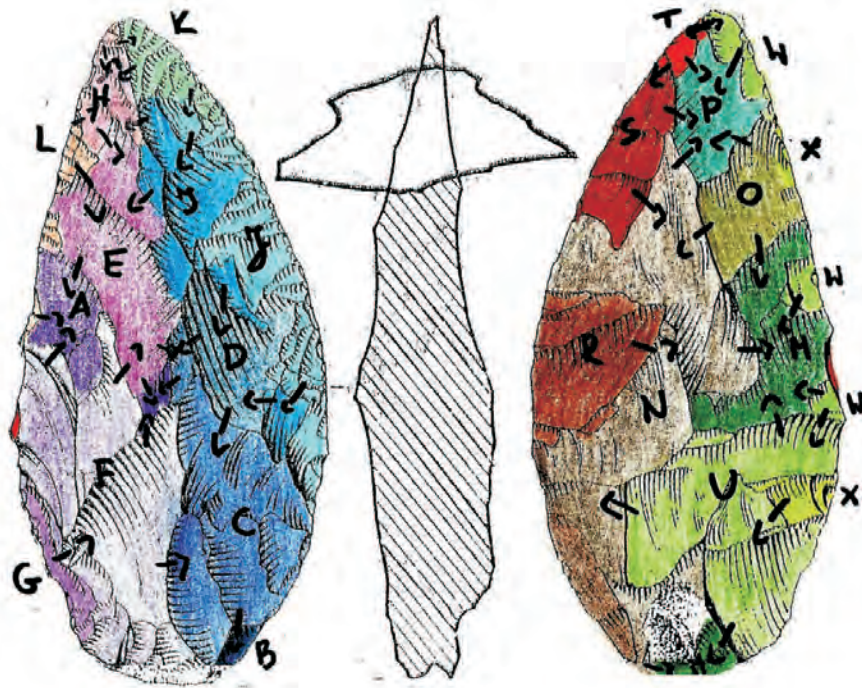


## Plate 240 Ripiceni Izvor MIV.3855



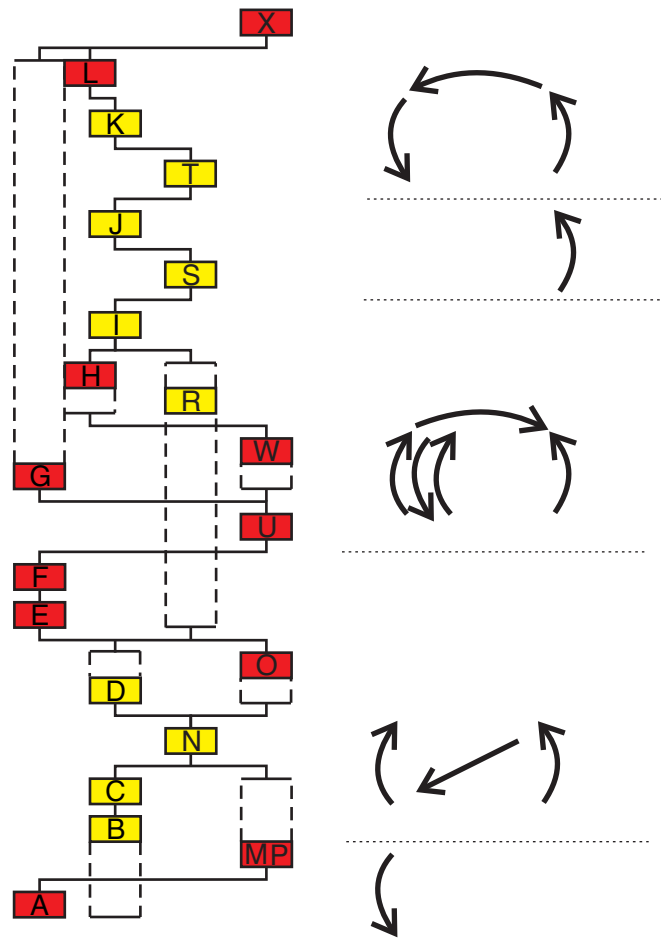
- K. tip breakage, impact point in the middle of lower surface, going far onto the upper face, damages the tip.
- J. semi-steep/semi-flat, fine, marginal retouch on the upper face, cutting edge resharpener
- S. small, marginal removals on the lower face, cutting edge correction
- I. semi-steep, precise, long, parallel removals, more steep near the tip, cutting edge resharpener
- U. single, flat removal derived from the tip on the lower face, surface/tip correction
- T. semi-steep retouch on the lower face of distal posterior edge, created a notch
- H. semi-flat removals, cutting edge rejuvenation
- F. semi-flat retouch near the tip on the upper face of distal posterior edge, tip rejuvenation
- G. flat, broad removals, cutting edge formation,
- E. flat and semi-flat removals, distal posterior edge formation
- O. semi-flat removals on the lower face, distal posterior and back edge correction
- R. single, flat, small removal on the lower face derived from the base, edge correction
- N. semi-flat, broad removals on the lower face, cutting edge formation
- P. flat removals, distal posterior edge formation on the lower face
- D. steep removals forming the base, derived from the direction of sequence A
- A. single, steep removal forming the back
- C, B. flat, broad removals on the upper face, surface formation
- M. flat, broad removals on the lower face, surface formation
- L. single, flat, broad removal on the lower face, surface formation

Plate 241 Ripiceni Izvor MIV.3856



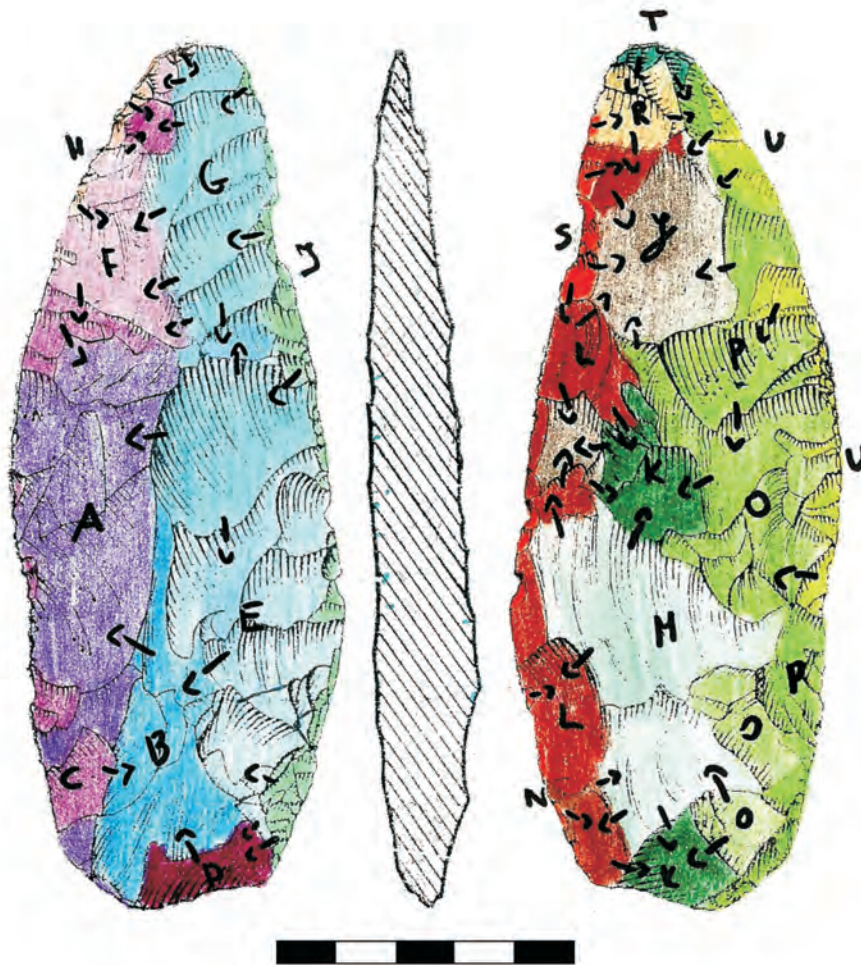
Plano-convex, nearly symmetrical knife with flat lower surface and retouched distal posterior edge. Cutting edge bears traces of several rejuvenation phases. Its edge angle was corrected by flat removals derived from distal posterior edge. Unsuccessful sequence F prevented the tool from further thinning. Tip was slightly moved out of vertical axis; sequence K deepened asymmetry and edge convexity near the tip. The tool shows lack of care for symmetry. Cutting edge was carefully retouched, whereas opposite edge was only roughly worked with less precise removals.

## Plate 241 Ripiceni Izvor MIV.3856



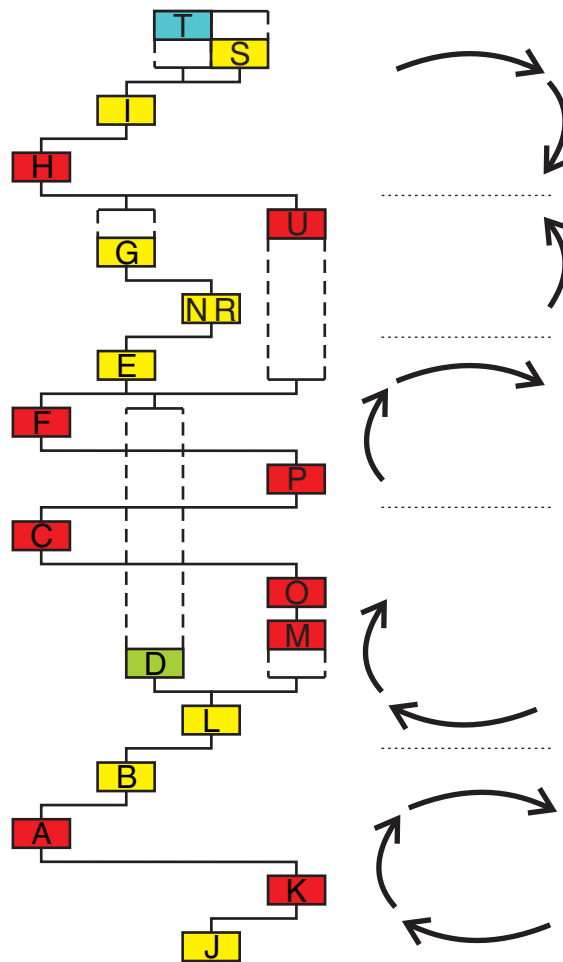
- X. deep, marginal truncations on the lower face of the back
- L. semi-steep, irregular, marginal retouch on the distal posterior edge
- H. semi-steep removals on the upper face, distal posterior edge formation
- E. semi-steep, broad removals on the upper face, distal posterior edge formation
- K. semi-steep/semi-flat, very precise retouch, cutting edge sharpening and usewear
- S, T. flat removals on the lower surface near the tip, edge correction
- R. flat removals on the lower face, edge correction
- J. semi-flat retouch on the cutting edge
- I. semi-flat partly hinged removals, cutting edge retouch, edge rejuvenation
- D. semi-flat, broad removals, cutting edge formation/rejuvenation
- C. semi-flat, broad removals, cutting edge formation/rejuvenation
- B. steep removals blunting the cutting edge near the base, remained from previous stages of manufacturing process (probably from decortication stage)
- M, N. flat, broad removals of the lower face, surface formation
- O. flat removals on the lower face, back edge angle correction
- U. flat removals, base formation, flattening
- G. flat, hinged removals, back edge formation after unsuccessful thinning- sequence F
- F. broad, high hinged removals, unsuccessful attempt to thin the tool from the side of a back
- A. semi-flat removals on the upper face, surface formation
- P. flat removals on the lower face, previous stages of surface formation, the direction of percussion is not visible
- W. flat removals, back edge angle correction

Plate 242 Ripiceni Izvor MIV.3857



Plano-convex knife with blunted base and subsequently rejuvenated edges. At the beginning, the whole tool was rejuvenated, but further on— only near-the-tip parts. There was no possibility to derive long, flat removals from distal posterior edge on the lower face; therefore, during rejuvenation—flat edge angle correcting removals were derived from cutting edge itself. Separate edge, formed at the tip, was retouched on the lower face. Cutting edge was retouched on the lower face by denticulated removals derived at last rejuvenation stage.

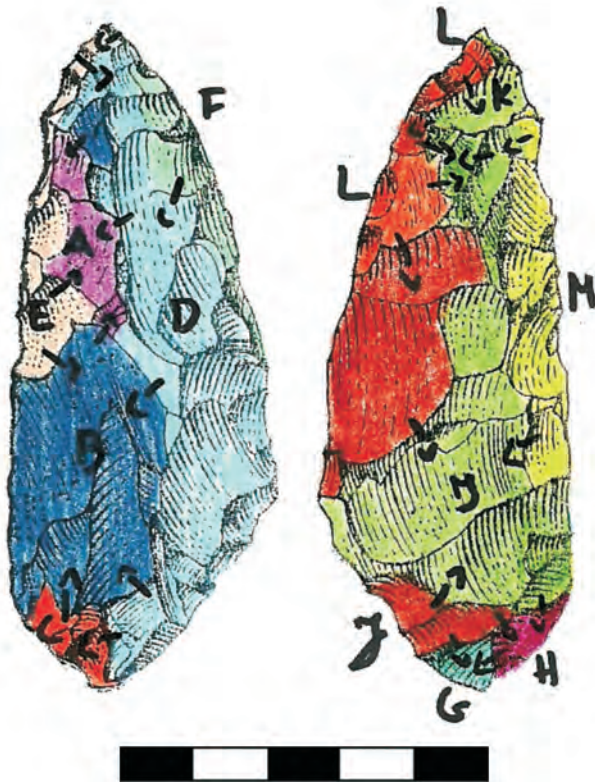
# Plate 242 Ripiceni Izvor MIV.3857



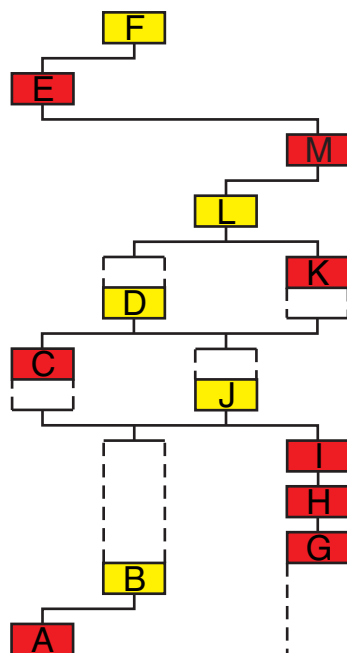
- T. semi-flat, fine retouch on the tip edge, derived from the tip on the lower face
- S. semi-steep, fine, marginal retouch on the lower face, forming notches along the cutting edge
- I. semi-flat, marginal retouch on the upper face of cutting edge
- H. semi-flat, fine, marginal retouch near the tip of distal posterior edge
- U. flat, small removals on the lower face, edge angle correction
- G. semi-flat removals near the tip, cutting edge rejuvenation
- R. flat removals near the tip, tip formation, thinning
- N. semi-flat removals on the lower face, edge angle correction
- E. semi-flat removals, cutting edge formation
- F. semi-flat removals near the tip on distal posterior edge, edge correction
- C. semi-flat removals near the tip and along back edge, edge correction
- P. flat removals on the lower face, distal posterior edge formation/rejuvenation
- O. flat removals on the lower face, back edge formation/rejuvenation
- M. flat, broad removals on the lower face, surface formation/rejuvenation (?)
- D. semi-steep, blunting, far going removals on the upper face, base formation
- L. semi-flat removals on the lower face, surface/edge formation (?)
- B. flat, broad removals, surface/edge formation (?)
- A. semi-flat removals on the upper face, back formation
- J, K. flat, broad removals on the lower face, surface formation



# Plate 243 Ripiceni Izvor MIV.3859

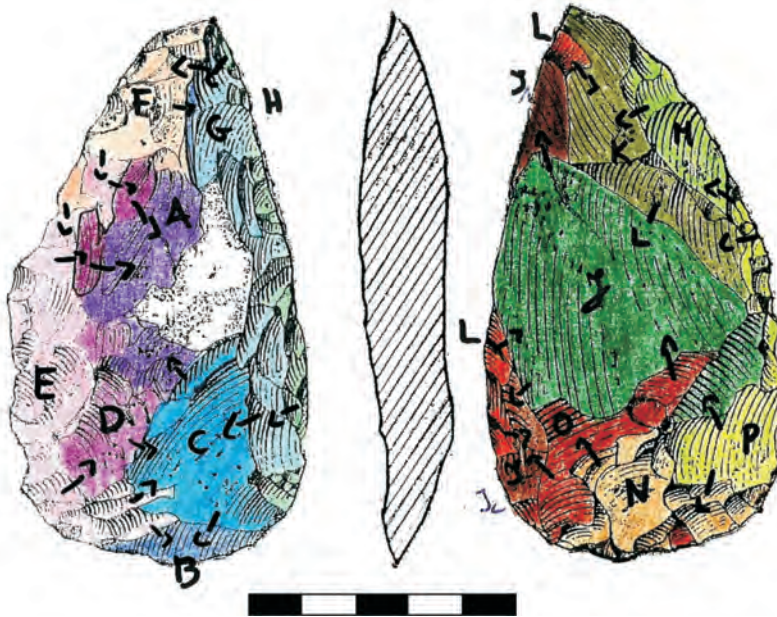


Knife with cutting edge remodeled by sequence D. It was thicker before remodeling. Distal posterior edge formed by steep retouch, blunted, which can be due to subsequent rejuvenations. Lower face is flat; tool is plano-convex in cross-section; tip is not located in the axis. The tool was abandoned due to lack of possibility to remove hinged scars of sequence D.

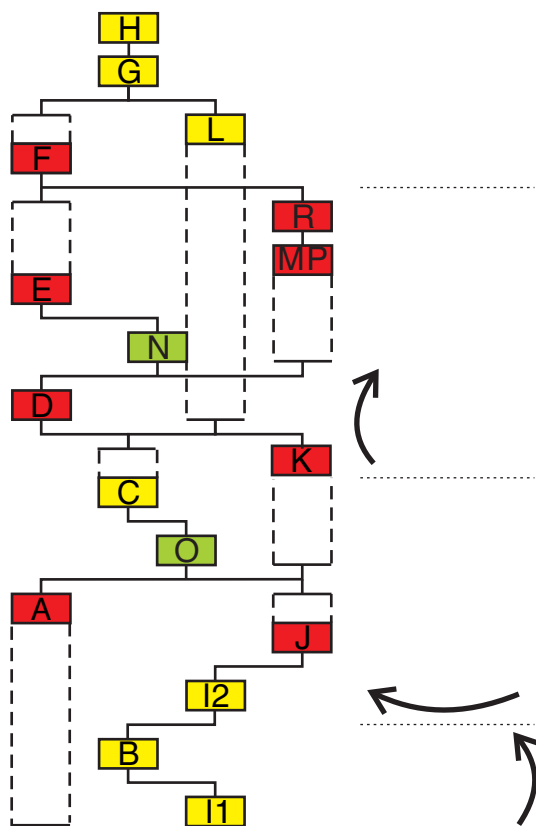


- F. semi-flat, marginal retouch
- E. steep retouch blunting the edge
- M. flat, hinged removals on the lower surface, edge angle correction
- L. flat removals on the lower surface, deep near the tip, edge angle correction
- K. flat removals on the lower surface near the tip, edge correction
- D. semi-flat retouch, cutting edge rejuvenation/remodeling and thinning
- C. flat, small removals on the lower face near the base, edge correction
- J. flat removals on the lower face, surface formation
- I. flat removals on the lower face, surface formation
- G. flat removals derived from the base, base formation
- H. semi-steep removals derived from the base, base formation
- B. flat, very broad removals reaching the opposite edge, surface formation
- A. flat removals, previous stages of manufacturing process

# Plate 244 Ripiceni Izvor MIV.3865

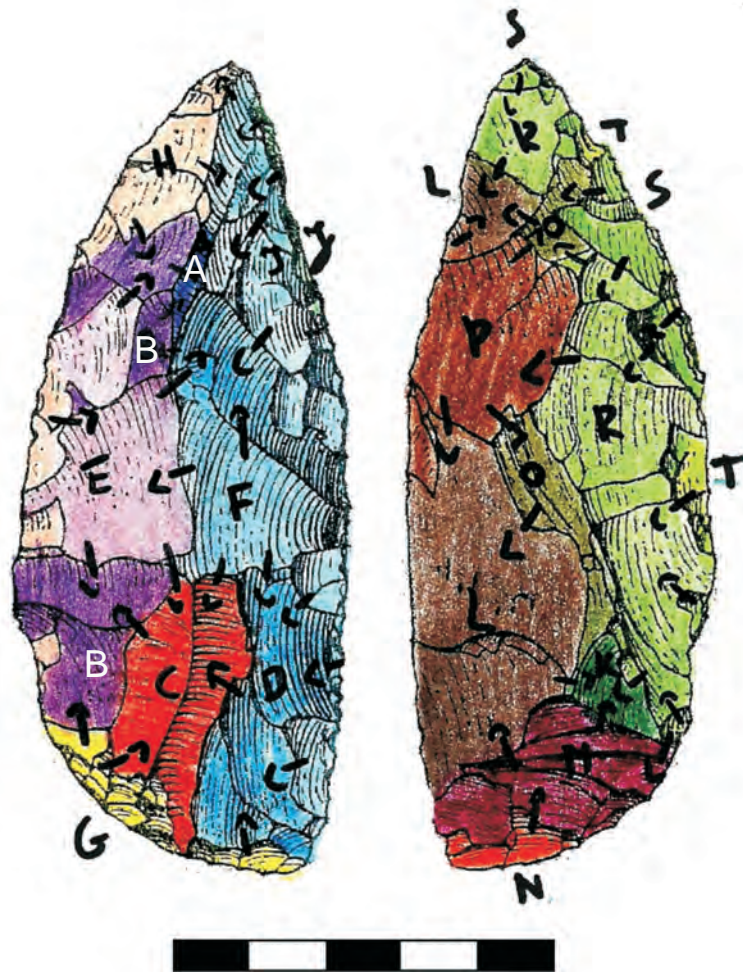


Plano-convex knife with multiple cutting edge rejuvenation stages. Further rejuvenation was not possible because of unremoved cortical fragment in the middle part of cutting edge. Unsuccessful thinning of the lower face was caused by hinged removal of sequence P. On the lower face, mostly removals derived from distal posterior edge are visible.



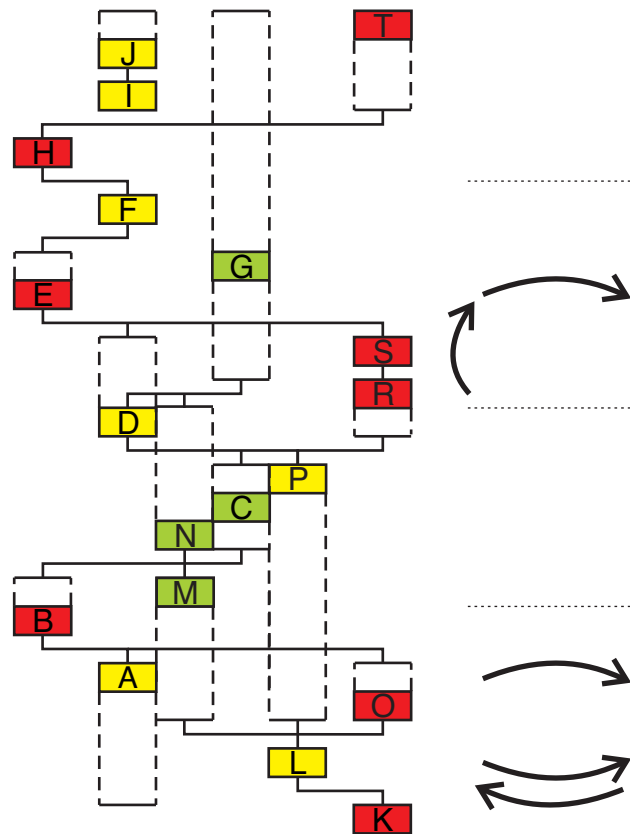
- H. semi-flat, precise, marginal retouch, cutting edge rejuvenation
- G. semi-steep removals, cutting edge rejuvenation, probably a few sequences combined
- B. hinged removals near the tip and semi-flat removals near the base, early stages of cutting edge formation, probably a few stages of rejuvenation
- L. flat, small removals on the lower face, edge correction
- F. semi-steep removals, distal posterior edge rejuvenation
- E. semi-flat/semi-steep removals, distal posterior edge rejuvenation
- M. semi-steep removals, back edge correction on the lower face
- P. hinged removals on the lower face, unsuccessful thinning, flattening
- N. semi-flat, irregular removals, base formation
- D, A. flat removals on the upper face, early phase of back formation
- C. flat removals, earlier stages of cutting edge rejuvenation
- K, J. semi-steep, broad removals on the lower face, surface formation
- I1, I2, O. semi-flat removals on the lower face, surface formation

Plate 245 Ripiceni Izvor MIV.3866



Plano-convex knife with multiple cutting edge rejuvenation stages. Last sequences of rejuvenation totally blunted the edge. Angular, flat removals were derived on the lower face from distal posterior edge to correct cutting edge angle. The tool was also retouched on base edge, which can be indicative of orientation change.

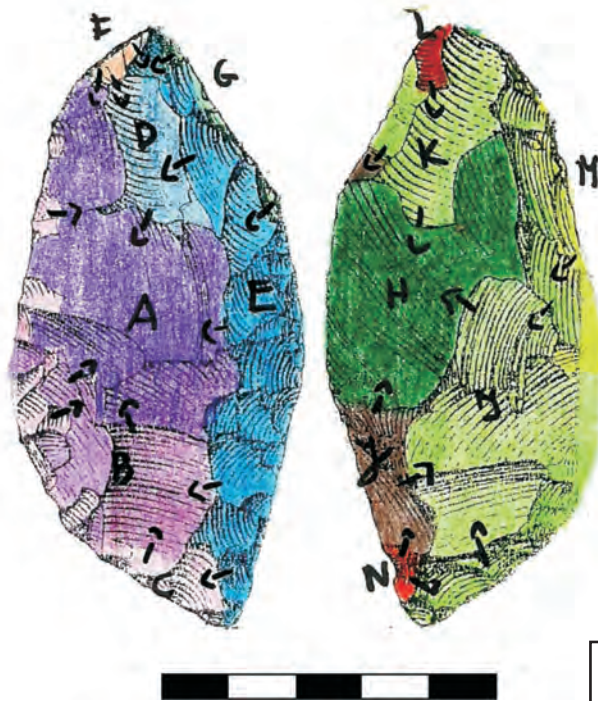
## Plate 245 Ripiceni Izvor MIV.3866



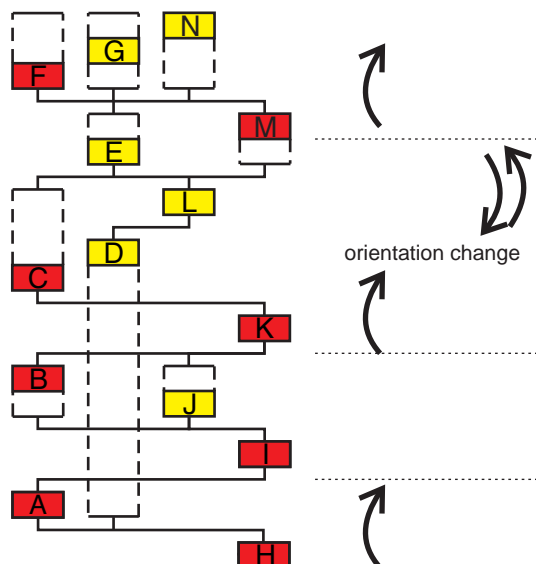
- T. deep, small truncations on the lower face, distal posterior edge correction
- J. steep, subsequently repeated removals on the upper face near the tip, cutting edge rejuvenation; they go under the edge and cause its blunting
- I. steep removals, cutting edge rejuvenation
- F. semi-steep removals, cutting edge rejuvenation
- H. semi-steep retouch near the tip and along the edge
- E. semi-steep removals, back edge corrections
- G. semi-steep and semi-flat removals on the upper face, base edge retouch
- S. flat, deep, partly hinged removals on the lower face, edge angle correction
- R. flat, partly hinged removals on the lower face, edge angle correction
- D. semi-steep removals, cutting edge rejuvenation
- P. flat removals on the lower face, edge angle correction
- C. semi-flat, long, far going removals, derived on the upper face from the base
- M, N. flat removals derived from the base, lower face thinning
- B. semi-steep removals on the upper face, surface formation
- A. semi-flat scar near the tip from earlier stages of surface/cutting edge formation
- O, L, K. flat removals on the lower face, surface formation



# Plate 246 Ripiceni Izvor MIV.3867



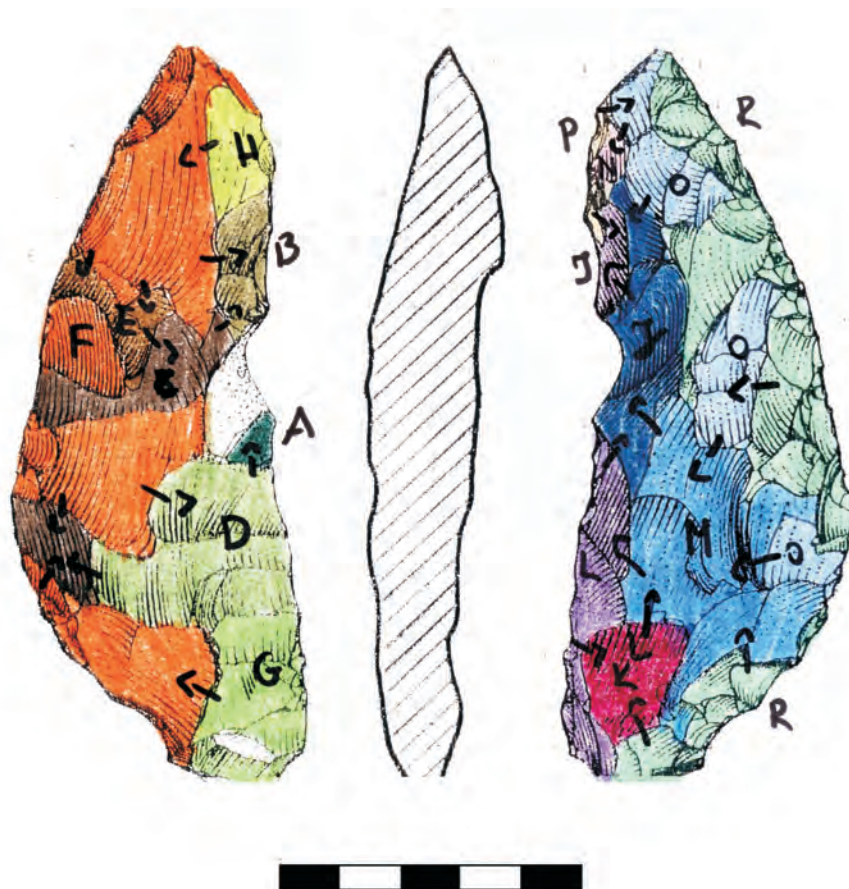
Plano-convex knife with orientation changed during rejuvenation process. Rejuvenation is visible on both edges but Edge II was retouched more precisely. The tool has two tips but they are not located in vertical axis, in manufacturing process, the edge near the tip was of greatest importance. It was precisely retouched with edge angle corrections on the lower face.



- N. truncations on the lower face, perhaps postdepositional
- G. semi-flat, marginal, irregular retouch of cutting edge
- F. flat, very precise retouch near the tip on the distal posterior edge
- M. flat, marginal retouch on the lower face
- E. semi-steep retouch on the upper face, cutting edge rejuvenation, perhaps consist of two stages: first E1-7 leading from the tip to the base and then E2-7 from the base towards the tip.
- L. flat removals on the lower face near the tip, edge correction
- C. irregular, marginal retouch on the lower face, mostly near the base, edge angle correction
- D. flat removals on the upper face derived from the tip
- I, K. flat, partly hinged removals on the lower face, less precise near the base, edge angle correction
- H. flat, broad removals on the lower face, surface formation
- B. flat, partly hinged removals, base formation
- A. flat removals on the upper face, surface formation
- J. flat removals on the lower face, cutting-edge angle correction



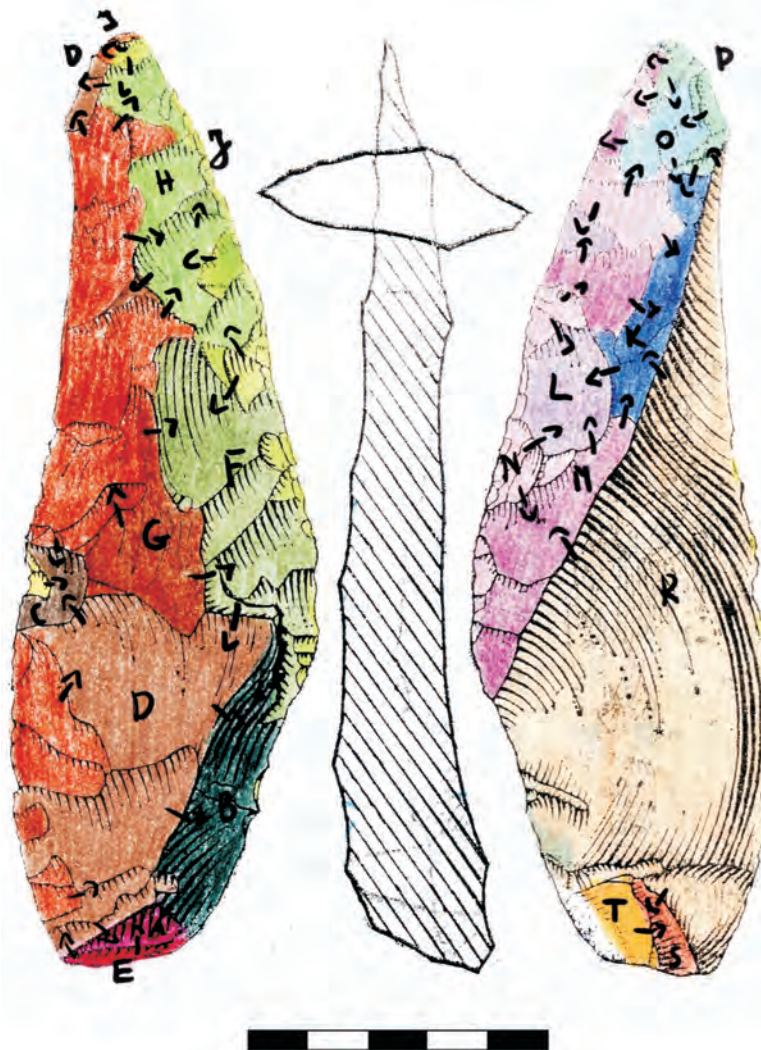
Plate 247 Ripiceni Izvor MIV.3870



Plano-convex knife with multiple phases of rejuvenation. Cutting edge angle correction sequences were derived from cutting edge on the lower face because of hinged removal scar, which prevented performing the thinning from distal posterior edge.

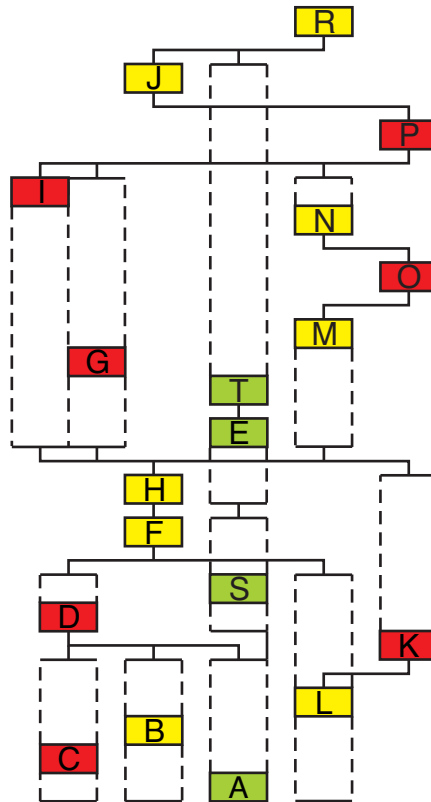
- P. steep, marginal retouch on the distal posterior edge
- G. flat removals on the lower face near the base, back edge formation/rejuvenation (?)
- H. flat removals on the lower face derived from distal posterior edge near the tip, thinning
- R. retouch, probably overlapping a few phases of cutting edge resharpening
- F. flat removals on the lower face, cutting edge angle correction
- O, M. semi-flat removals, cutting edge rejuvenation/resharpening
- E. flat removals, edge angle correction on the lower face
- D. flat removals on the lower face, surface formation
- N. semi-steep removals, back formation
- C. flat, broad removals on the lower face, surface formation
- B. semi-steep removals on the lower face, surface decortication, back edge formation
- A. semi-steep removals from earlier phases of manufacturing process, surface decortication
- L. semi-flat removals on the upper face, back formation
- K. single, flat removal on the upper face derived from the base, surface formation
- J. very high and deep, hinged removal from earlier phases of manufacturing process
- I. steep removal on the upper face from early phases of manufacturing process

Plate 248 Ripiceni Izvor MIV.3872



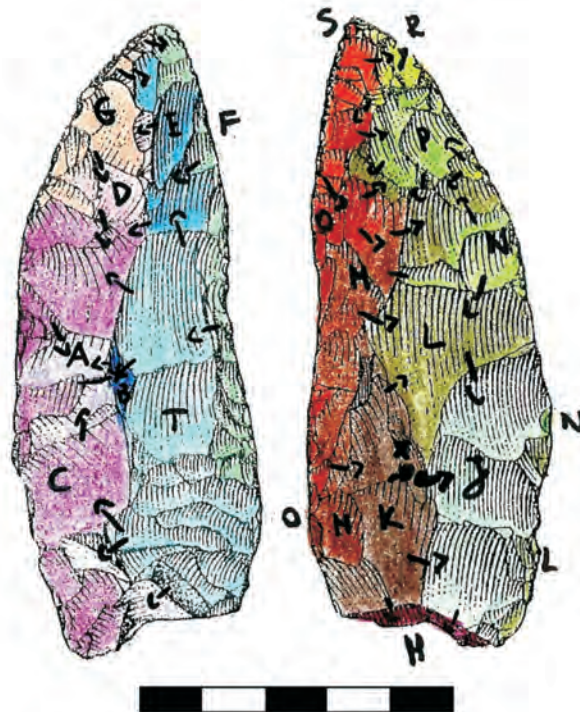
Knife with cutting edge almost entirely removed by overpassed removal derived from the back onto the upper face. The tool was abandoned after the overpassed removal. Tip is located out of vertical axis; base is partly cortical; edges, especially the retained distal posterior edge, show multiple phases of resharpening.

## Plate 248 Ripiceni Izvor MIV.3872



- R. big, deep, overpassed removal derived from the back edge onto the upper face; it removes almost the whole cutting edge and the upper face of tool
- J. semi-flat, fine, irregular, marginal retouch on the lower face
- P. semi-flat, long removals, fine retouch of cutting edge
- I. small removals on the lower face near the tip
- N. semi-flat retouch on the upper face, edge line correction
- O. flat, long removals near the tip, cutting edge rejuvenation
- M. semi-flat removals on the upper face, edge correction
- G. flat removals, probably cutting edge angle correction, partly removed by sequence R
- T, S. semi-flat removals on the upper face derived from the base, base formation
- E. steep removals at the base, base formation
- A. steep removals, from earlier stages of manufacturing process
- H. flat removals on the lower face near the tip, distal posterior edge resharpener
- F. semi-steep, partly hinged removals, unsuccessful thinning on the lower face
- D. semi-flat/semi-steep, broad removals, surface formation
- B. semi-steep removals on the lower face, back formation
- K. flat removals on the upper face, removals by sequence R, edge formation
- C. semi-flat removal on the lower face, earlier phases of manufacturing process

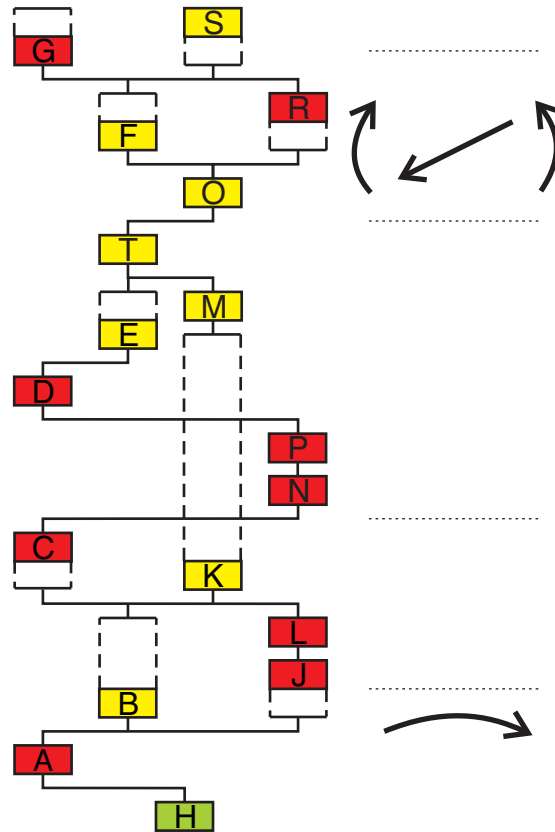
Plate 249 Ripiceni Izvor MIV.3873



Knife with very fine, marginal retouch of cutting edge. Tip is located out of vertical axis and distal posterior edge is convex in outline. Base was formed abruptly. The tool was rejuvenated on both edges. Lower face is flat near the tip, less precisely worked near the base. There was certain care put not only to sharpness, but also to outline—vertical line of cutting edge; one of rejuvenating sequences was focused on near-the-base part to obtain vertical lineage of cutting edge.

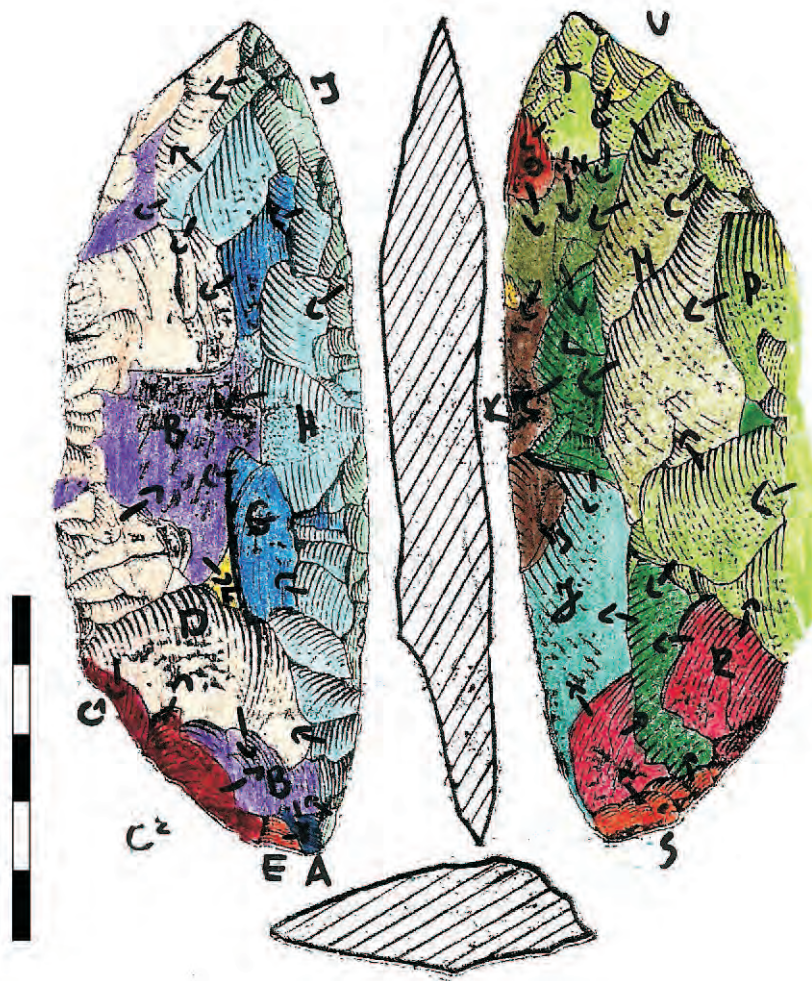


# Plate 249 Ripiceni Izvor MIV.3873



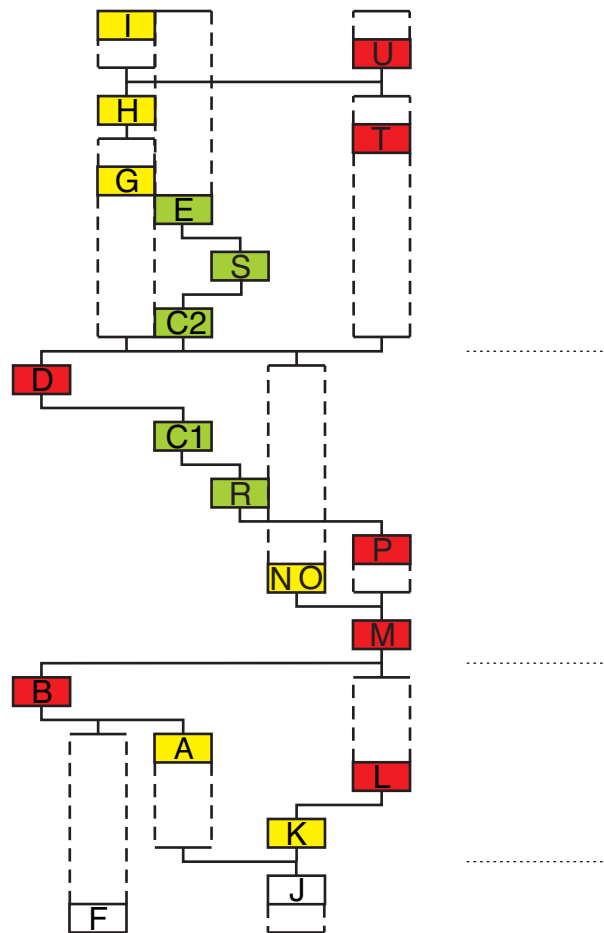
- S. flat, fine retouch on the lower face of cutting edge
- R. flat, fine retouch on the lower face of distal-posterior edge
- G. semi-flat, marginal retouch, distal posterior edge resharpening
- F. semi-flat/semi-steep, marginal retouch, cutting edge resharpening
- O. flat removals on the lower face, edge angle correction/retouch (?)
- M. flat removals on the lower face, edge angle correction/retouch (?)
- T. semi-steep removals on the cutting edge, edge rejuvenation/remodeling to keep its vertical outline
- E. semi-flat retouch, cutting edge rejuvenation
- D. semi-flat removals, distal posterior edge rejuvenations
- P. flat, small removals on the lower face, edge correction
- N. flat, small removals on the lower face, edge correction
- C. semi-flat/semi-steep removals, back line correction
- K. semi-flat removals on the lower face, surface formation (?)
- L. semi-flat, broad removals on the lower face, surface formation
- J. semi-steep removals, earlier stages of surface formation
- B. remains of a semi-flat removal scar from earlier phases of manufacturing process, located in the thickest tool part
- A. semi-steep removals, partly hinged near the base, surface formation
- H. steep removal or natural surface forming the tool base

Plate 250 Ripiceni Izvor MIV.3875



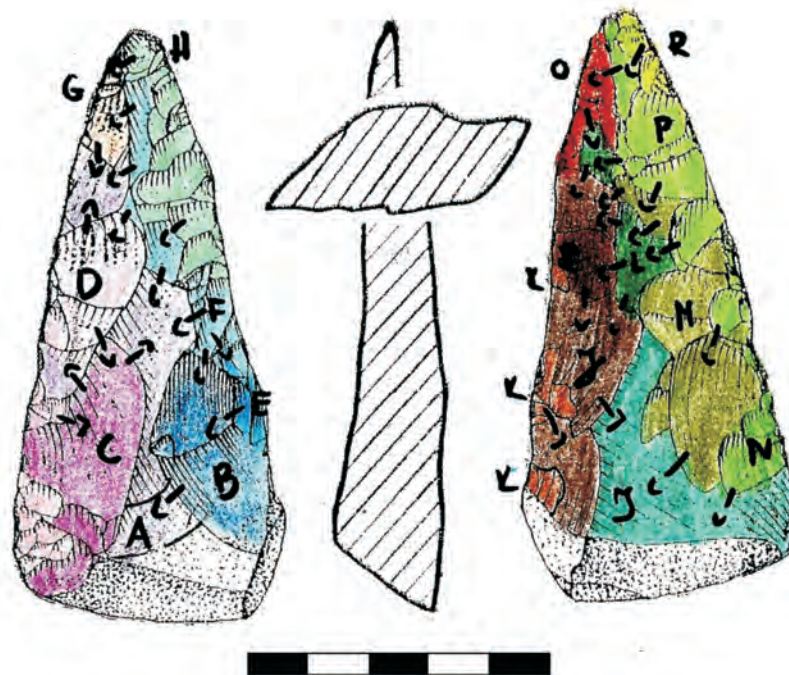
Plano-convex knife with vertical, finely retouched cutting edge. The tool bears traces of several rejuvenation stages; probably earlier rejuvenation sequences are not visible on surface. Lower face is flat and was formed by broad removals reaching the opposite edge. Base is located angularly to vertical axis and was formed by semi-steep and steep removals. Distal posterior edge is long. Cutting edge rejuvenation moved the tip out of vertical axis.

## Plate 250 Ripiceni Izvor MIV.3875



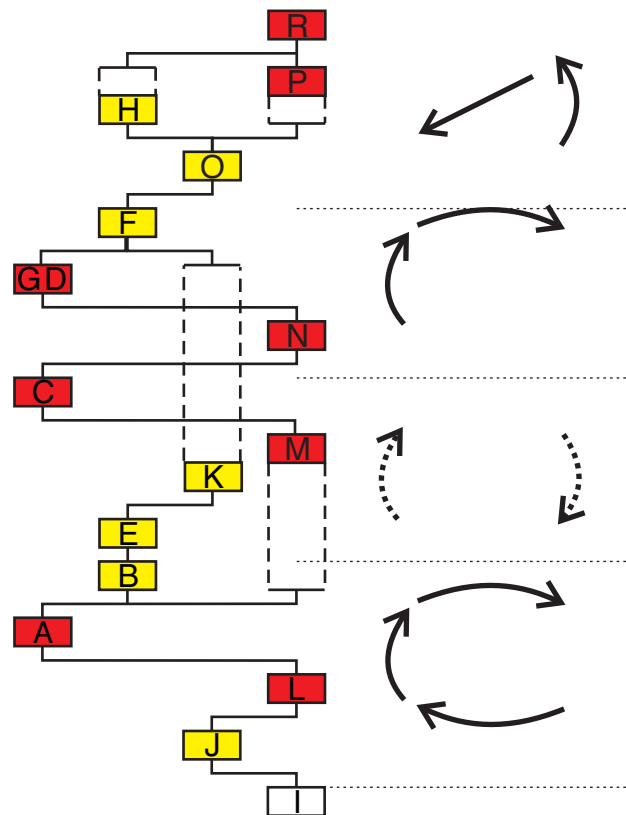
- I. fine, marginal retouch on the upper face of cutting edge, semi-steep along the edge, semi-flat and more precise near the tip
- U. flat, very fine, marginal retouch on the lower face near the tip, less regular and semi-steep along the edge
- H, G. semi-steep retouch, cutting edge rejuvenation
- T. flat removals on the lower face near the tip
- P. semi-flat imprecise removals, back formation
- E. semi-flat, fine removals on the upper face of base
- S. semi-flat, fine, precise retouch of base edge near the cutting edge
- C1, C2. semi-steep removals on the upper face, base formation
- R. flat removals on the lower face, surface formation
- M, L, K. flat, broad removals on the lower face, surface formation
- N, O. flat, broad removals on the lower face, surface formation, edge correction (?)
- D. flat removals on the upper face derived from the back
- B. flat, broad removals on the upper face, surface formation
- F. scar located on the top of tool, the direction of percussion is not visible
- J. broad scar on the lower face, the direction of percussion is not visible
- A. single, semi-flat removal on the upper face, earlier stage of manufacturing process

Plate 251 Ripiceni Izvor MIV.I5



Symmetrical biconvex tool made on a thick, cortical flake with exposed, but not retouched tip, cortical base and two convergent edges. Both edges were retouched alternately. Multiple rejuvenation phases are visible on both edges, especially edge I. Symmetry is connected with analogical, but alternate treatment of both edges.

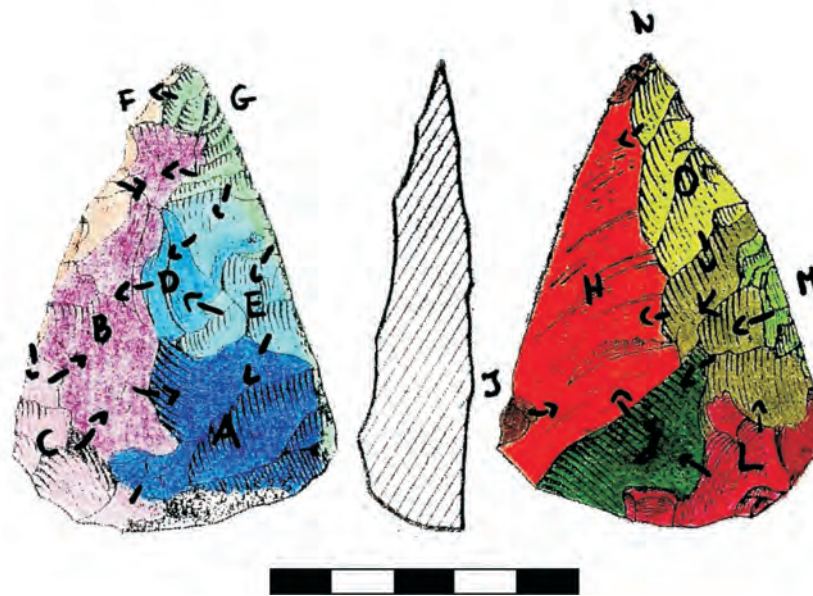
## Plate 251 Ripiceni Izvor MIV.I5



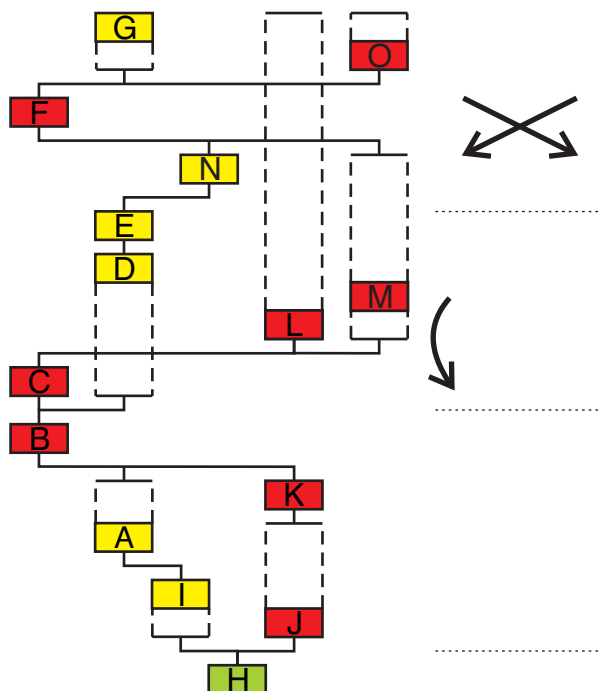
- R. semi-flat, marginal retouch on the lower face near the tip, resharpening
- P. flat/semi-flat retouch on the lower face, precise removals going far onto the surface near the tip, resharpening
- N. flat, long, marginal removals on the lower face, resharpening
- M. flat and semi-flat removals on the lower face, edge formation/retouch
- L. flat, broad removals, surface formation, thinning and butt removing stage
- K. semi-flat and semi-steep, marginal removals on the lower face, edge correction
- O. flat removals near the tip, edge correction
- J. broad removals on the lower face, semi-steep near the base and more flat near the tip, edge formation
- H. semi-flat, fine, long, precise removals on the upper face near the tip, edge resharpening
- F. semi-flat removals on the upper face, broader than sequence H, more steep in the thickest part, edge resharpening,
- E. semi-flat, partly hinged removals, edge resharpening
- B. semi-flat/semi-steep removals on the upper face, edge formation
- G. flat removals near the tip, analogical to sequence O, edge correction
- D. semi-flat removals along the edge, edge correction analogical to sequence K
- C. semi-flat removals on the upper face near the base, surface formation
- A. semi-flat, broad removals, going far onto the upper face, surface formation
- I. flake ventral surface, impact direction is not visible



# Plate 252 Ripiceni Izvor MIV.U11

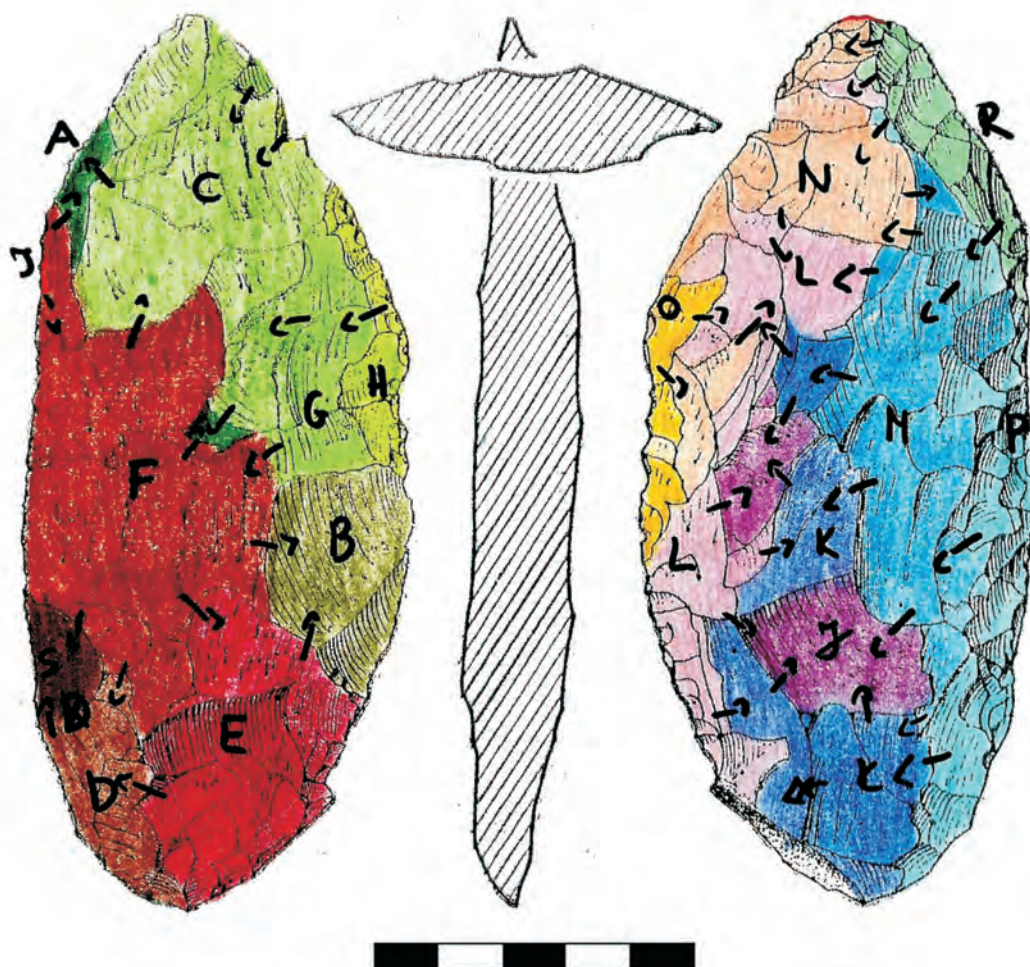


Knife with one edge more precisely formed, but rejuvenated on both edges. Lower face was used for edge angle correction and cutting edge was left with no removals on the lower face, to let it remain straight in profile.



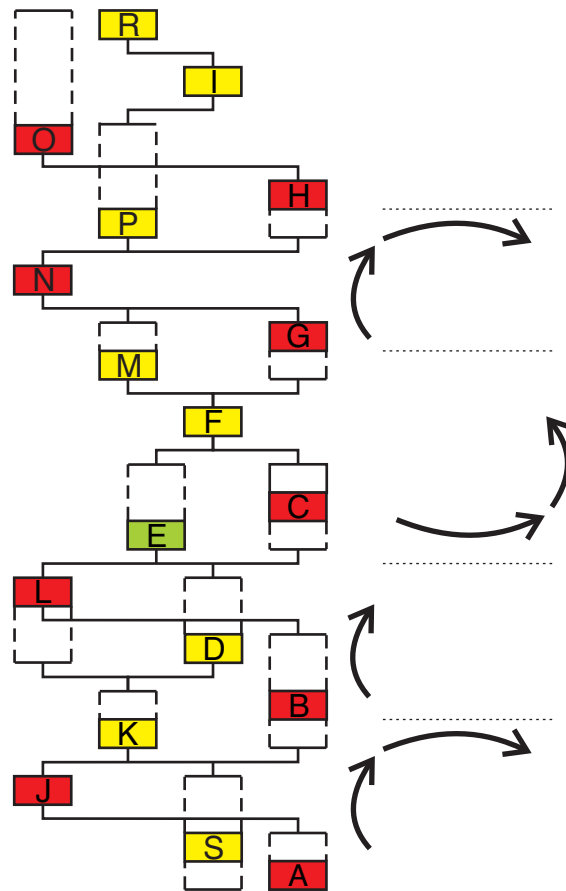
- G. fine, semi-flat, regular retouch of cutting edge
- O. flat, deep removals on the lower face near the tip, edge angle correction
- F. semi-flat and steep removals on the upper face near the tip
- N. flat, small removals on the lower face near the tip, edge angle correction
- D, E. semi-flat removals, cutting edge formation
- A. removals derived near the base, earlier phases of edge formation
- L. flat removals on the lower face derived from the base, surface formation
- M. small removals on the lower face, edge correction
- C. flat, high hinged removals near the base, unsuccessful thinning
- B. flat, broad removals on the upper face, surface formation
- K, J. flat, broad removals on the lower face, thinning and removing the bulb on the ventral side of a flake
- I. small, marginal removals on the lower face, surface correction
- H. ventral surface of a flake

Plate 253 Ripiceni Izvor MIV.V8



Big, plano-convex knife with partly cortical base, multiple stages of cutting edge rejuvenation and angular removals derived on the lower face from distal posterior edge. Bi-angular cutting edge was probably vertical at the beginning. Rejuvenation caused its curving and tip exposure.

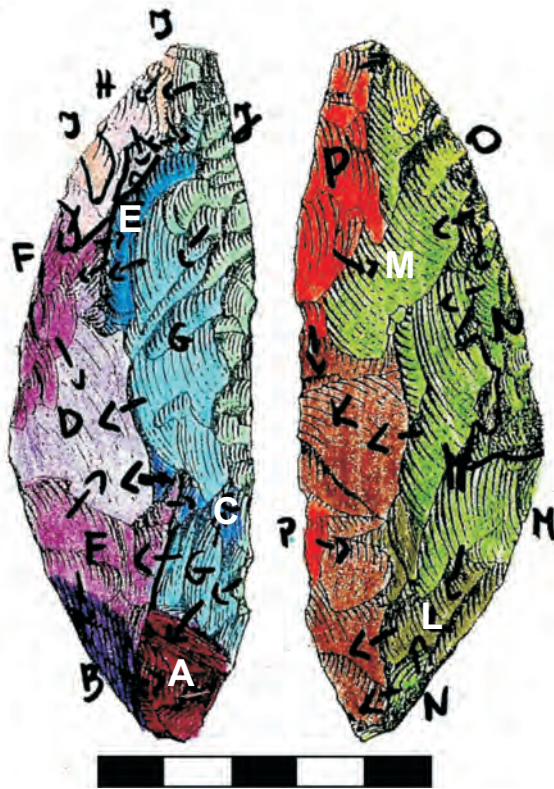
## Plate 253 Ripiceni Izvor MIV.V8



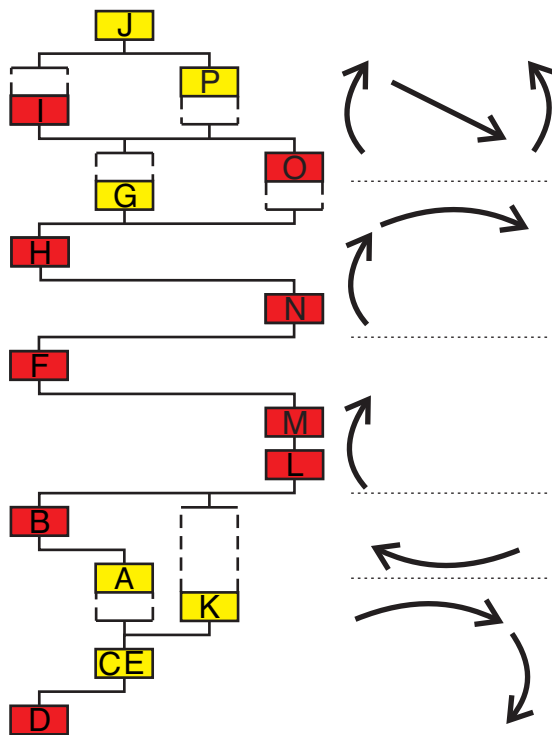
- R. semi-steep, partly hinged retouch, cutting edge rejuvenation
- I. flat, marginal retouch on the lower face
- P. semi-flat removals on the upper face, cutting edge rejuvenation/resharpening
- O. flat removals, back edge correction, created a notch
- H. semi-flat precise retouch on the lower face of back edge
- N. flat, hinged removals on the upper face, back and distal posterior edge rejuvenation, distal posterior edge retouch near the tip
- G. flat removals on the lower face of back edge
- M. semi-flat, broad removals, cutting edge rejuvenation/formation
- F. flat, broad removals, lower face formation, flattening
- C. flat, broad removals, lower face formation, flattening, derived from the distal posterior edge and from the tip along the cutting edge
- E. flat removals on the lower face, derived from the base, surface formation
- L. flat, partly hinged removals on the upper face, back edge formation
- D. semi-flat removals on the lower face, cutting edge formation
- K. flat removals on the upper face, cutting edge formation or first retouch
- B, S, A. flat removals on the lower face, surface formation
- J. flat removals on the upper face, surface formation



## Plate 254 Ripiceni Izvor MIV.V9

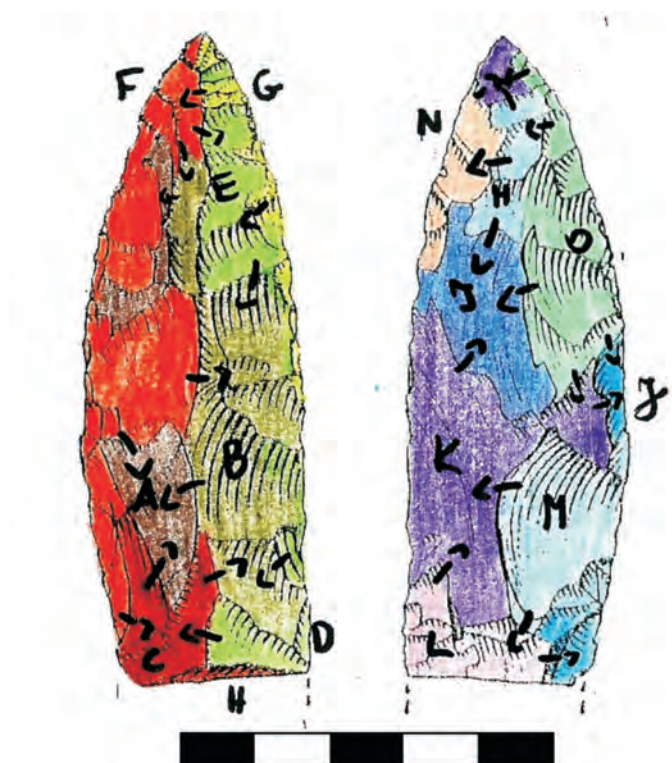


Knife with twisted cutting edge and abruptly worked base. Lower surface is flat, except for near-the-base part, which is convex. Multiple stages of rejuvenation are visible on the tool; sequence C is already a resharpener sequence. The tool was remodeled during rejuvenation phases. Last retouch is extremely precise and fine.

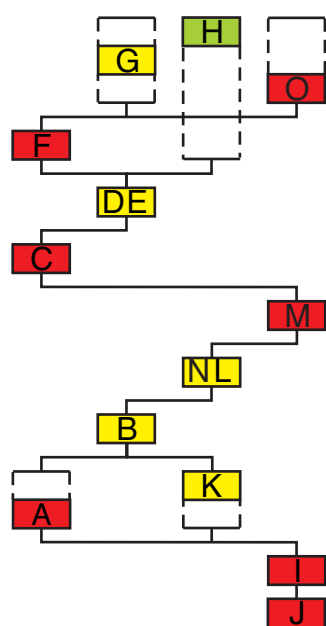


- J. flat, fine, very precise retouch of the cutting edge
- P. flat removals on the lower face, edge angle correction
- I. flat retouch near the tip of distal posterior edge
- O. flat removals on the lower face of distal posterior edge, edge angle correction and retouch
- H. semi-flat retouch near the tip of distal posterior edge
- N. semi-flat, hinged removals on the lower face, back edge formation
- F. flat, hinged removals on the upper face, partly successful back edge thinning, earlier phases of back and distal posterior edge formation
- M. semi-flat, broad removals (more flat near the tip) on the lower face, surface formation
- L. semi-steep removals on the lower face near the base, surface thinning, formation
- B. steep removals, earlier stages of base and back formation
- A. flat, angular removals derived from the base on the upper face, surface formation
- K. flat removals on the lower face, cutting edge angle correction
- E. semi-flat removals, earlier phases of cutting edge rejuvenation/formation
- C. steep removals, earlier phases of cutting edge rejuvenation/formation
- D. flat removals derived from distal posterior edge, earlier phases of manufacturing process

# Plate 255 Ripiceni Izvor MIV.W7(a)



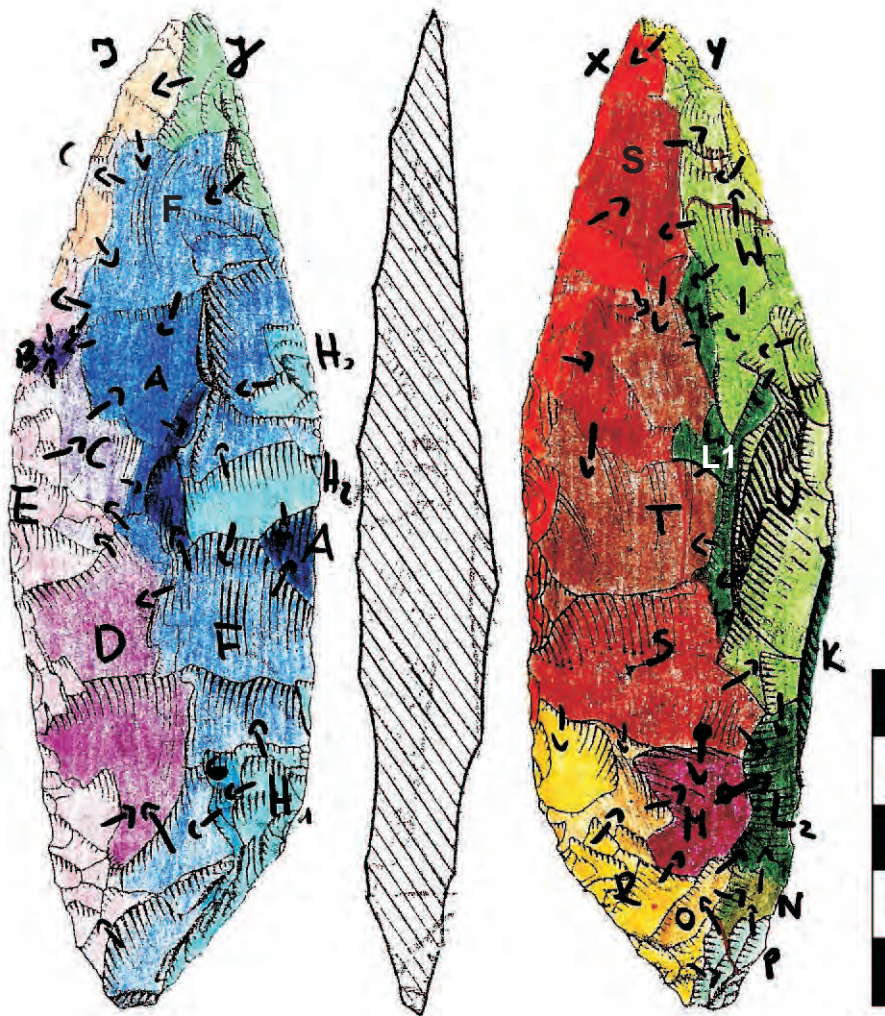
Plano-convex tool with semi-steep edges and multiple traces of rejuvenation on the upper face. It was broken at the base. Lower face was used only for edge angle correction. One of edges was more precisely worked and has usewear retouch near the tip.



- H. transversal breakage, impact point in the middle of the lower face
- G. semi-steep, very fine, marginal retouch, probably partly usewear
- O. flat, deep removals on the lower face, edge angle correction
- F. semi-steep, partly hinged removals, distal posterior edge retouch (?)
- D, E. semi-steep retouch, cutting edge rejuvenation
- C. semi-steep removals on the upper face, thinning
- M, N, L. flat removals on the lower face, edge angle correction, flattening
- B. semi-steep removals, cutting edge rejuvenation/resharpening
- A. semi-steep removals, back edge rejuvenation
- K, I. flat, very broad removals reaching the opposite edge on the lower face, flattening, surface formation
- J. flat removals on the lower face

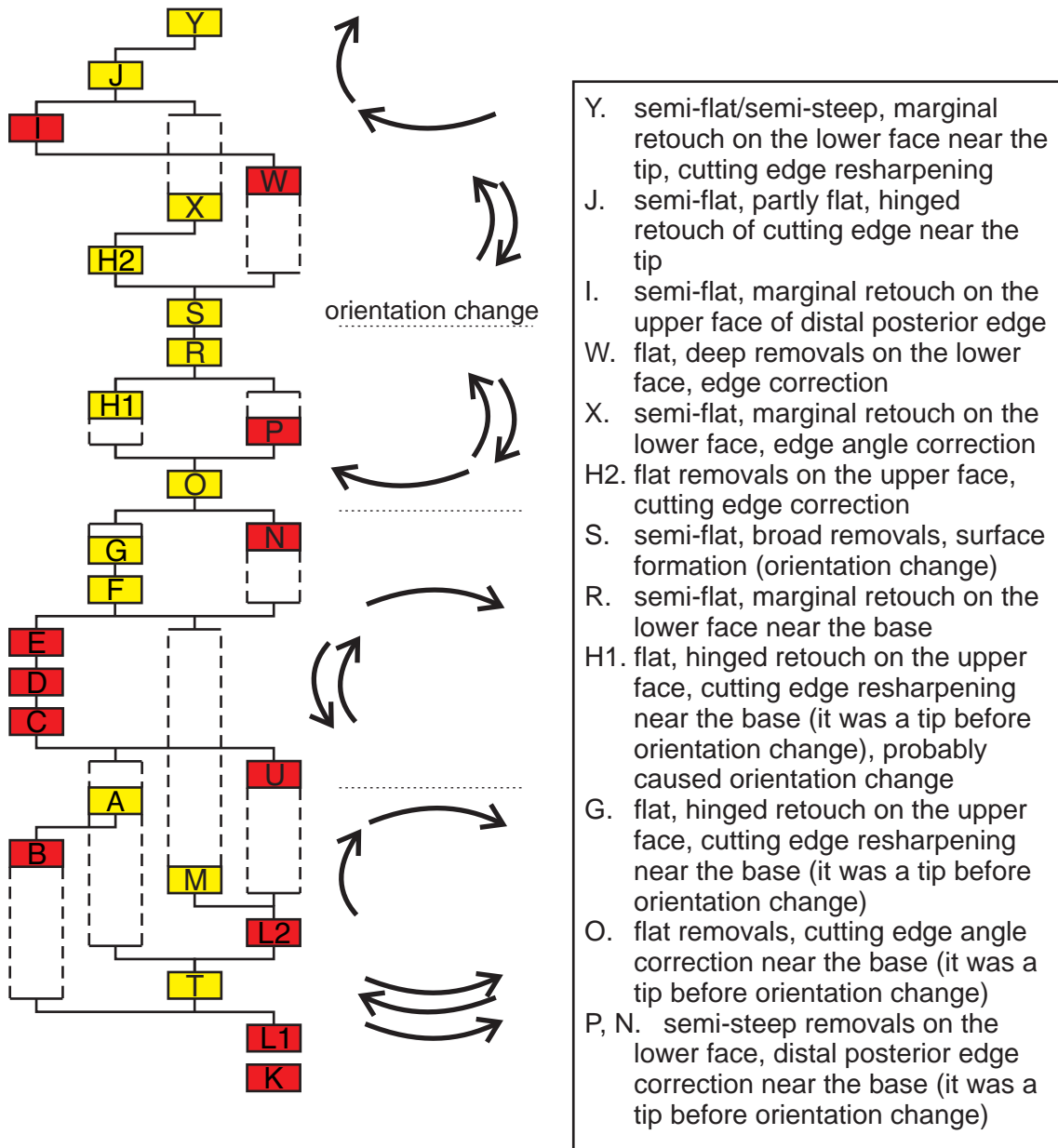


Plate 256 Ripiceni Izvor MIV.W7(b)



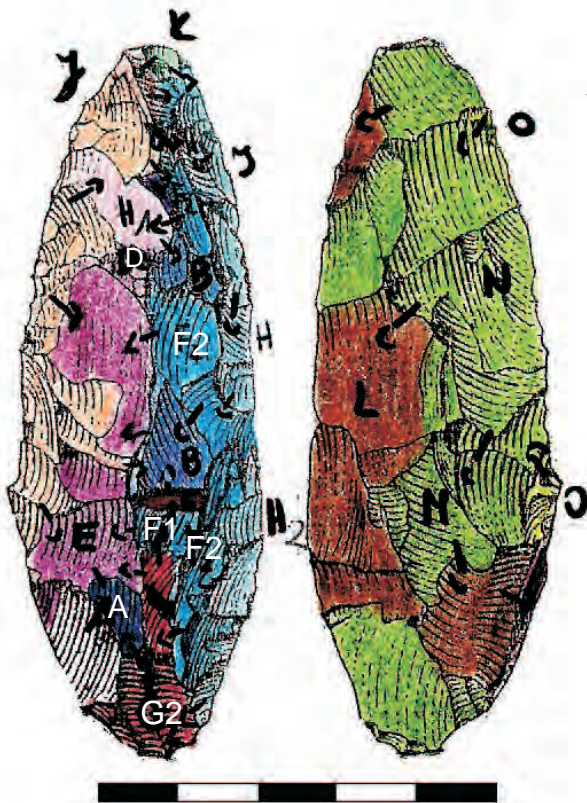
Biconvex knife with its orientation changed during one of rejuvenation phases. Very high hinged removal (>1cm high) damaged back surface; therefore, rejuvenation was limited to only 1/3 of distal posterior edge. Orientation was changed after a series of hinged removals blunting the cutting edge near the tip. After orientation change, the same edge was used as cutting edge, and further resharpening sequences were derived on the cutting edge near the new tip. Due to reorientation, the tool was almost symmetrical in vertical axis.

## Plate 256 Ripiceni Izvor MIV.W7(b)

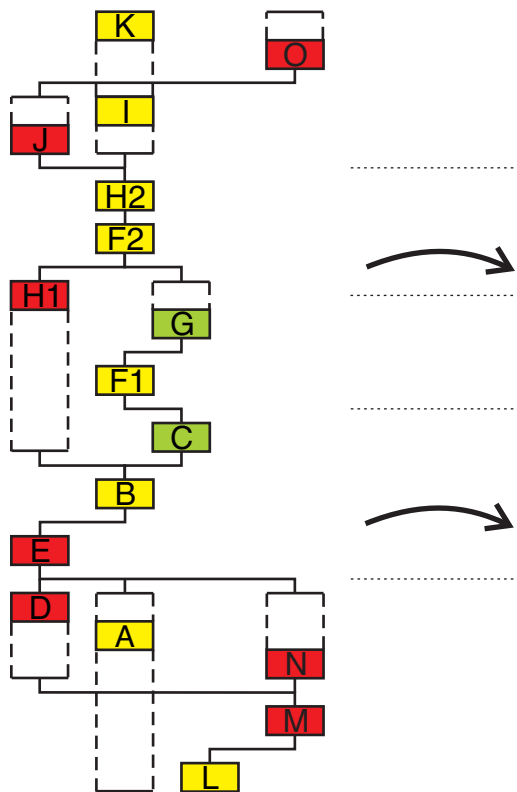


- F. semi-flat, broad removals, cutting edge formation
- E. flat removals on the upper face of distal posterior edge near the base (it was a tip before orientation change)
- D, C. flat removals, rejuvenating the surface and the edge after hinged sequence U
- U. flat, very high hinged removal, damaging the whole lower face and the edge, additional series of removals aimed at removing the hinged scar and rejuvenating the edge, unsuccessful
- A. flat, broad removals on the upper face, surface formation
- L1, T. flat, broad removals on the lower face, surface formation
- K. steep removal or very high hinge from earlier phases of manufacturing process, was used as a back
- M. flat, broad removals derived from the base, surface formation
- B. removal scar from earlier phases of surface formation
- L2. steep removal, back surface formation

## Plate 257 Ripiceni Izvor MIV.Z9



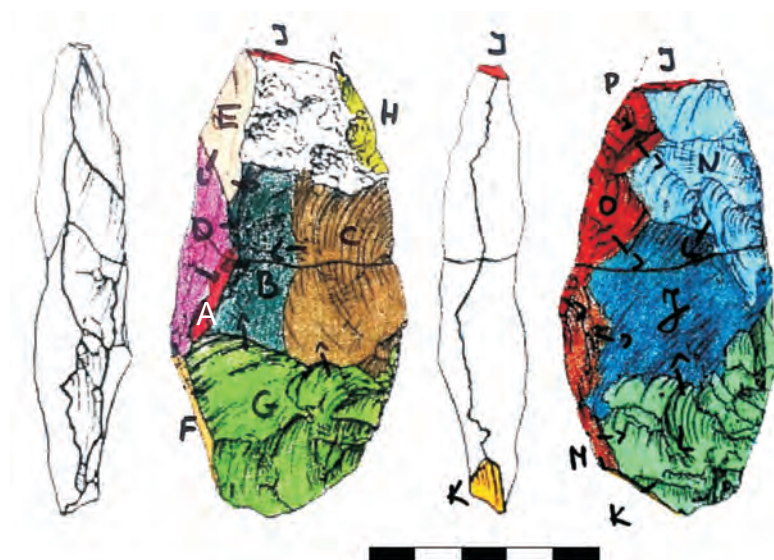
Symmetrical, plano-convex tool with both edges retouched precisely. Tip was broken and then remodeled and thinned. Intensive usewear is visible on cutting edge; lack of it on distal posterior edge. The tool bears traces of multiple rejuvenation stages. Resharpener sequences caused cutting edge blunting. Lack of edge angle correction on the lower face caused the blunting of both edges.



- K. flat removals on the upper face, derived from the tip, tip rejuvenation after breakage
- O. flat, small removals on the lower face, edge correction
- J. semi-steep removals, distal posterior edge correction in the middle part of edge
- I, H2. semi-steep, fine removals, cutting edge retouch and usewear
- F2. semi-steep retouch, partly hinged near the base, cutting edge correction/formation
- H1. semi-steep removals on the upper face near the tip, distal posterior edge rejuvenation
- G. semi-steep removals derived from the base, rejuvenation
- F1. semi-steep removals near the base, surface formation/rejuvenation
- C. flat scars on the top of tool, removals derived from the base, surface formation
- B, E, D. semi-steep removals, cutting edge rejuvenation
- A. scar located near the base, next to cortical part, earlier stages of manufacturing process
- N, M, L. flat, broad removals on the lower face, thinning, surface formation

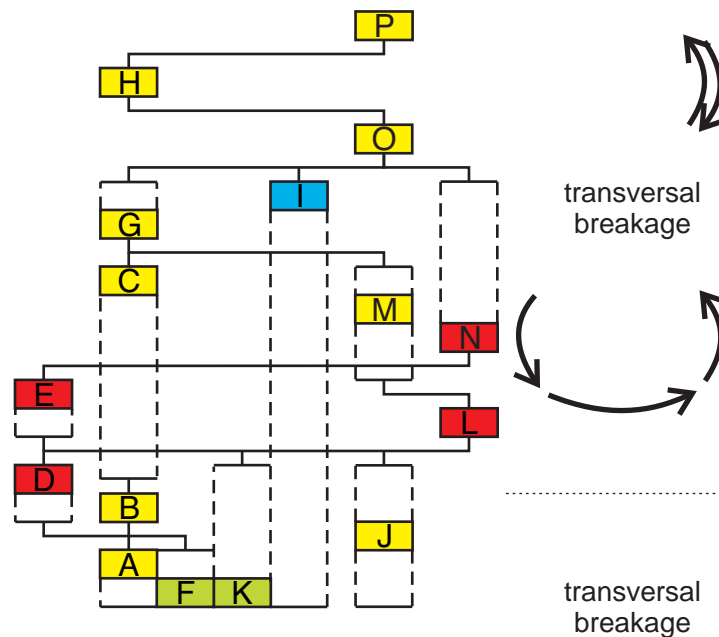


Plate 258 Korolevo II K.II.1



Unfinished, broken, plano-convex preform with thinning sequences derived alternately near the base. Unsuccessfully thinned and decorticated near the tip.

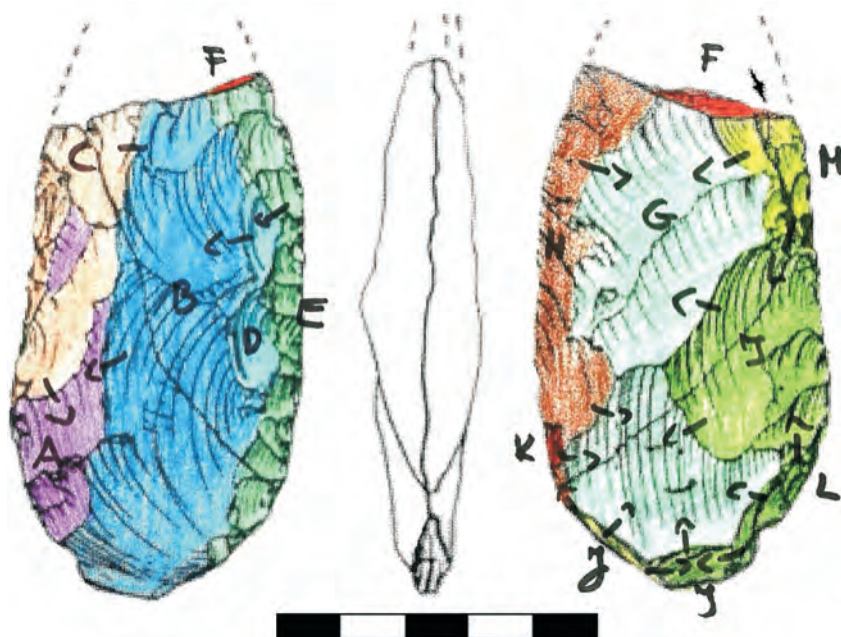
## Plate 258 Korolevo II K.II.1



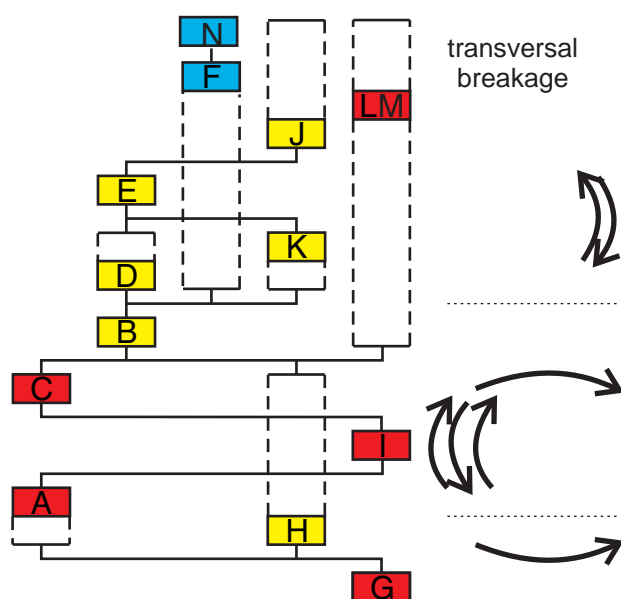
- P. semi-flat, marginal truncation on the lower face after breakage
- H. semi-flat, marginal removals on the upper face near the breakage, edge decortication, thinning, was supposed to go further on the surface, analogically to sequence N
- O. semi-flat removals on the lower face, near-the-tip part thinning
- I. transversal breakage and flat removals derived on the breakage scar for flattening
- G. flat, far going removals reaching the opposite edge on the upper face near the base, successful thinning, surface formation, analogical and alternate to sequence L
- L. flat, far going removals reaching the opposite edge on the lower face near the base, successful thinning, surface formation, analogical and alternate to sequence G
- C. semi-flat, deep, broad removals on the upper face, surface thinning
- B. flat, broad removals on the upper face, surface formation, thinning, decortication
- M. semi-flat removals on the lower face near the base, edge angle formation for sequence G
- N. flat, far going removals on the lower face near the tip, surface formation, thinning
- E, D. single, semi-steep, hinged removals on the upper face near the tip, edge thinning, and edge angle formation
- F, K. steep removal or natural surface near the base
- J. flat, broad scar or ventral surface of a flake
- A. flat scars on the upper face, earlier phases of manufacturing process, decortication



## Plate 259 Korolevo II K.II.2

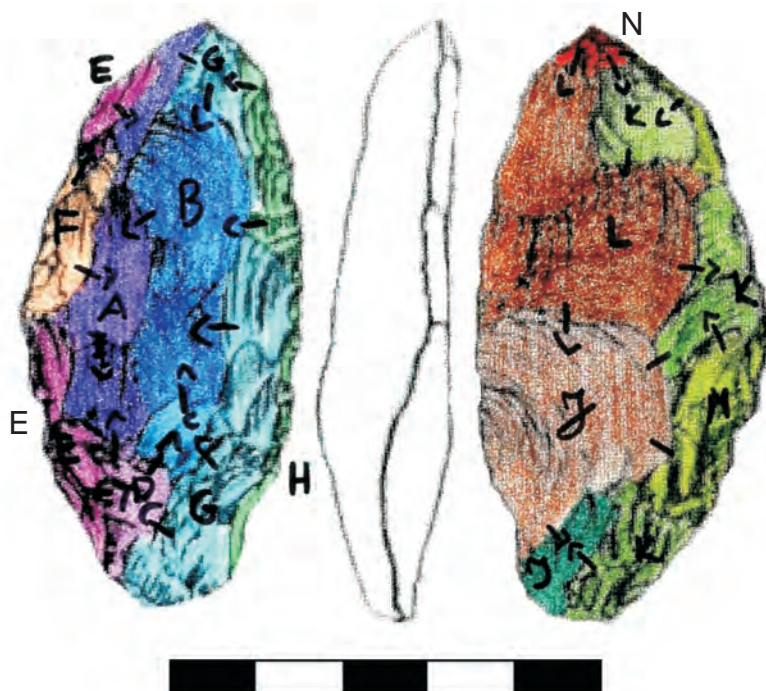


Plano-convex base part of broken tool, successfully thinned on both surfaces, but unsuccessfully remodeled after breakage (sequence N). The tool has two refitted flakes (sequence G and B from the thinning stage of manufacturing process.) One of edges was retouched, and probably resharpended.

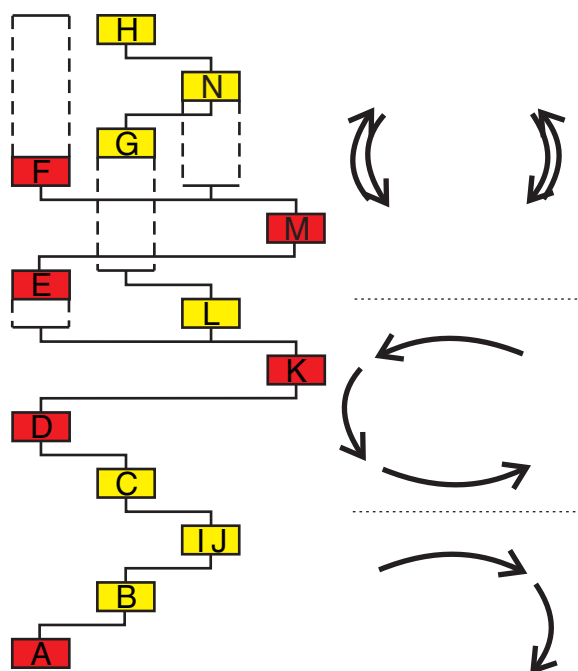


- N. single truncation derived on the breakage scar, probably aimed at removing the edge and created a back surface, unsuccessful and bent, caused an overpassed tool breakage
- F. transversal breakage
- M. flat, marginal retouch on the lower face, edge correction
- L. flat, marginal retouch on the lower face at the base, edge correction
- J. steep, hinged removal near the base, base formation(?)
- E. flat/semi-flat, marginal retouch on the upper face, edge sharpening
- D. flat/semi-flat removals on the upper face, edge sharpening
- K. single, flat, marginal removal on the lower face, edge angle correction
- B. semi-flat, broad removals on the upper face, surface formation, thinning
- C. semi-steep and semi-flat removals on the upper face, edge formation
- I. flat removals on the lower face, edge angle formation, thinning
- A. semi-steep/semi-flat removals on the upper face, surface thinning
- H, G. flat, broad removals on the lower face, surface formation, thinning

# Plate 260 Korolevo II K.II.3

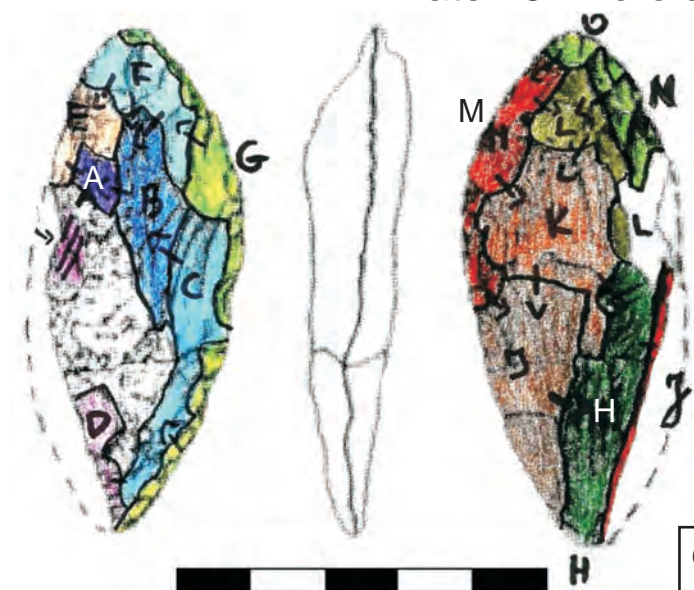


Plano-convex tool without exposed tip, with one edge retouched and resharpener several times and another one blunted. Lower face was used for edge angle correction only. Tool orientation was probably changed during manufacturing process, which would explain thinning sequences on the upper face near the base (sequences C and D).

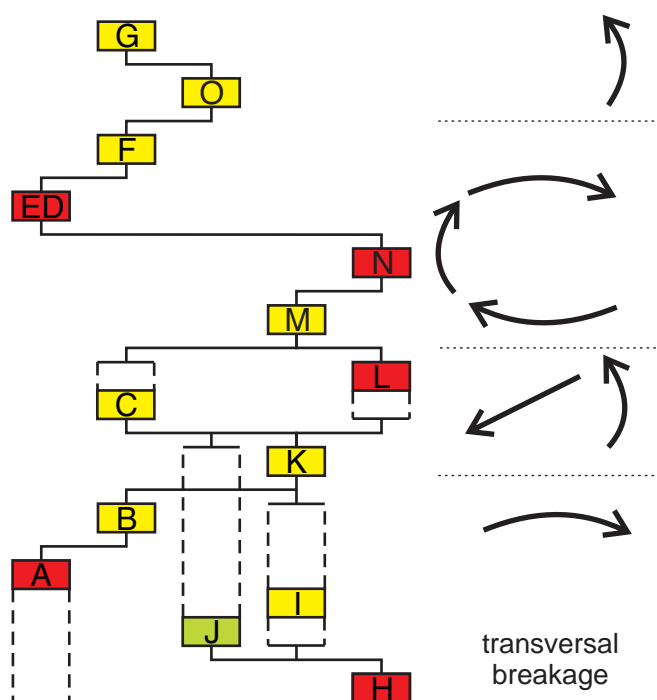


- H. steep, marginal retouch on the upper face, edge resharpener
- N. flat removals on the lower face at the tip, tip thinning
- G. semi-steep and steep retouch on the upper face, edge resharpener
- F. semi-steep, partly hinged retouch on the upper face, edge resharpener
- M. flat, partly hinged removals on the lower face, edge angle correction
- E. semi-steep removals on the upper face, back edge formation
- C, D. semi-flat removals on the upper face near the base, surface thinning
- L, K, I, J. flat removals on the lower face, surface and edge angle formation
- A. flat, broad removals on the upper face, surface formation, thinning
- B. semi-flat removals on the upper face, surface formation, thinning

# Plate 261 Korolevo II K.II.4

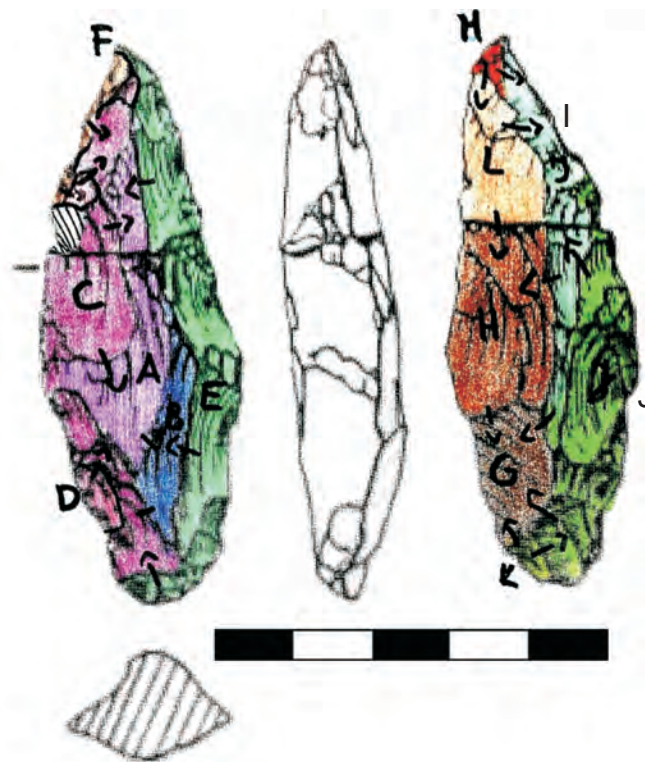


Plano-convex knife without exposed tip, with transversal breakage which created the back. Cutting edge was thinned and resharpened several times as well as the near-the-tip part of opposite edge.

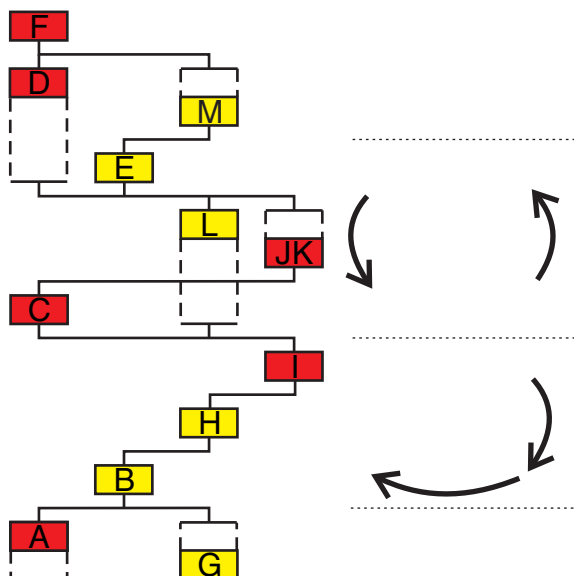


- G. semi-flat, marginal retouch on the upper face, edge resharpening
- O. flat removals on the lower face at the tip, tip thinning
- F. flat, hinged retouch on the upper face near the tip, edge resharpening
- E. steep removals on the upper face near the tip, distal posterior edge formation
- D. flat removals on the upper face near the base, near-the-base surface formation
- N. flat removals on the lower face near the tip, edge angle correction
- M. semi-steep removals on the lower face near the tip, edge angle correction
- C. hinged removals: semi-steep near the base and more flat along the edge, edge resharpening
- L, K. semi-flat removals on the lower face, near-the-tip part thinning, edge angle formation
- B, A. semi-flat removals on the upper face, surface formation, thinning
- I, H. flat, broad removals on the lower face, surface formation, thinning
- J. transversal breakage located angularly to vertical axis, created the back

Plate 262 Korolevo II K.II.5



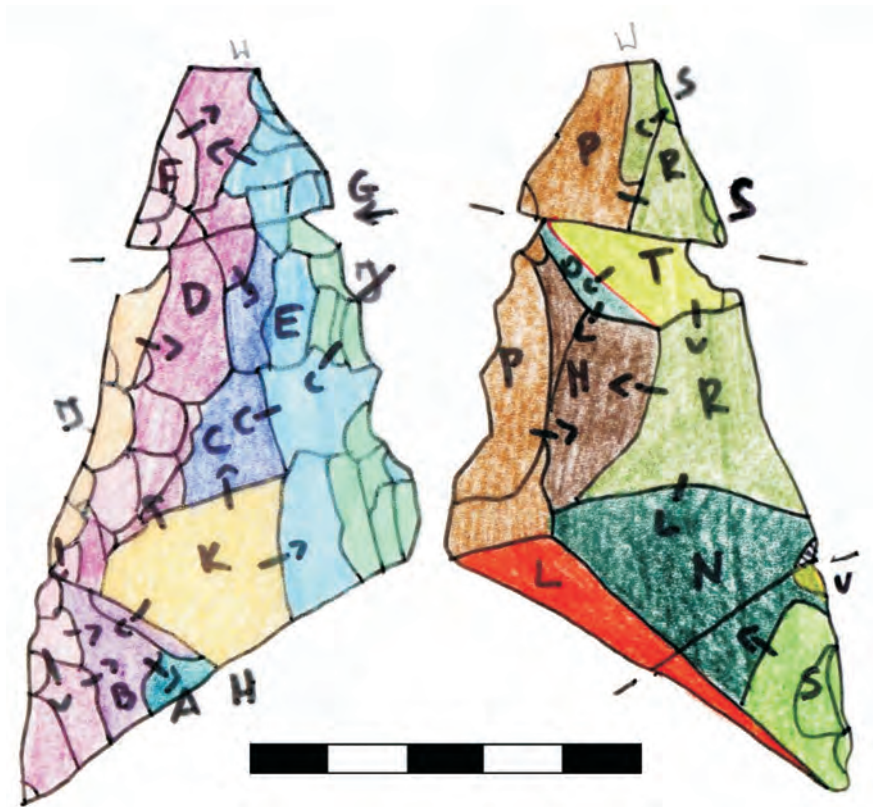
Plano-convex tool with blunted back edge and exposed tip. Cutting edge was probably rejuvenated several times. Lower face was used for edge angle correction.



- F. steep, marginal retouch on the upper face near the tip, tip exposure
- D. semi-steep, marginal removals on the upper face, edge rejuvenation
- M. flat, marginal removals on the lower face at the tip, edge thinning
- E. semi-steep retouch on the upper face, edge resharpener
- L, H. flat removals on the lower face, edge angle correction
- J, K. semi-steep removals on the lower face near the base, edge and base formation
- C. semi-steep and steep removals on the upper face, back formation
- I. semi-flat removals on the lower face, edge angle formation, thinning
- G, H. flat removals on the lower face, edge angle formation, surface formation, thinning
- A, B. semi-flat removals on the upper face, surface formation, thinning



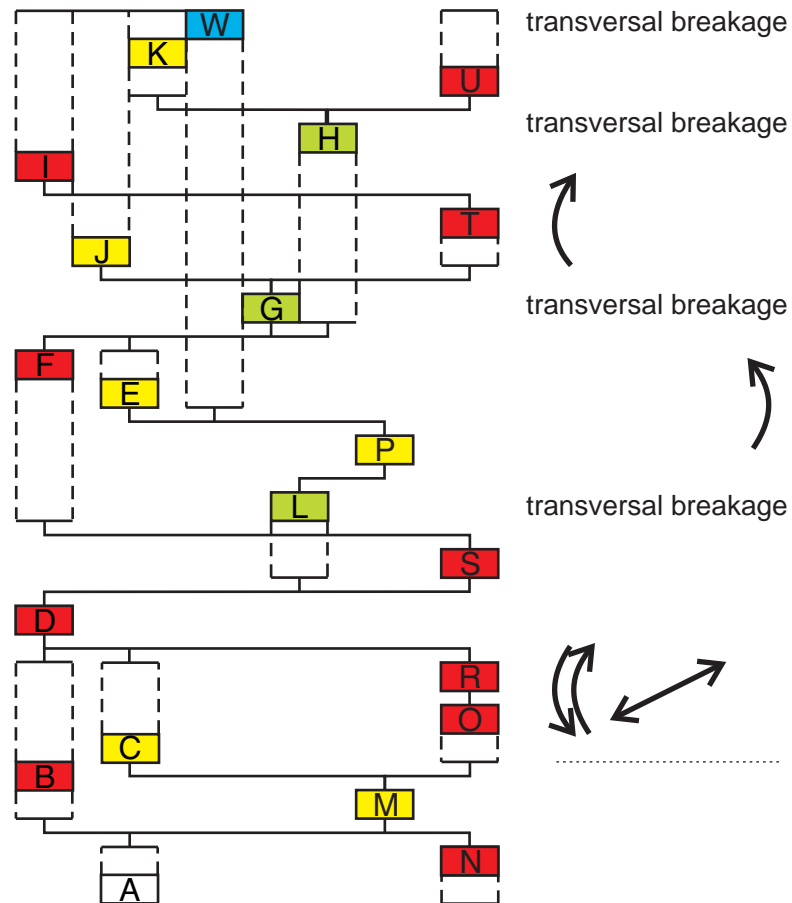
Plate 263 Korolevo II K.II.6



Biconvex tip part of tool with four transversal breakages. The middle part was resharpened along both edges after breakage. Acute angle near the L breakage was probably intentionally removed (sequence H) to blunt the base.

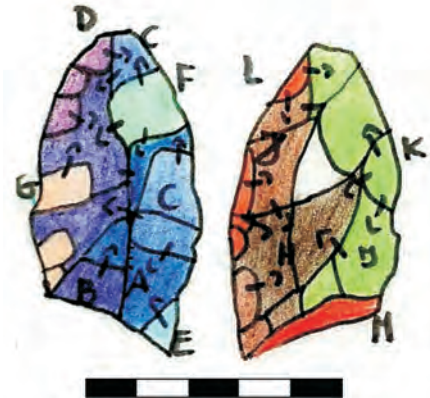


## Plate 263 Korolevo II K.II.6

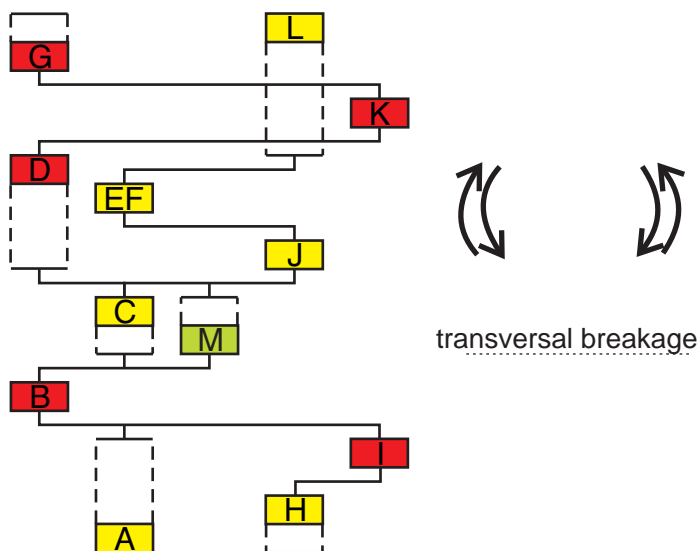


- W. transversal breakage at the tip
- G. transversal breakage
- H. transversal breakage, impact point on the lower face at the transversal breakage edge
- L. transversal breakage, impact point in the middle of the upper face
- K. flat, hinged removal on the upper face derived from the breakage scar, thinning
- U. small truncation near the H breakage
- I, J. semi-steep, marginal retouch on the upper face, edge resharpening
- T. single, semi-steep removal derived on the breakage scar, near-the-breakage part remodeling, thinning
- F. semi-flat, marginal retouch on the upper face, edge resharpening
- E. semi-steep retouch on the upper face, edge sharpening
- P, R. semi-flat removals on the lower face, edge angle formation, thinning
- D. semi-flat/semi-steep removals on the upper face, edge formation, sharpening
- S. flat removals on the lower face, edge thinning, sharpening (?)
- B, C. semi-flat, broad removals on the upper face, surface formation, thinning
- A. eroded scar
- M, N, O. semi-flat removals on the lower face, surface formation, thinning

# Plate 264 Korolevo V K.V(2)

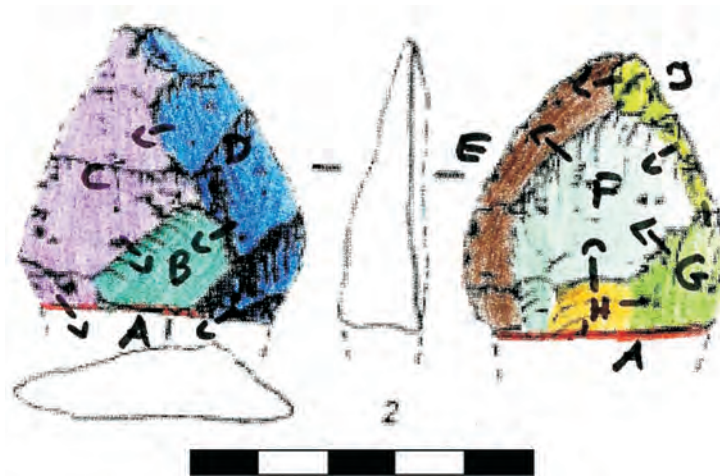


Biconvex, small, broken tool with unexposed tip and edge rejuvenation sequences derived after breakage. The tool bears no traces of intensive resharpening sequences and neither of edges was blunted.

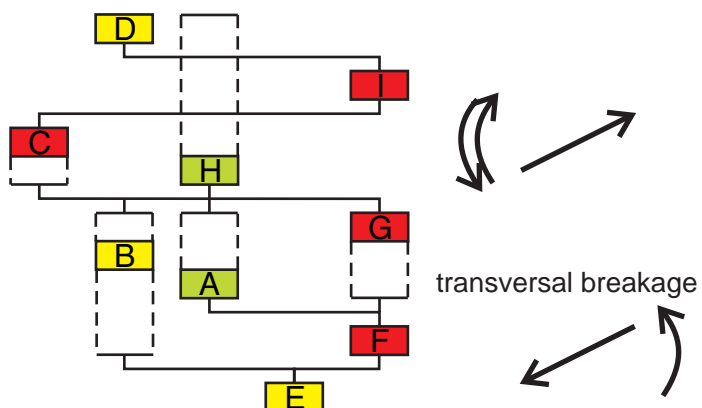


- L. flat, small truncations on the lower face, edge correction
- G. semi-flat removals on the upper face and semi-steep near breakage, edge rejuvenation after breakage
- K. single, flat removal on the lower face, edge/edge angle correction
- D. semi-flat, marginal retouch on the upper face near the tip, edge sharpening
- E. single, semi-flat, hinged removal on the upper face near breakage scar, edge rejuvenation after breakage
- F. single, semi-flat removal on the upper face, edge thinning
- J. flat removals on the lower face, edge thinning
- C. semi-flat removals on the upper face, edge formation
- M. transversal breakage
- A, B. semi-flat removals on the upper face, earlier phases of manufacturing process
- H, I. flat and semi-flat, broad removals on the lower face, earlier phases of manufacturing process

Plate 265 Korolevo V K.V.86

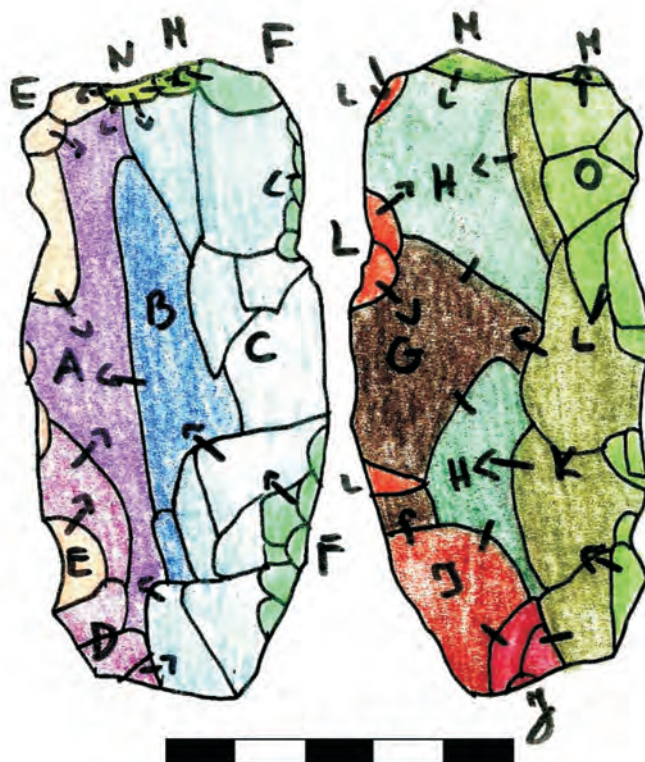


Plano-convex, small tool with unexposed tip and base formed by transversal breakage. Both edges were thinned and sharpened, but bear no traces of intensive resharpening sequences.



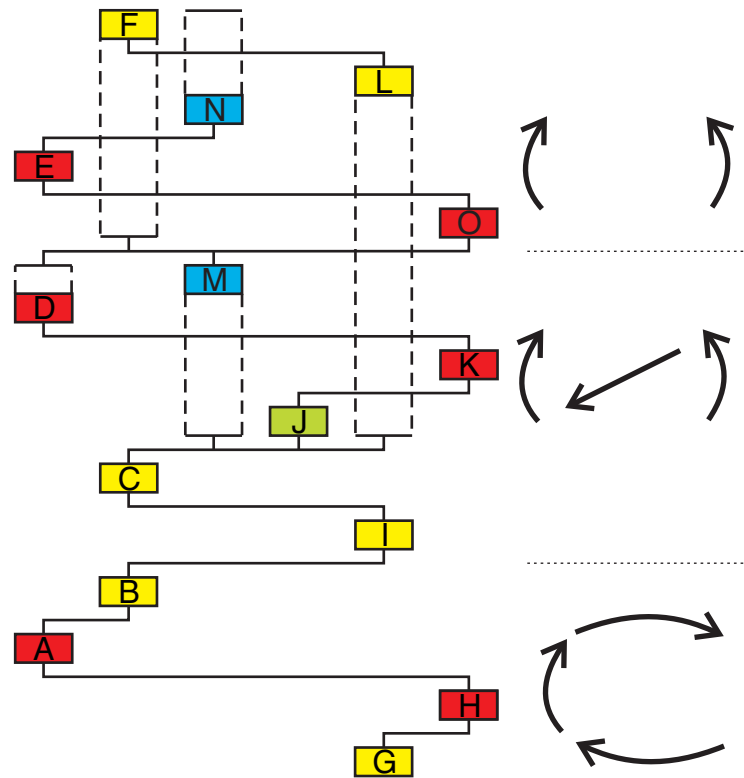
- D. semi-flat/flat removals on the upper face, more steep near the base, unsuccessful thinning
- I. semi-flat, marginal retouch on the lower face along the edge, edge sharpening
- C. semi-flat removals on the upper face, edge formation, thinning
- H. single, flat removal derived on the lower face from the breakage scar, surface correction
- G, E, F. single, flat removal on the lower face, surface formation, thinning
- A. transversal breakage at the base
- B. flat, hinged removals, earlier phases of manufacturing process

Plate 266 Korolevo V K.V.2100/4555



Plano-convex tool without exposed tip or base. Both ends are blunted. One of edges was more precisely worked and was probably the working edge, the second was blunted and bears no traces of sharpening retouches. Knapping was focused on edges and edge angles.

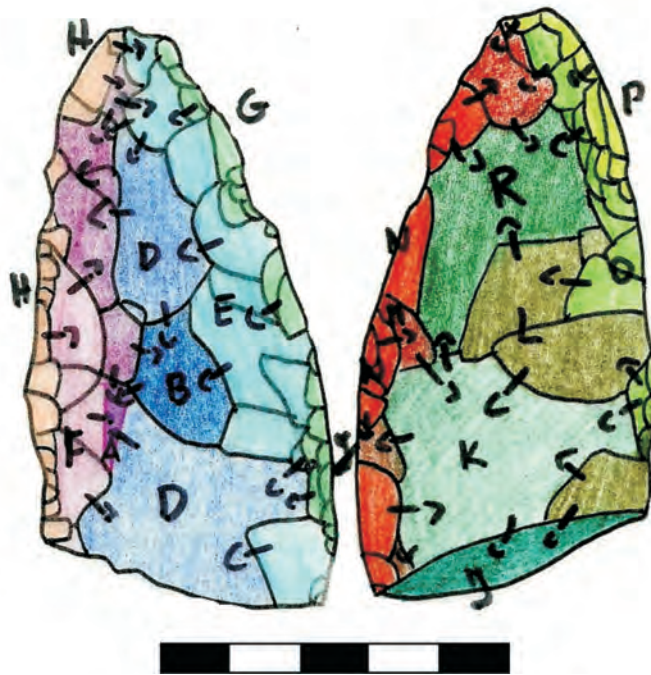
Plate 266 Korolevo V K.V.2100/4555



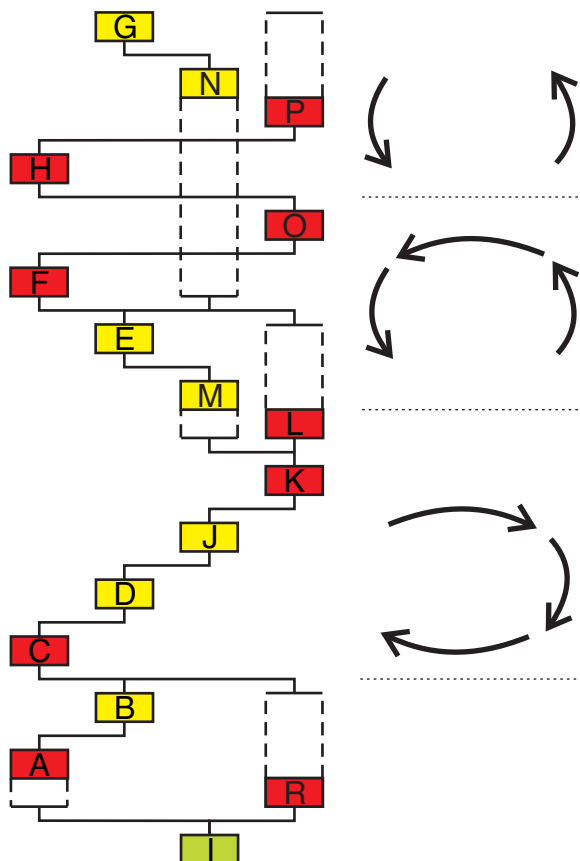
- F. semi-steep, marginal retouch on the upper face and semi-steep removals at the end, edge resharpening
- L. flat removals on the lower face, edge angle correction
- N, M. steep removals at the end, edge blunting
- E. semi-steep removals on the upper face near the end, edge blunting, rejuvenation (?)
- O. flat removals on the lower face, edge angle correction, edge thinning
- D. semi-steep removals on the upper face near the end, edge formation, thinning, shaping (?)
- K. flat, hinged removals on the lower face, edge angle correction, edge thinning
- J. semi-steep removals on the lower face derived from one of the ends, edge correction
- C. semi-steep and semi-flat removals on the upper face, edge formation, sharpening
- I. single, flat removal on the lower face, edge angle correction
- B. flat, broad removals on the upper face, surface formation, thinning
- A. single, semi-steep, broad removal on the upper face, surface formation, thinning
- G. flat surface, the scar is not clearly visible, probably flat scar
- H. flat, broad removals on the lower face, surface formation, thinning



Plate 267 Korolevo V K.V.2100/4556

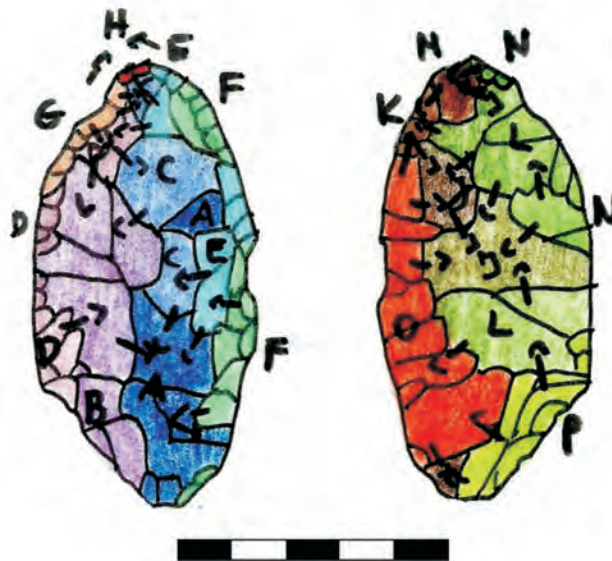


Plano-convex tool with transversal base, poorly exposed tip and both edges retouched and subsequently resharpened on the upper face, lower face was used for edge angle correction, except perhaps the last stage of rejuvenation, when semi-flat retouch was derived on the lower face near the tip. Manufacturing process and rejuvenation sequences were focused on edges and edge angles, not on the tip itself, which was moved out of vertical axis and left unexposed.

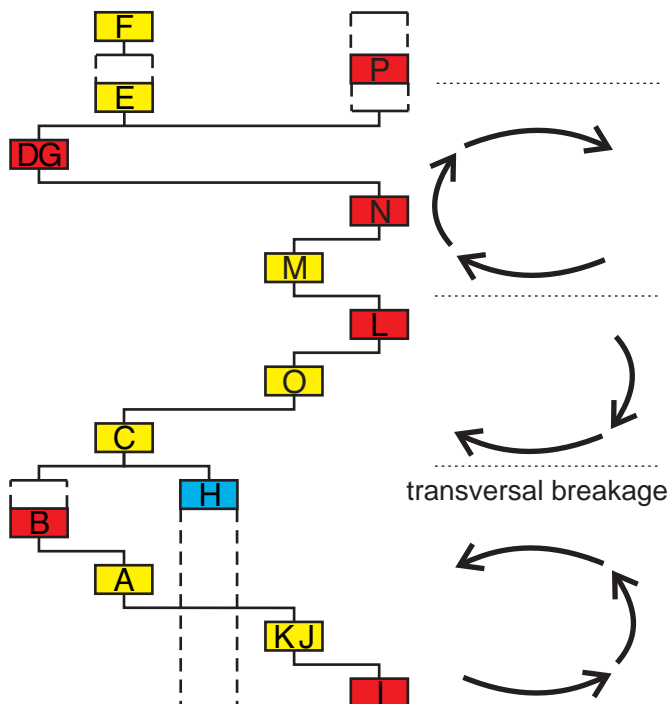


- G. semi-steep, marginal retouch, edge resharpening, created notches along the edge
- P. semi-flat, marginal retouch on the lower face near the tip and at the tip, edge resharpening
- N, M, J. flat removals on the lower face, edge angle correction
- H. semi-steep, marginal retouch on the upper face, edge resharpening
- O. flat removals on the lower face near the tip, edge angle correction
- E. semi-steep, regular removals on the upper face, edge resharpening
- F. semi-flat removals on the upper face, edge resharpening, correction
- C. semi-flat removals on the upper face, edge, formation, sharpening, thinning (?)
- B, D. flat, broad removals on the upper face, surface formation, thinning
- A. single, flat scar on the upper face, earlier phases of manufacturing process
- L. flat removals on the lower face, edge angle correction
- K, R. flat, broad removals on the lower face, surface formation, thinning
- I. semi-steep, natural surface created the base

Plate 268 Korolevo V K.V.2100/4558

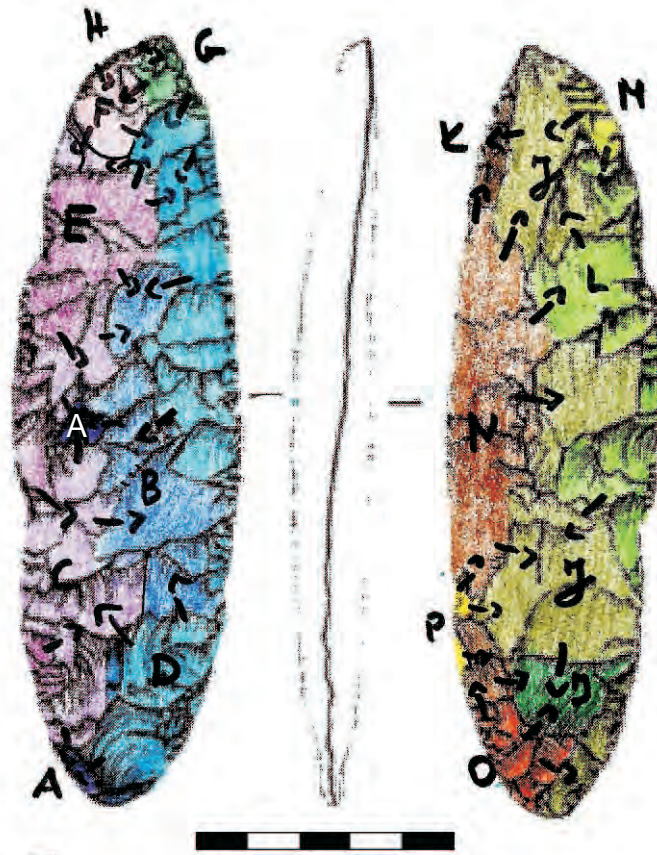


Plano-convex tool with unexposed tip and transversal surface at the tip, which remained unremoved during rejuvenation stages. Near-the-base part of back was formed by semi-steep removals on the lower face. Cutting edge and distal posterior edge were rejuvenated several times. Lower face was used for edge angle correction only.



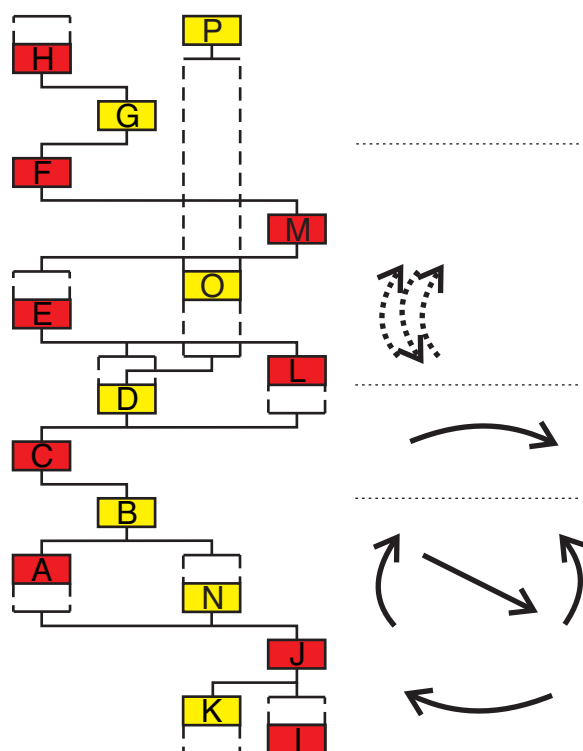
- F. flat and semi-flat, marginal retouch on the upper face, cutting edge resharpening
- E. semi-flat/semi-steep, marginal retouch on the upper face, cutting edge resharpening
- P. semi-steep removals on the lower face near the base, back/base rejuvenation
- G. semi-steep, marginal retouch on the upper face, distal posterior edge rejuvenation
- D. semi-flat/semi-steep, marginal retouch on the upper face, edge rejuvenation
- N, L, O. flat removals on the lower face, edge angle correction
- I. flat, broad removals on the lower face, surface formation, thinning
- M. flat removals on the lower face near the tip, edge angle correction, tip exposure
- K. semi-flat removals on the lower face near the tip, edge angle correction, edge formation
- J. flat removals on the lower face, surface formation, thinning
- C, B, A. semi-flat removals on the upper face, edge formation/resharpening (?)
- H. transversal surface at the tip, breakage scar or natural surface

Plate 269 Korolevo V K.V.2100/4559



Plano-convex, elongated tool without exposed tip. Flat, long, angular removals on the lower face, which were derived from distal posterior edge, were aimed at cutting edge angle correction. Cutting edges were rejuvenated, one cutting edge was retouched more precisely. Lower face was used for edge angle correction.

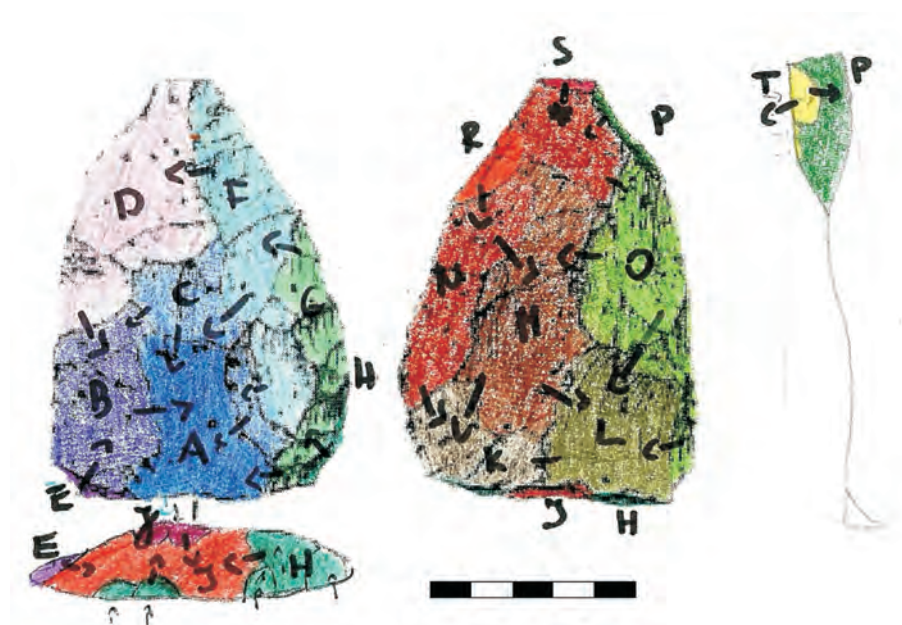
Plate 269 Korolevo V K.V.2100/4559



- P. steep truncation on the lower face, probably postdepositional
- H. steep, fine, marginal retouch on the upper face near the tip, distal posterior edge rejuvenation
- G. semi-steep, marginal retouch on the upper face near the tip, cutting edge resharpener
- F. semi-flat removals on the upper face near the tip, near-the-tip part thinning
- L. flat removals on the lower face, edge angle correction
- O. semi-flat removals on the lower face near the base, near-the-base part of the cutting edge formation
- E. semi-flat, partly hinged removals on the upper face, edge formation/rejuvenation (?)
- M. flat removals on the lower face, edge angle correction
- D. semi-flat removals on the upper face along the edge and near the base, cutting edge resharpener, at least two steps of rejuvenation
- C. semi-flat removals on the upper face, edge formation, thinning
- B. semi-flat, broad removals on the upper face, edge formation, thinning
- A. semi-flat scars on the upper face from earlier stages of manufacturing process
- J. flat, far going removals on the lower face, surface formation, shaping, thinning, and edge angle formation
- K. flat removals on the lower face, edge angle formation
- N, I. flat removals on the lower face, surface formation, thinning



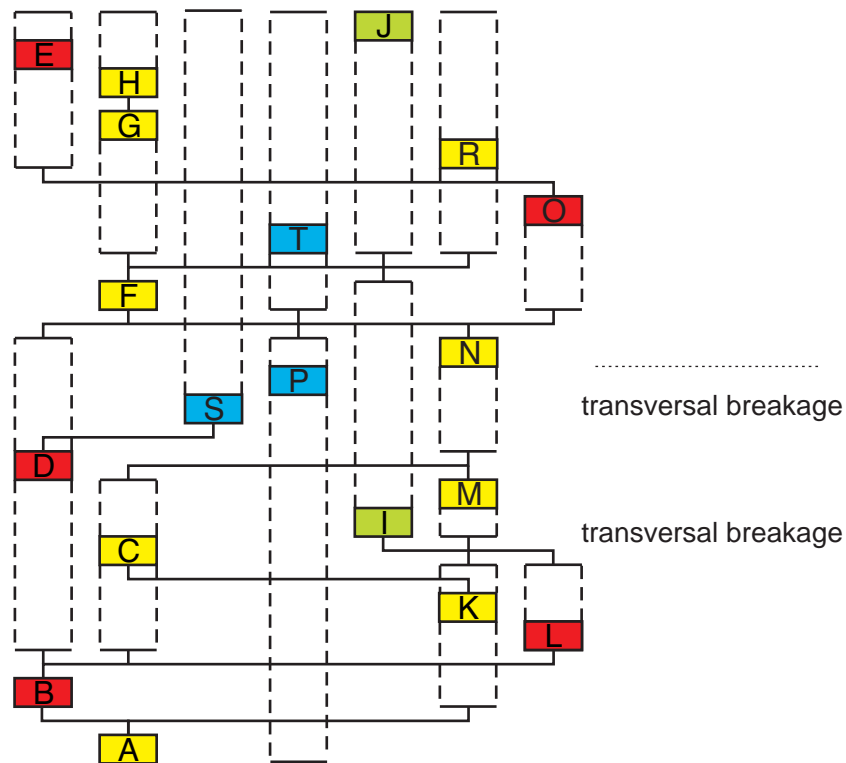
Plate 270 Korolevo V K.V.2100/4560



Biconvex tool with broken base and probably natural, transversal surfaces at the base and along one of edges near the base. Opposite edge was blunted near the breakage and retouched close to the tip; therefore, it can be treated as a working edge. The near-the-base part of broken tool was remodeled after breakage.

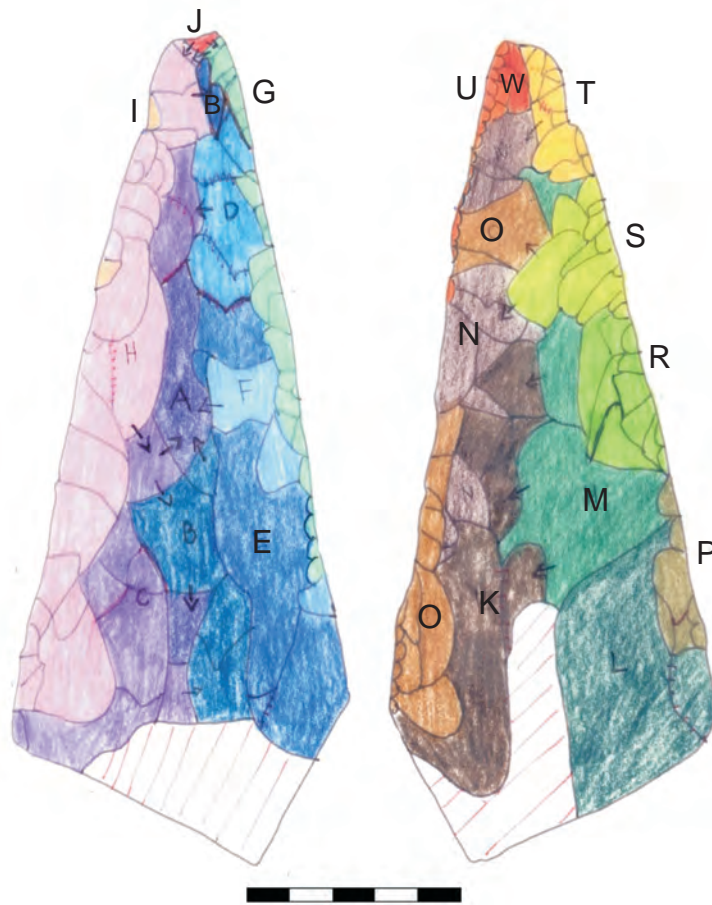


# Plate 270 Korolevo V K.V.2100/4560



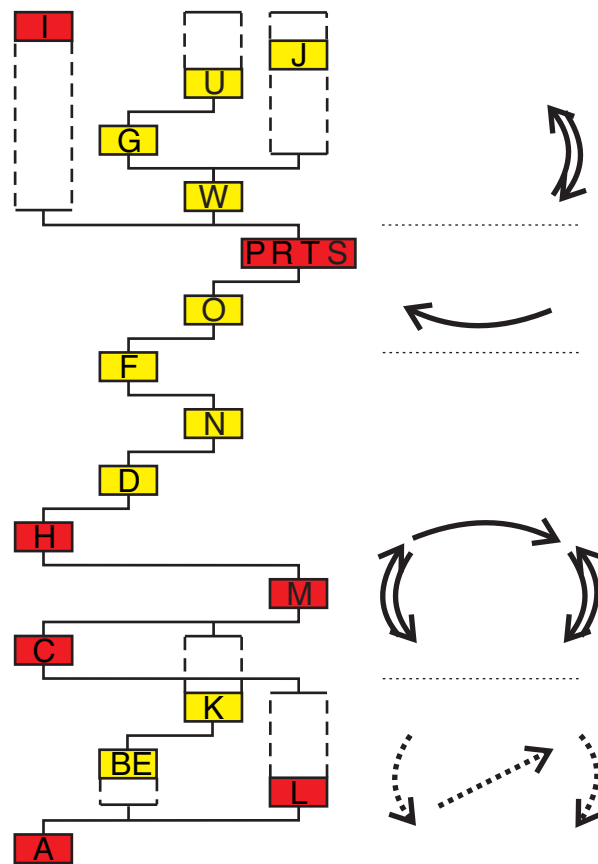
- E. semi-steep removals on the upper face near the base angle, base formation
- H. steep removals on the upper face near the base angle and flat removals on the breakage scar, base formation
- J. flat removals on the breakage scar, base formation
- G. semi-steep removals on the upper face, near-the-base edge part formation
- R. semi-flat retouch on the lower face, edge sharpening (?)
- F. flat retouch on the upper face, edge formation, sharpening
- N. semi-flat and flat removals on the lower face near the tip, edge thinning, edge angle formation
- O. semi-flat removals on the lower face, edge sharpening (?)
- P. probably natural, steep surface located angularly to vertical axis, created the back near the tip
- S. probably natural transversal surface at the tip
- T. flat removals derived on surface P
- D. flat removals on the upper face near the tip, near-the-tip part thinning
- A, B. flat, broad removals on the upper face, surface formation, thinning
- K, L, M. flat, broad removals on the lower face, surface formation, thinning
- C. semi-flat, broad removals on the upper face, surface formation, thinning
- I. transversal breakage at the base

Plate 272 Klausennische 1914\_1048



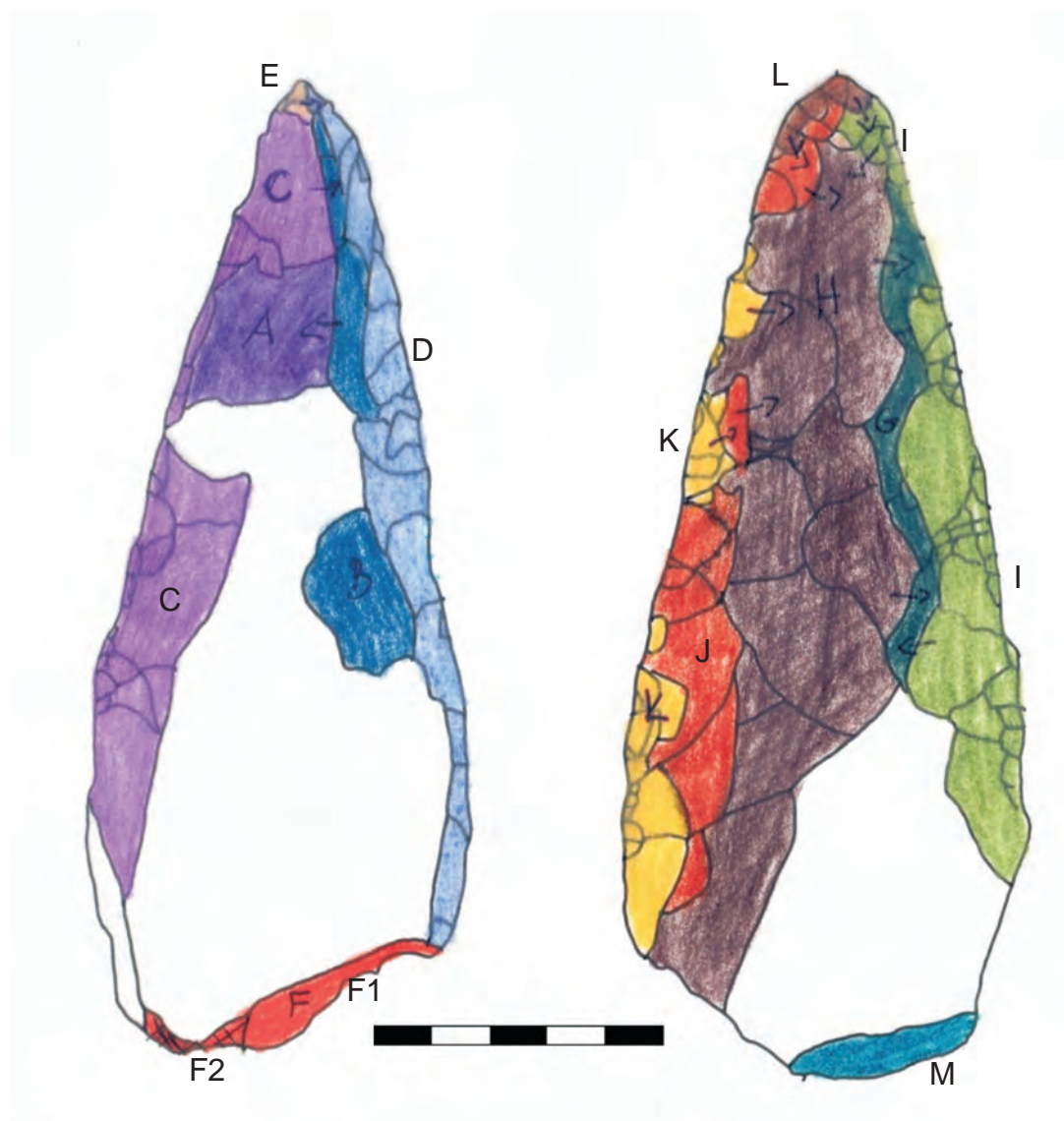
Thick knife with base formed by two angularly located transversal, natural surfaces, base left unworked, both edges straight and convergent at an exposed, broken tip; retouched alternately, resharpened mainly near the tip.

# Plate 272 Klausennische 1914\_1048



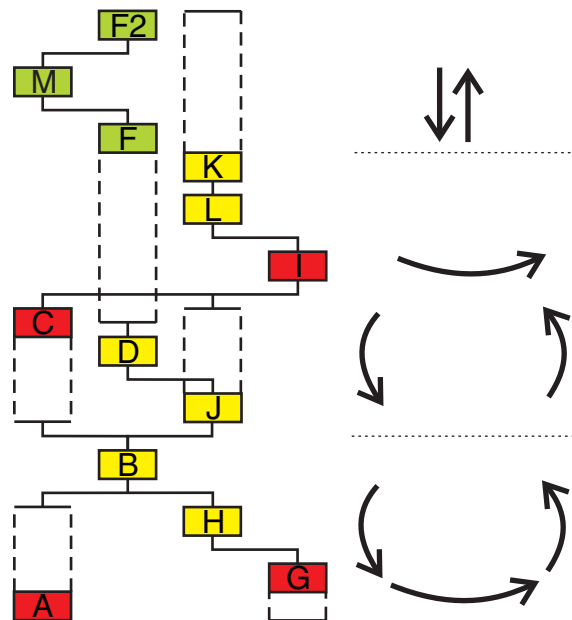
- J. steep removals at the tip, created a notch at the tip
- U. flat, very small, fine, partly hinged, marginal retouch on the lower face near the tip, edge correction
- I. irregular truncations along the edge on the upper face
- G. flat, partly hinged, marginal retouch on the upper face, edge resharpening
- W. flat, angular removals on the lower face near the tip, edge angle correction, and near-the-tip part thinning
- T, S, R, P. semi-flat, regular, partly hinged retouch on the lower face near the tip, edge resharpening
- O. flat, partly hinged (mainly near the base) removals, edge angle formation, thinning
- F. flat removals on the upper face, edge formation, sharpening
- N. flat removals on the lower face, edge angle formation, thinning
- D, H. semi-flat removals on the upper face near the tip, thinning, edge formation/sharpening
- M, L, K. semi-flat, broad removals on the lower face, surface formation, thinning
- C. flat and semi-flat removals on the upper face, thinning, edge/surface formation
- E. semi-flat and semi-steep removals on the upper face, thinning, edge/surface formation
- A, B. flat, broad removals on the upper face, surface formation, thinning, decortication

Plate 273 Klausennische 1914\_1049



Big knife made on a thin slab with cortex on both surfaces, unworked base, and both straight edges convergent at an exposed tip. Both edges were resharpened, but not intensively. The tool was formed in plano-steep, alternate manner.

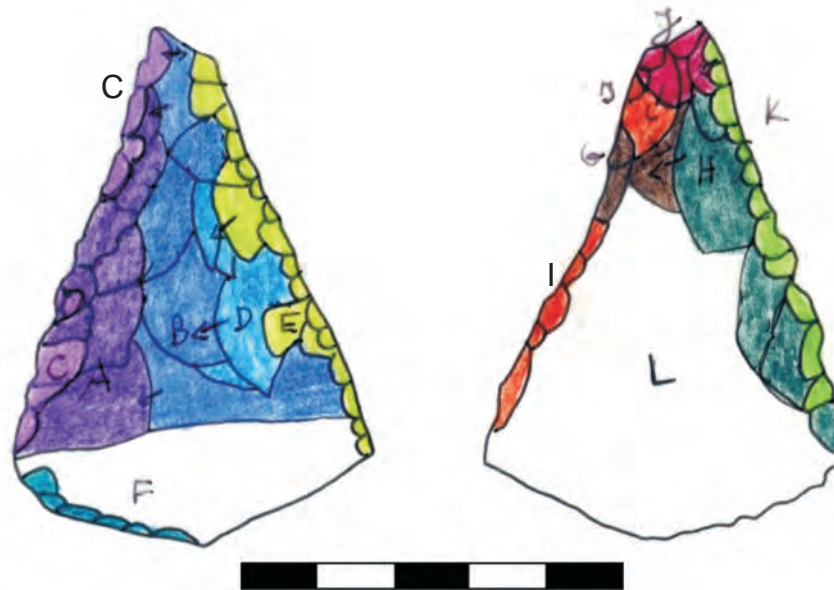
# Plate 273 Klausennische 1914\_1049



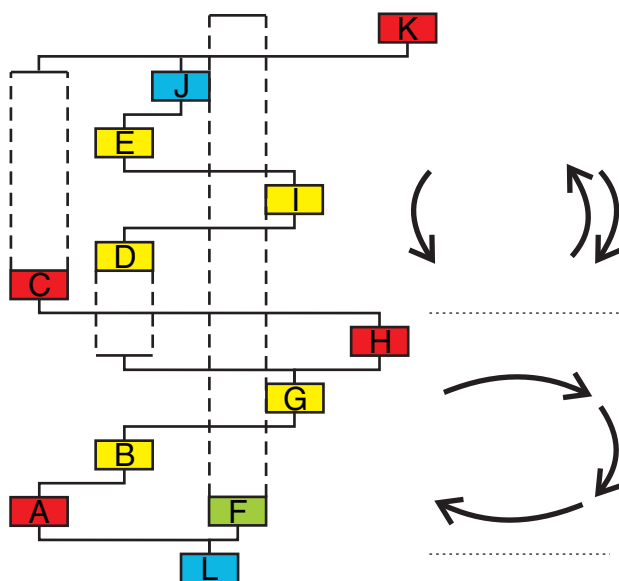
- F2. single, semi-steep and steep removal on the upper face at the base, decortication, base formation
- M. single, semi-flat removal on the lower face at the base, decortication, base formation
- F1. single, semi-flat removal on the upper face at the base, decortication, base formation
- K, L. flat, marginal retouch on the lower face, edge resharpening, correction
- D. semi-flat/semi-steep, partly hinged retouch on the upper face, edge resharpening
- E. single removal on the upper face near the tip, near-the-tip part resharpening
- I. semi-flat removals on the lower face, edge sharpening
- J. flat removals on the lower face, edge sharpening
- C. semi-flat removals on the upper face, edge formation, thinning
- A. single, flat, broad removal on the upper face, surface formation, decortication
- B. semi-flat and flat, broad removals on the upper face, surface formation, decortication
- H. flat, broad removals on the lower face, surface formation
- G. semi-flat removals on the lower face, surface formation



Plate 274 Klausennische 1914\_1052

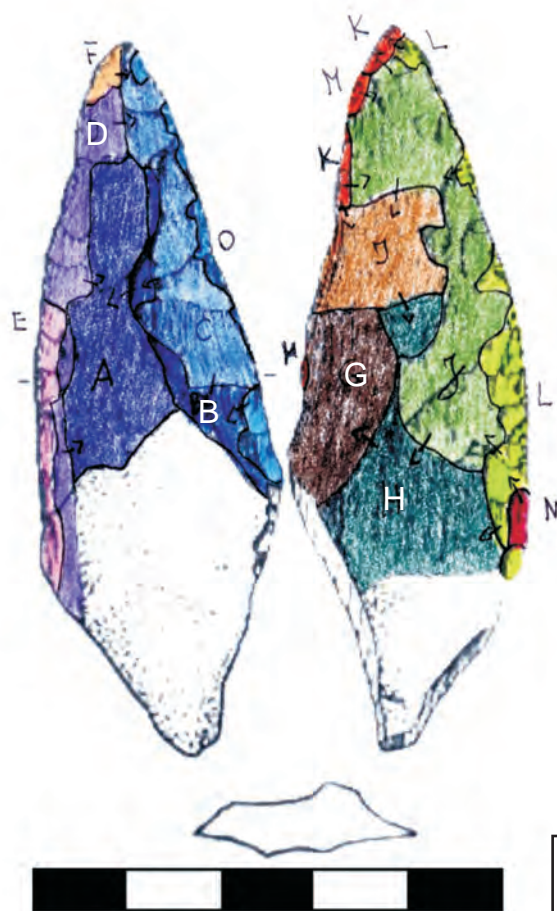


Plano-convex, thin tool made on a cortical flake with exposed tip and two straight edges retouched alternately, they both bear traces of resharpening, tip was thinned during rejuvenation process by flat removals on the lower face.

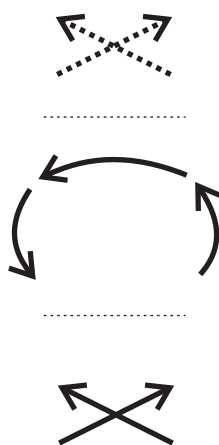
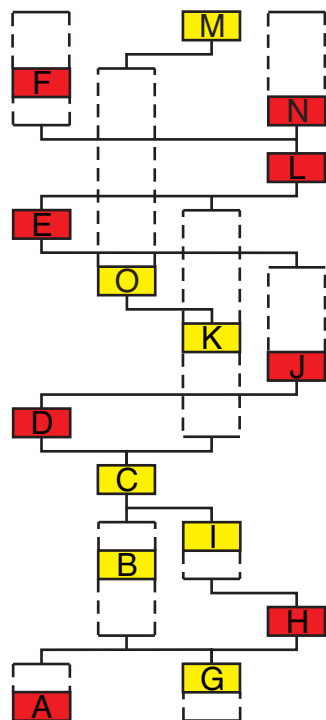


- K. semi-steep, partly hinged, marginal retouch on the lower face, edge resharpening
- J. flat removals on the lower face derived from the tip, near-the-tip part thinning
- E. semi-steep, marginal retouch on the upper face, analogical to sequence K, edge resharpening, blunting the edge near the base
- I, G, H. semi-flat removals on the lower face, edge angle correction
- C. semi-flat removals on the upper face, edge angle correction
- D. semi-flat removals on the upper face, edge sharpening
- A, B. semi-flat, broad removals on the upper face, decortication, surface formation, thinning
- F. marginal cortical removals on the upper face, base edge formation
- L. ventral surface of a flake

# Plate 275 Klausennische 1914\_1055

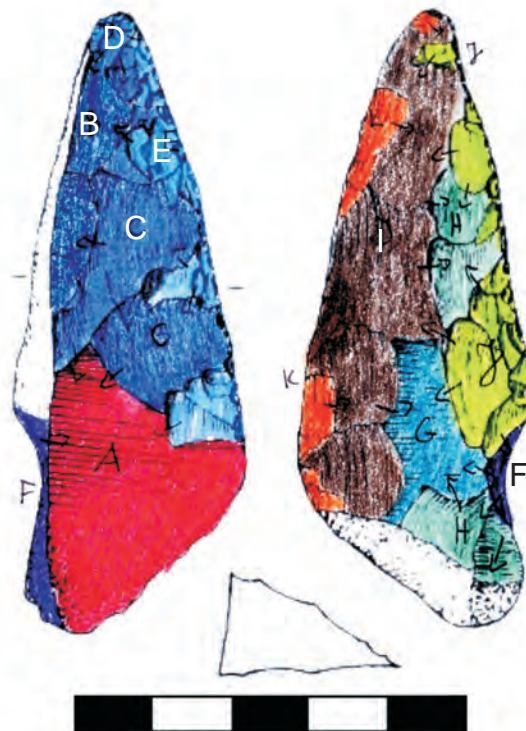


Knife with exposed tip and unworked, cortical base formed by two angularly located, natural surfaces. Both edges were retouched and resharpener several times on the upper face. Lower face was used for edge angle correction.

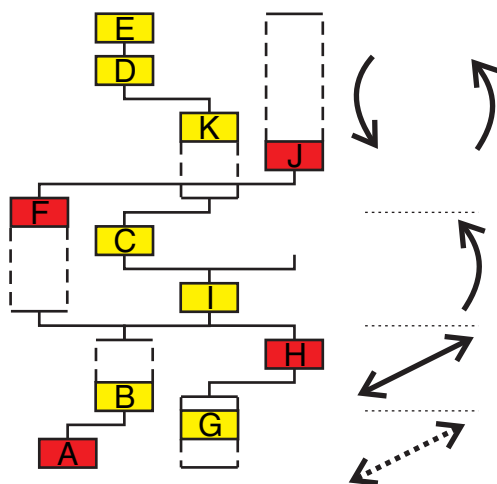


- M. single truncation on the lower face
- N. single, long, burin spall-like removal derived along the edge from the base
- F. semi-steep, marginal retouch near the tip on the upper face, near-the-tip part resharpener
- E, O. steep, marginal retouch on the upper face, edge resharpener
- K, L. flat, small, marginal removals on the lower face, edge correction
- D. removals on the upper face: steep near the base and semi-flat near the tip, edge resharpener
- C. semi-flat removals on the upper face, edge resharpener
- B. semi-steep, broad removals on the upper face, surface formation, decortication,
- A. flat, deep, broad removals on the upper face, surface formation, decortication, thinning
- I, G, J. flat and semi-flat removals on the lower face, edge angle correction
- H. flat, broad removals on the lower face, surface formation, thinning, decortication

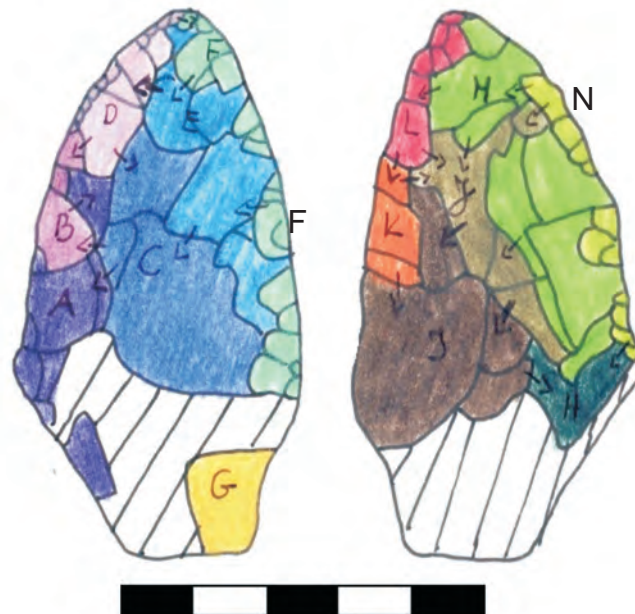
Plate 276 Klausennische 1914\_1057



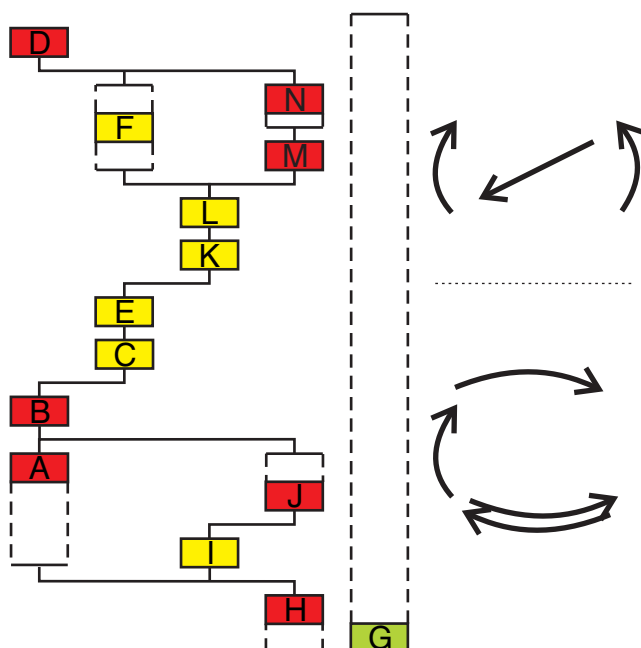
Bifacial knife made on a flake with exposed tip, single cutting edge and vertical, cortical back edge located opposite the cutting edge. Cutting edge was resharpened several times.



- E, D. semi-steep, marginal retouch on the upper face, edge resharpening
- C. semi-steep, broad removals on the upper face, edge formation
- B. semi-steep/semi-flat removals on the upper face, surface formation or derived before obtaining the flake
- K. flat, small removals on the lower face, edge correction
- I. flat removals on the lower face, edge angle correction
- J, H. flat removals on the lower face, edge thinning, flattening
- A. single, flat, broad removal on the upper face, probably derived before obtaining the flake
- G. ventral surface of a flake
- F. steep, deep removals on the upper face near the base, back formation

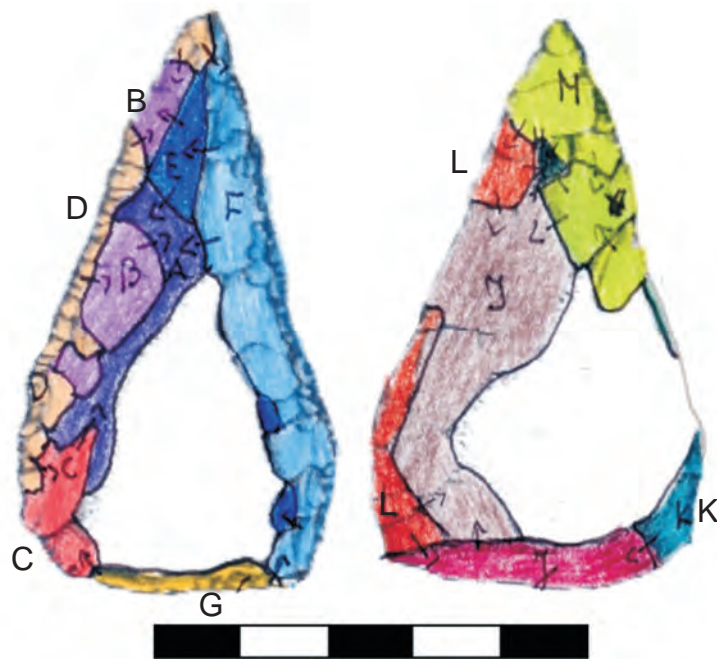


Bifacial knife with unworked, cortical base, unexposed tip and both edges convex, retouched and resharpened. Thinning removals were derived on the lower face from edge II. Burin spall-like removal was derived on the lower face from the tip.

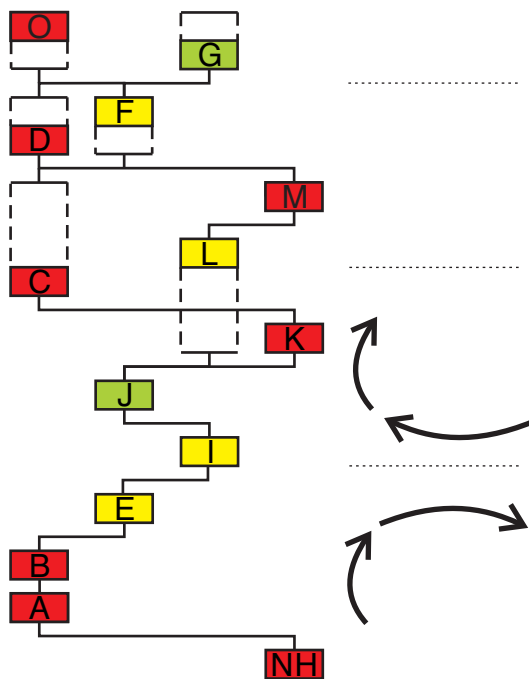


- D, B. marginal retouch and semi-flat removals on the upper face, edge resharpening and usewear
- F. partly hinged, irregular, marginal retouch on the upper face, edge resharpening
- L. flat, burin spall-like removal derived from the tip on the lower face and flat retouch near the tip
- K. flat removals on the lower face, edge angle correction, burin spall-like removal limitation
- N. flat, marginal removals on the lower face, edge correction
- E. semi-flat removals on the upper face, edge resharpening
- A. semi-flat removals on the upper face, edge formation, sharpening
- C. flat, broad removals on the upper face, surface formation, thinning, rejuvenation (?)
- M, J, H. semi-flat removals on the lower face, thinning, edge angle correction
- I. flat removals on the lower face, surface formation
- G. flat, hinged removal derived from the base, decortication

Plate 278 Klausennische 1957\_440



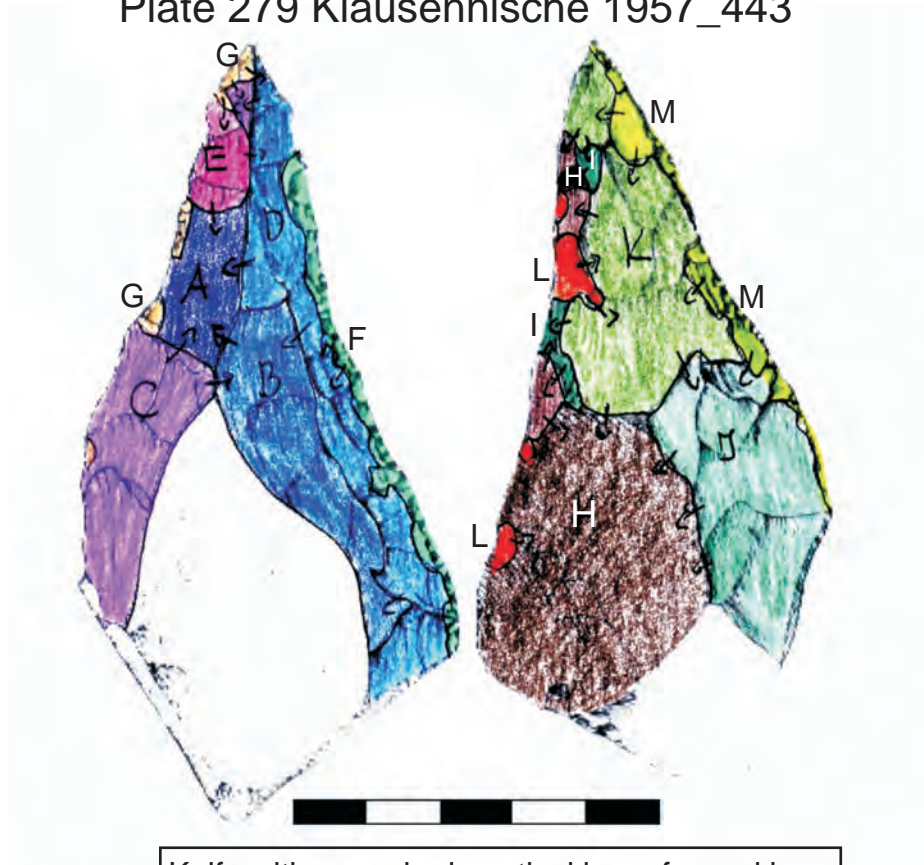
Flat knife with exposed tip and both edges retouched and resharpened several times. One of edges reached the cortical part due to resharpening sequences.



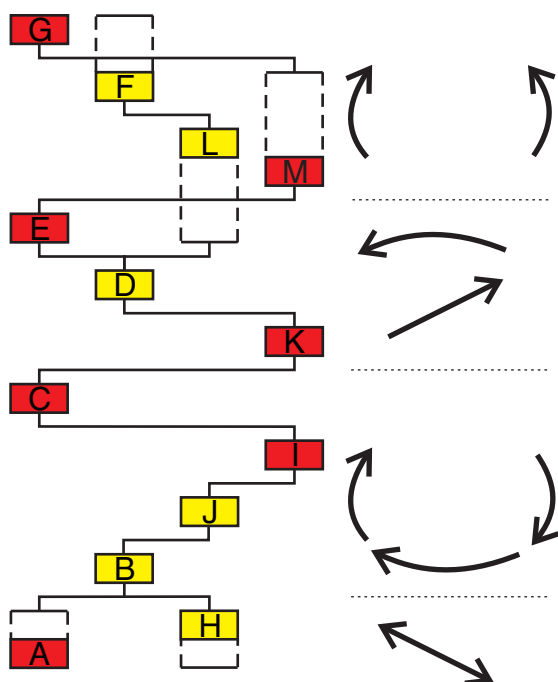
- G. semi-steep, marginal retouch on the upper face at the base, base formation
- O, F, D. semi-steep retouch on the upper face, several stages of edge resharpening
- M, N, L. flat and semi-flat removals on the lower face, edge angle correction
- A, B. semi-flat removals on the upper face, edge formation, decortication of earlier resharpening stages
- C. semi-flat removals on the upper face near the base, edge formation
- H, I. flat, broad removals on the lower face, surface formation, thinning, decortication
- K. single, steep removal on the lower face, near-the-base part formation
- J. single, flat removal derived from edge I on the lower face near the base, base formation
- E. flat, broad removals on the upper face, surface formation, thinning, decortication



Plate 279 Klausennische 1957\_443

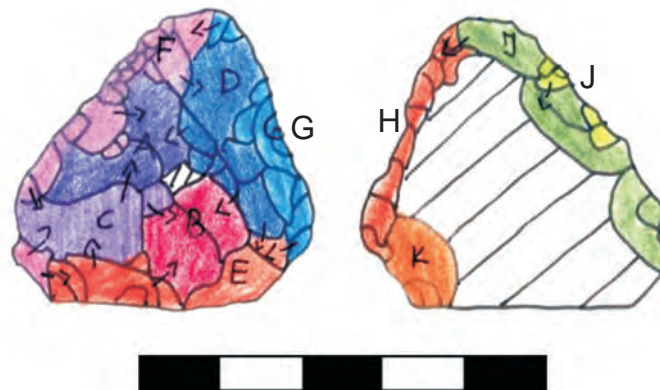


Knife with unworked, cortical base formed by two angularly located transversal, natural surfaces. Tip is heavily exposed. Both edges are concave due to multiple resharpening sequences. Both edges were retouched on the upper face; lower face was used only for edge angle correction and thinning.

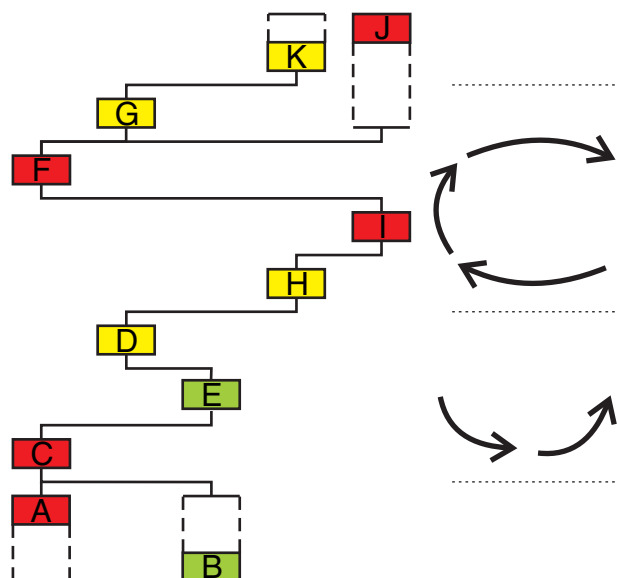


- G. semi-steep, marginal retouch on the upper face, edge resharpening
- F. steep, hinged, marginal retouch on the upper face, edge resharpening
- E, D. semi-steep removals on the upper face, edge resharpening
- M, L, J. flat, small removals on the lower face, edge angle correction
- K, I. flat and semi-flat removals on the lower face, edge angle correction
- H. flat, broad removals on the lower face, surface formation, thinning, flattening, decortication
- C. steep removals on the upper face, edge rejuvenation/formation (?)
- A, B. semi-flat/semi-steep removals on the upper face, previous stages of rejuvenation or surface formation

Plate 280 Klausennische 1957\_447

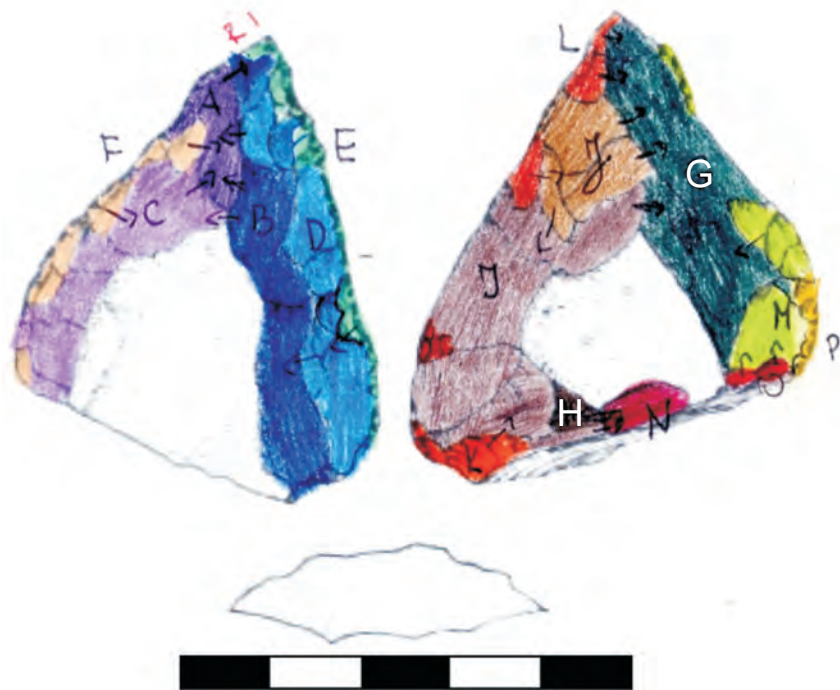


Small knife with cortical lower face, natural, transversal surface of base, and unexposed tip. Both edges were retouched and resharpened. Edge I was retouched more abruptly.

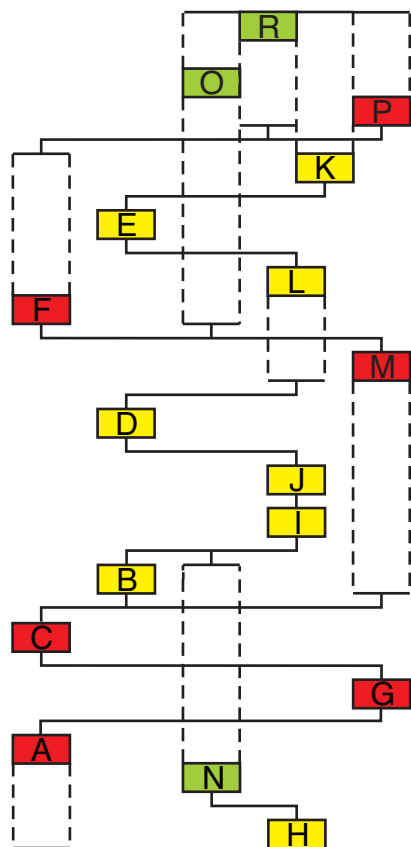


- J. small, marginal retouch on the lower face, edge correction
- H, I. flat, marginal retouch on the lower face, edge angle correction
- G, F. semi-steep, marginal retouch on the upper face, edge resharpening
- D. semi-steep removals on the upper face, edge resharpening
- C, A. semi-flat removals on the upper face, edge formation, resharpening (?)
- E. flat, partly hinged removals on the upper face derived from the base, base formation
- K. removals derived on the lower face near the base, base angle correction
- B. semi-flat removals on the upper face, derived from the base, surface formation

Plate 281 Klausennische 1957\_457

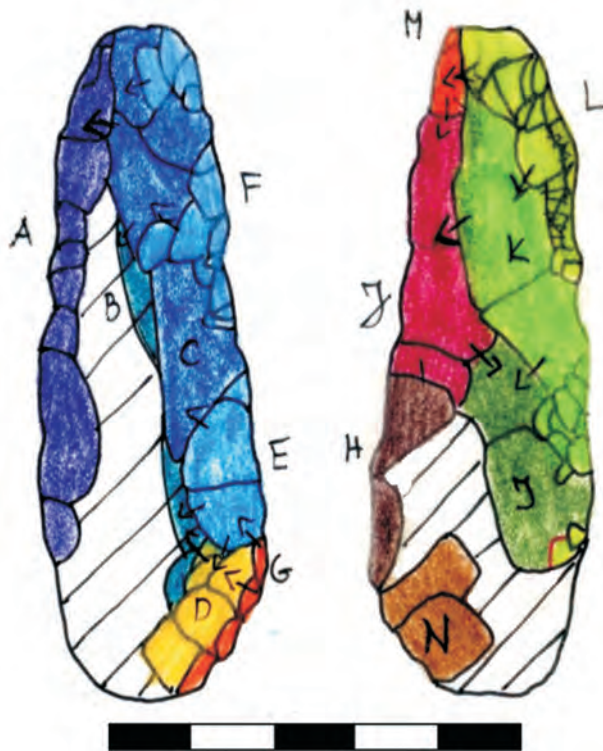


Knife made on a flat and thin slab, cortical on both faces, with exposed but broken tip and transversal, natural surface of base. Both edges were resharpened several times; one of them is concave due to resharpening sequences.

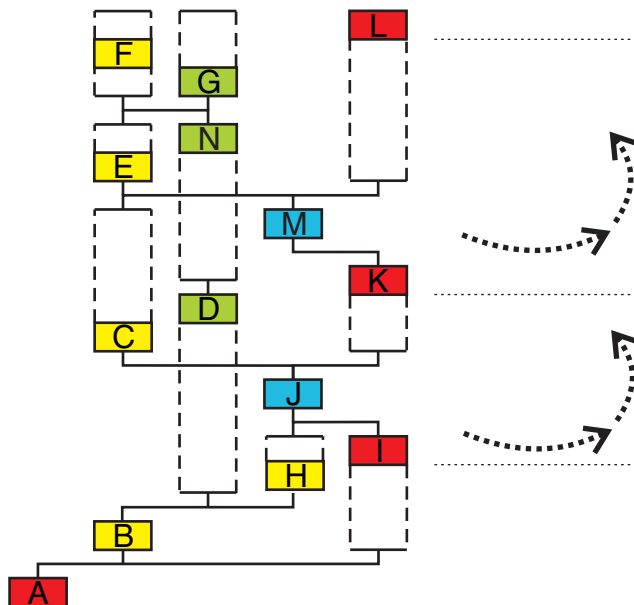


- R. transversal breakage at the tip
- P. small, marginal retouch on the lower face near the base
- K. removals on the lower face aimed at thinning the near-the-base part
- E, F. marginal retouch on the upper face, edge resharpening
- D. semi-flat and semi-steep retouch on the upper face, edge resharpening
- C. flat and semi-flat removals on the upper face near the base, edge formation, and decortication
- L, M, J, I. flat removals on the lower face, edge angle correction
- N, O. flat, marginal removals on the lower face derived from the base, edge correction
- H, G. flat removals on the lower face, surface thinning, edge formation, edge angle formation, decortication
- A, B. semi-flat removals on the upper face, earlier sharpening or edge formation

Plate 282 Klausennische 1957\_464(1)

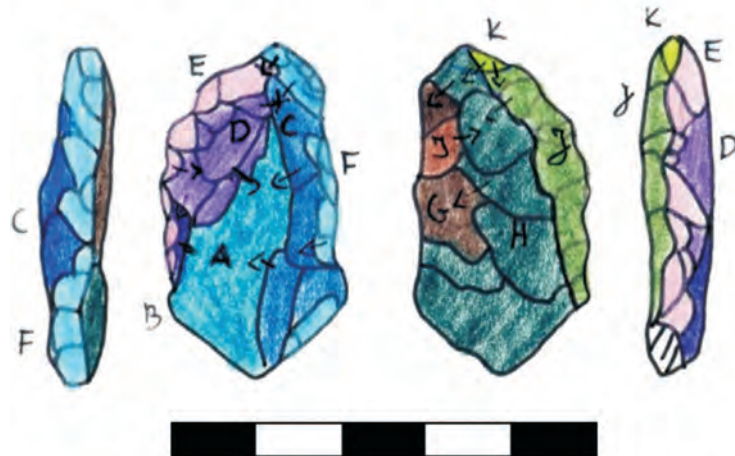


Knife with single cutting edge resharpened several times, with subsequent burin spall-like removals on the lower face along cutting edge. Opposite edge remained cortical and unworked. Tip is unexposed and was thinned by flat removals derived on the lower face from distal posterior edge.

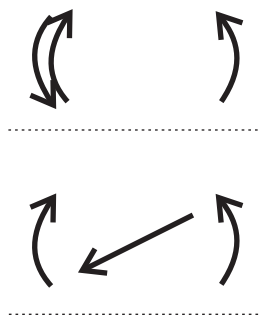
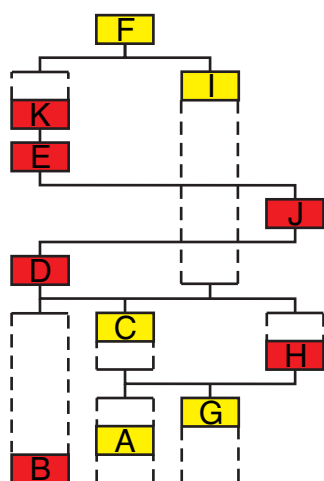


- L, K, I. flat and semi-flat, partly hinged removals on the lower face near the tip, edge angle correction, thinning
- F. hinged, marginal retouch on the upper face, edge resharpening
- E. semi-steep removals on the upper face, edge resharpening
- G. steep, very invasive retouch on the upper face near the base, edge blunting
- D. steep removals on the upper face near the base, edge blunting
- C. steep removals on the upper face, edge rejuvenation
- N, H. flat removals on the lower face, edge angle correction
- M, J. flat, long, burin spall-like removals derived on the lower face from the tip, edge resharpening, thinning
- A, B. flat removals on the upper face, surface/edge formation, decortication

Plate 283 Klausennische 1957\_464(2)



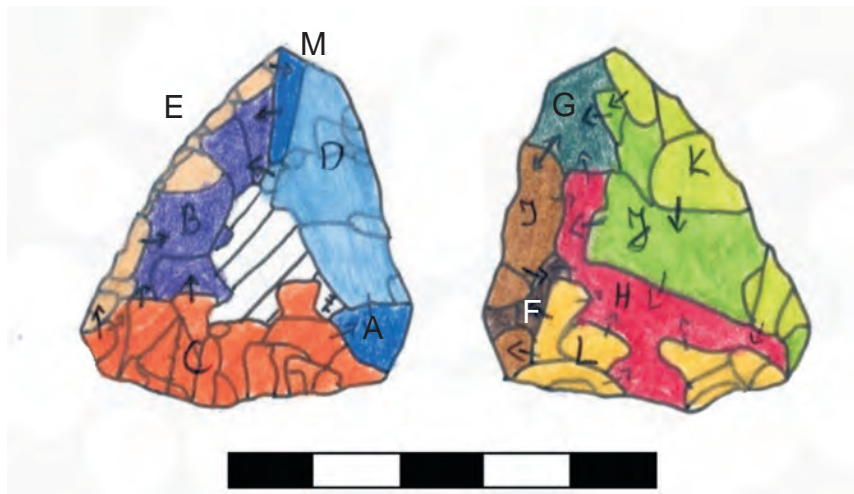
Small, heavily exhausted knife with multiple rejuvenation sequences, no exposed tip and vertical, blunted cutting edge.



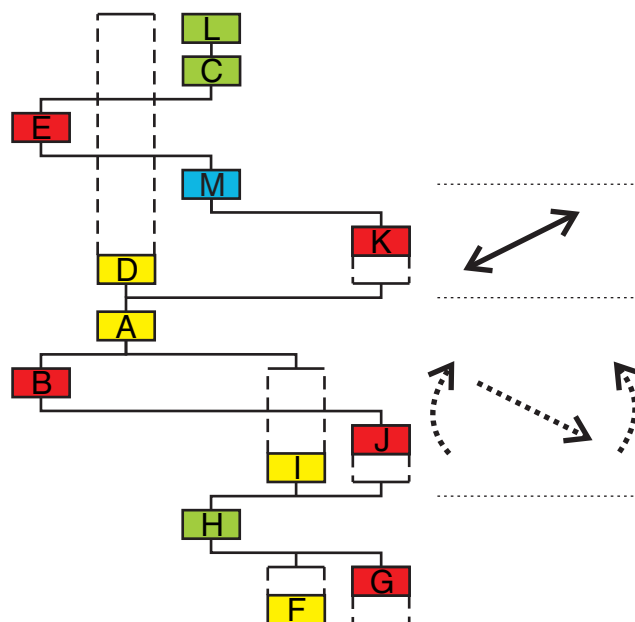
- F, C. steep, marginal retouch on the upper face, edge resharpening
- E. marginal retouch on the upper face: steep near the tip and more flat in the middle part of the edge, edge resharpening
- K. single, steep removal near the tip on the lower face, edge blunting
- J, H, I, G. flat removals on the lower face, edge angle correction
- D. semi-flat removals on the upper face near the tip, edge resharpening
- B. steep removals on the upper face, edge rejuvenation
- A. flat scar on the upper face, earlier stages of manufacturing process



Plate 284 Klausennische 1957\_464(3)

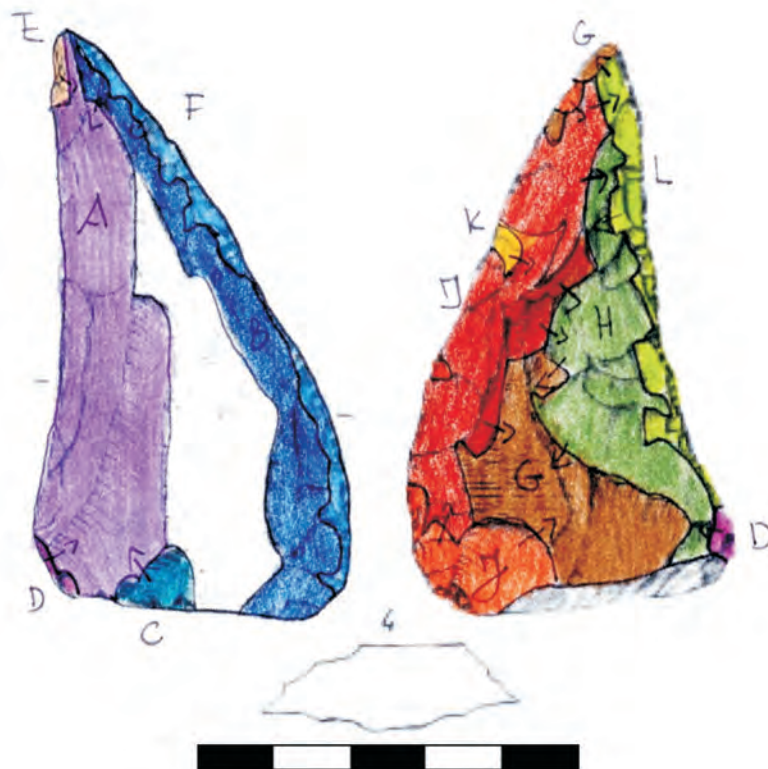


Small, triangular, plano-convex knife with broken tip. Both edges retouched and resharpened several times on the upper face. Lower face was used for edge angle correction; removals were derived mostly from edge II onto the lower face.

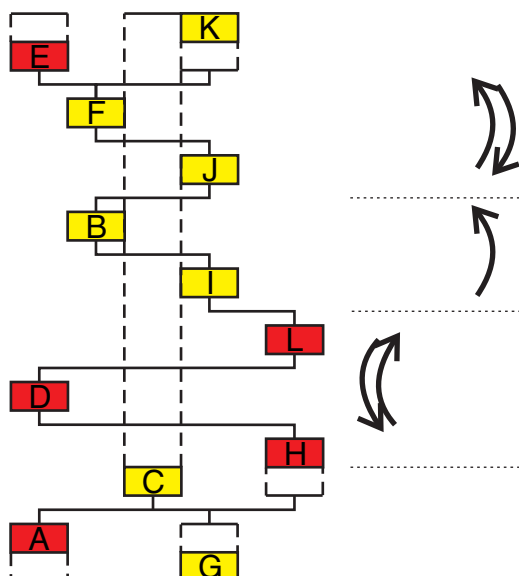


- L. flat, hinged removals on the lower face, base edge rejuvenation
- C. semi-flat, long removals on the upper face, edge angle rejuvenation, sharpening (?)
- E. semi-flat, marginal retouch on the upper face, edge rejuvenation
- M. transversal breakage at the tip, impact point in the middle of the lower face
- K, J, I, F, G. flat removals on the lower face, edge angle correction, thinning
- H. flat removals on the lower face derived from the base, edge angle correction, thinning
- D. semi-steep removals on the upper face, edge resharpening
- A, B. semi-flat/semi-steep removals on the upper face, earlier phases of resharpening (?)

Plate 285 Klausennische 1957\_467



Plano-convex tool with exposed tip, transversal base and both edges retouched/resharpened several times. Edge II is concave due to resharpening sequences. Probably that was the reason to use and sharpen the second edge.

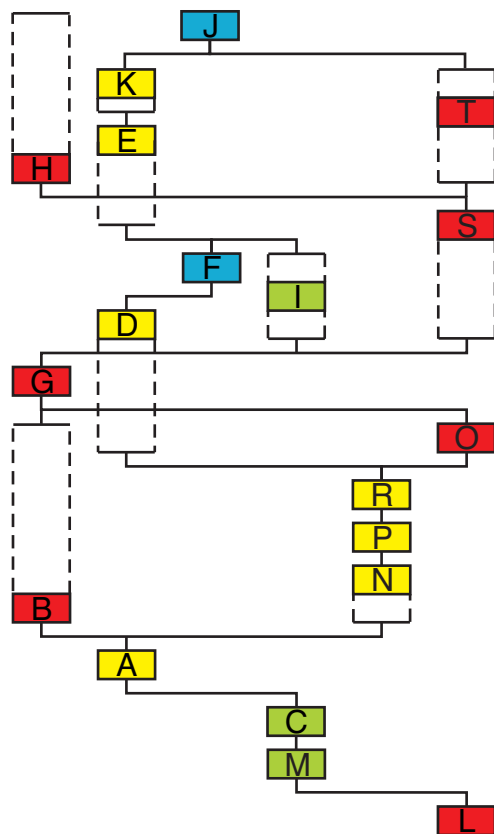


- K. single, flat truncation on the lower face
- E. single, flat, burin spall-like removal derived from the tip
- F. steep, marginal retouch on the upper face, edge resharpening
- D. steep, partly hinged removals on the upper face near the base, near-the-base part formation
- L. flat, irregular, marginal retouch on the lower face
- H. flat, irregular removals on the lower face, edge resharpening
- J. semi-flat removals on the lower face near the base, near-the-base part of the edge formation, thinning
- I. flat, broad removals on the lower face, edge angle correction
- G. flat, broad removals on the lower face, surface formation
- A. semi-steep, long removals on the upper face, edge rejuvenation, partly blunting the edge
- C. flat removals on the upper face at the base, base edge correction
- B. semi-steep removals on the upper face, decortication, surface formation

Plate 286 Klausennische 1957\_468

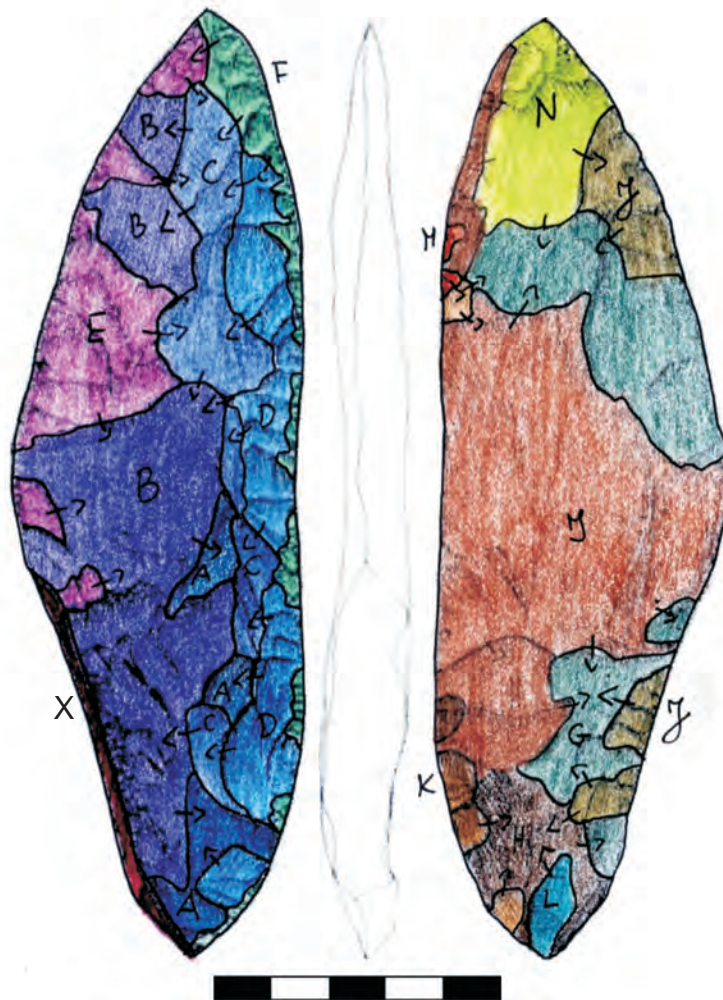


Bifacial knife with transversal base, vertical, concave cutting edge and convex distal posterior edge. The whole tool was rejuvenated several times.



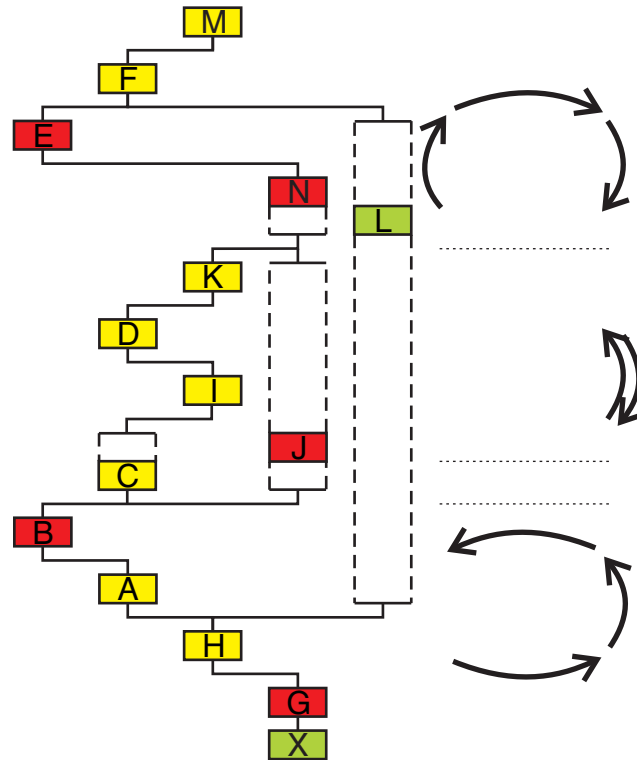
- J. flat, hinged retouch on the upper face near the tip, edge thinning
- T. partly hinged, marginal removals on the lower face, edge correction
- H. flat, hinged removals on the upper face near the base, edge rejuvenation
- S. semi-flat, hinged removals on the lower face near the tip, edge angle correction
- K. semi-flat, hinged, marginal retouch on the upper face, edge resharpening
- E, D. semi-steep removals on the upper face, edge resharpening
- F. single, steep removal on the upper face, edge sharpening at the tip
- G. semi-flat removals on the upper face, edge rejuvenation/resharpening (?)
- I. semi-flat, marginal retouch on the upper face at the base, base correction
- C. single, semi-steep removal on the upper face, base formation
- O, L, R, P, N. flat removals on the lower face near the tip, edge angle correction
- M, L. flat removals on the lower face, surface formation or earlier stages of rejuvenation
- A, B. flat/semi-flat removals on the upper face, surface formation or earlier stages of rejuvenation

Plate 287 Königsau 26.1



Big, plano-convex knife with exposed tip, surface back and long distal posterior edge. Cutting edge is very long and was retouched at its whole length. The tool was subsequently rejuvenated by resharpening sequences on the upper face and edge angle correction on the lower face, near-the-tip part was thinned by long removals derived from distal posterior edge. The tool was worked very precisely.

# Plate 287 Königsau 26.1



- M. very small, marginal removals on the lower face, edge correction
- F. semi-steep, marginal retouch on the upper face, cutting edge resharpener
- K. flat removals on the lower face, cutting edge angle correction
- E. precise removals on the upper face, distal posterior edge correction
- N. flat, long removals on the lower face derived from the distal posterior edge, near-the-tip surface thinning and rejuvenation
- D. semi-steep, regular removals on the upper face, cutting edge resharpener
- C. semi-flat removals on the upper face, cutting edge resharpener
- J. flat removals on the lower face, edge rejuvenation
- B. semi-flat, broad removals on the upper face, smaller and more precise near the tip, perhaps two different sequences of surface and edge formation
- I, H, G. flat, very broad removals on the lower face, surface formation
- A. semi-flat and flat removals from cutting edge formation or even first stages of rejuvenation
- L. single, flat, long removal on the lower face derived from the base, flattening
- X. natural, abrupt surface of the back

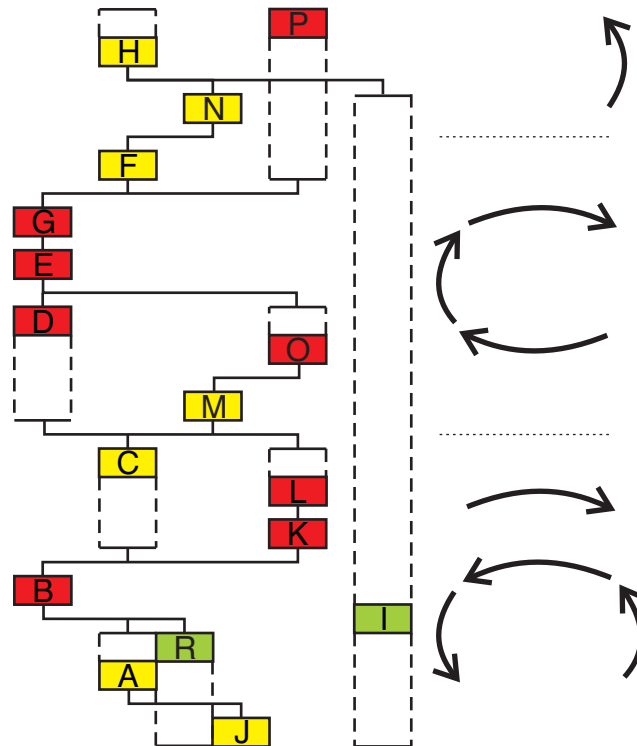


Plate 288 Königsau 27.1



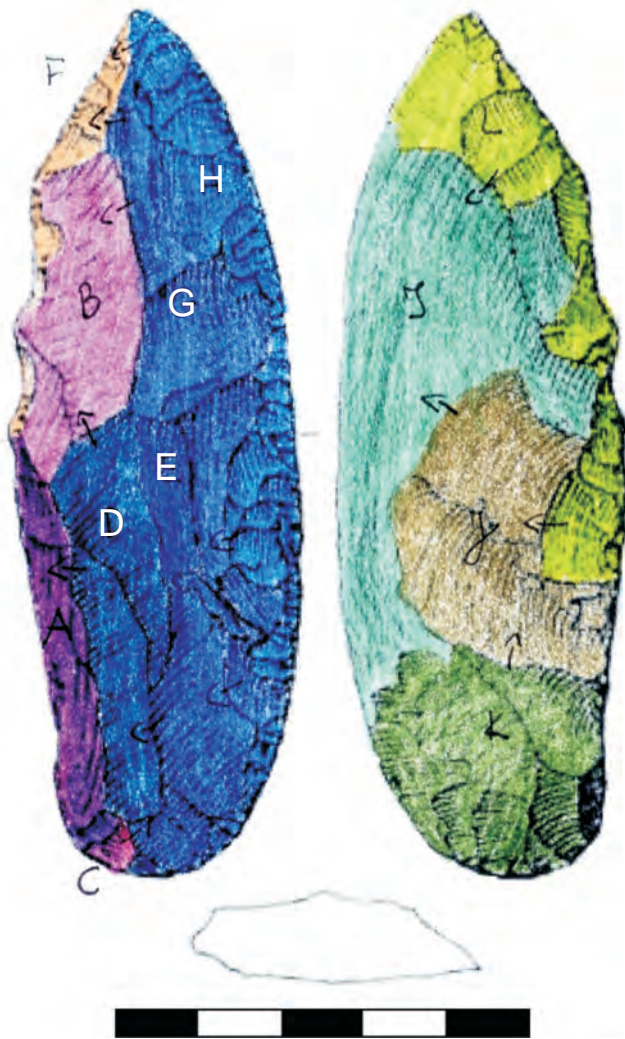
Nearly symmetrical, plano-convex knife with concave cutting edge, base is partly cortical, formed by two alternate notches, the tool was resharpened several times on cutting edge and distal posterior edge near the tip. Distal posterior edge was remodeled during one of rejuvenation stages and back surface was removed then, making the distal posterior edge longer. The tool was worked very precisely.

# Plate 288 Königsau 27.1



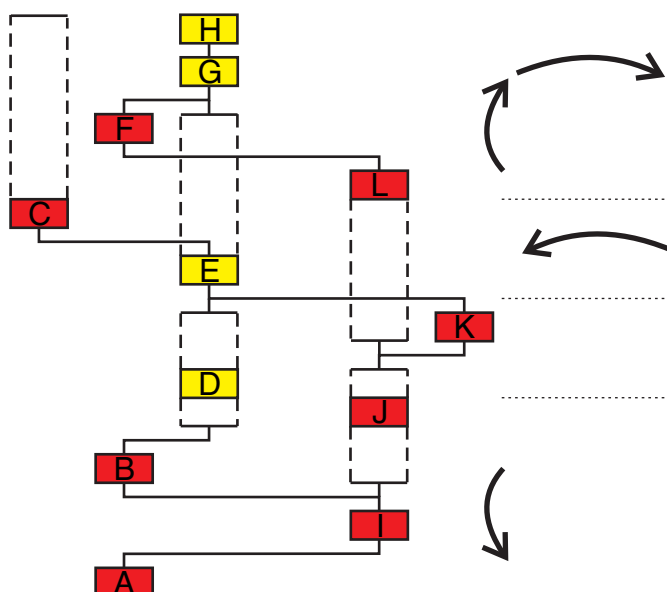
- P. flat, small removals on the lower face near the tip, edge correction
- H. retouch: flat near the tip and more steep near the base, cutting edge resharpening
- N. flat removals on the lower face, edge angle correction
- F. flat removals on the upper face of cutting edge, more steep near the base, edge resharpening
- G, E, D. flat, far going removals on the upper face of distal posterior edge, edge rejuvenation
- O, M. flat removals on the lower face, edge/edge angle correction
- L. flat removals on the lower face, edge correction and tool remodeling, one scar is the trace of previous back surface, removed during rejuvenations
- C, B. semi-flat removal on the upper face, surface/edge formation
- R. single, steep removal on the lower face at the base, base formation
- I. single, steep removal on the upper face at the base, base formation
- K, J. flat, broad removals on the lower face, surface formation, thinning
- A. flat, broad removals on the upper face, surface formation, thinning

# Plate 289 Königsau 27.2

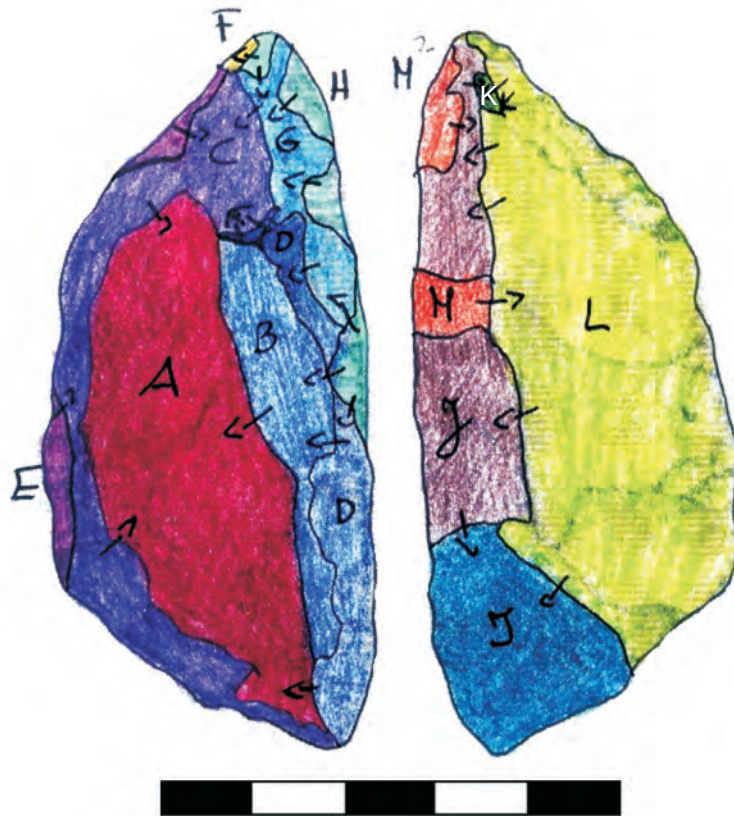


Plano-convex knife with blunted back surface, long, concave cutting edge and exposed tip. Distal posterior edge is long and was steeply retouched. Cutting edge was resharpened very precisely, several times, on the upper face

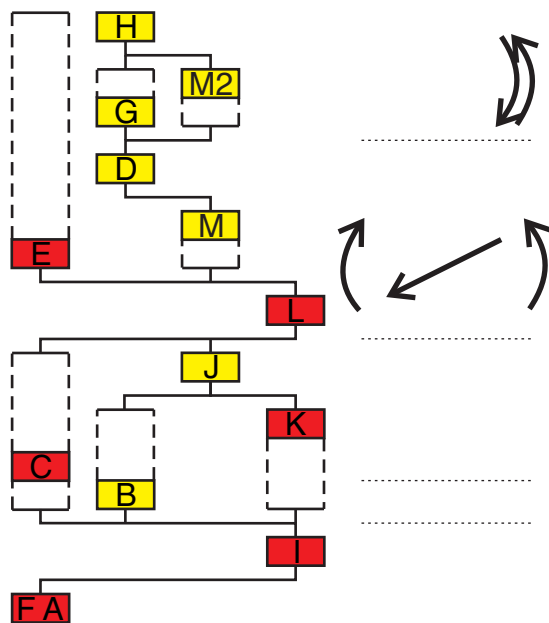
- H. semi-steep, regular, marginal retouch on the upper face, cutting edge resharpening
- G. semi-steep removals on the upper face, cutting edge resharpening/sharpening (?)
- E. semi-flat/semi-steep removals on the upper face, cutting edge formation
- D. flat and semi-flat, broad removals on the upper face, surface formation
- C. single, semi-flat removal on the upper face near the base, edge correction
- A. semi-steep/steep removals on the upper face, back formation
- B. semi-flat/semi-steep, broad removals, distal posterior edge formation/rejuvenation (?)
- F. steep, marginal removals on the upper face, distal posterior edge rejuvenation, tip exposure
- L. flat removals on the lower face along the distal posterior edge, edge formation and near-the-tip part thinning
- K. semi-flat removals on the lower face, near-the-base surface formation, thinning
- J. flat removals on the lower face, surface thinning, formation
- I. flat, very broad removals reaching the opposite edge, surface formation, thinning



# Plate 290 Königsau 27.3



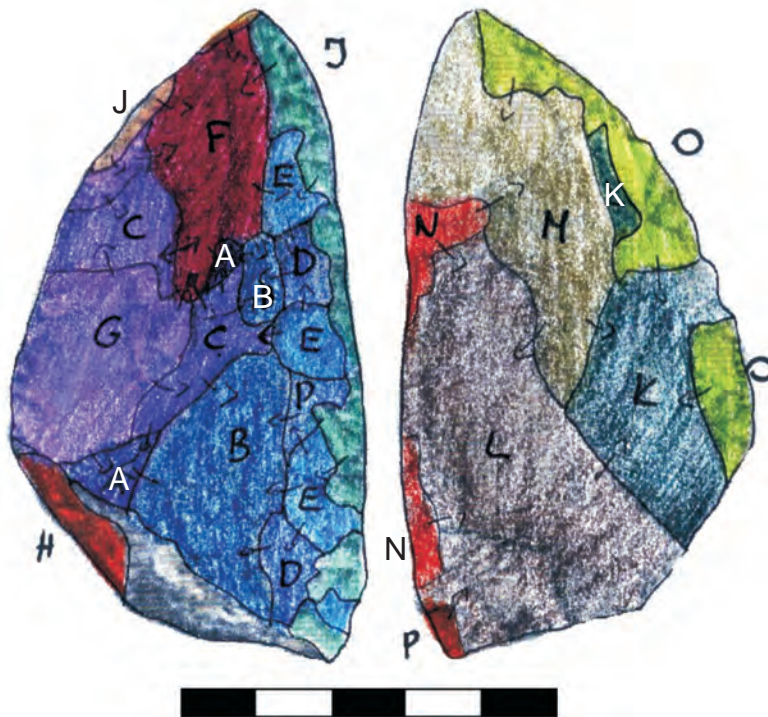
Plano-convex knife made on a flake with back formed by semi-steep removals derived along the edge. Cutting edge was resharpened several times on the upper face. Lower face was used for deriving edge angle correcting sequences. The tip is exposed, cutting edge is vertical and nearly blunted by subsequent retouches.



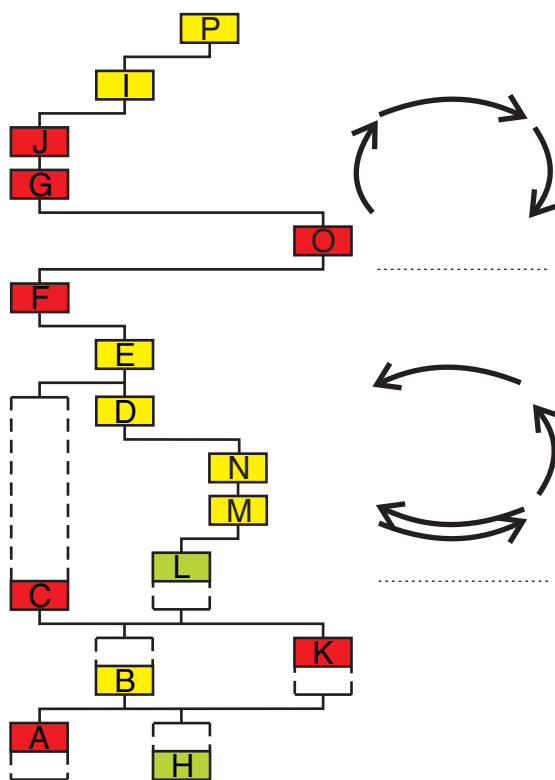
- H. steep, marginal retouch on the upper face, cutting edge resharpening
- G, D. semi-steep, marginal retouch on the upper face, cutting edge resharpening
- M2, M, J. flat removals on the lower face, cutting edge angle correction
- E. steep, marginal retouch on the distal posterior edge and along the back edge, rejuvenation
- F. steep removals on the upper face near the tip
- L, K. flat scar on the lower face, surface formation
- B. semi-flat removals on the upper face, cutting edge formation
- C. semi-flat/semi-steep removals on the upper face, distal posterior edge and back edge formation
- A. flat, very broad removal, probably removed before obtaining the blank
- I. ventral surface of a flake



## Plate 291 Königsau 28.2



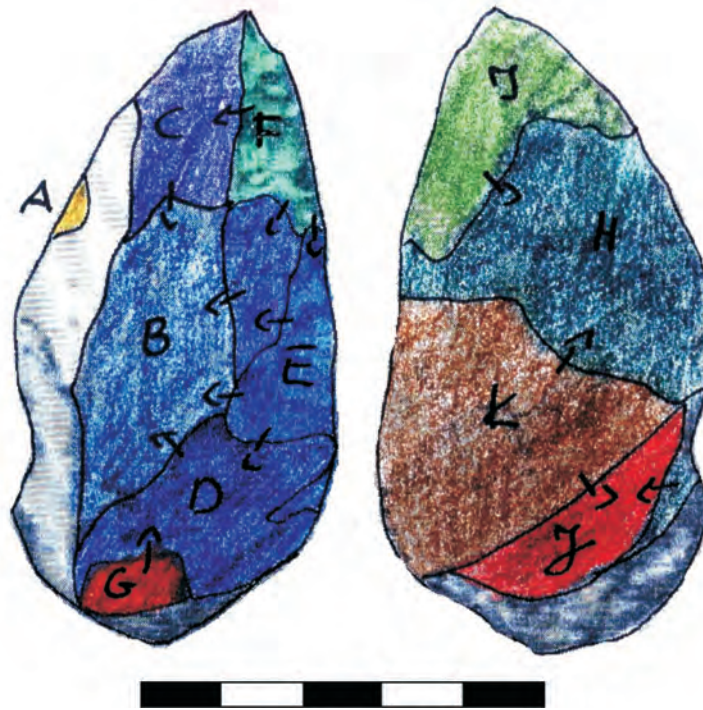
Plano-convex knife with cortical angular back/base and long distal posterior edge, exposed tip and long, vertical cutting edge. The tool was resharpened several times on the cutting edge's upper face. Perhaps the tool has separate, vertical surface of back, which was removed during rejuvenation process.



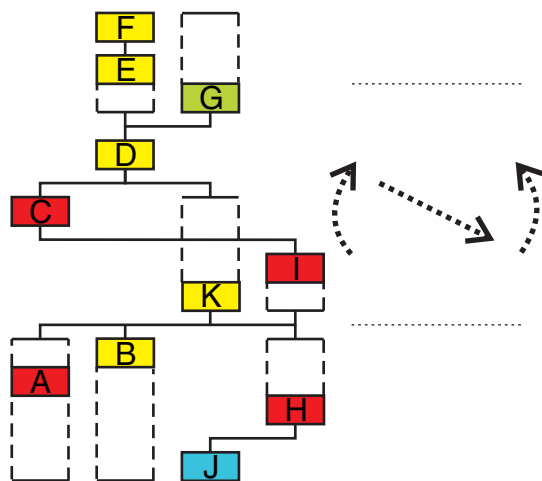
- P. flat, hinged, small removals on the lower face, derived from the base along the cutting edge
- I. semi-steep, marginal retouch on the upper face, more steep near the tip, cutting edge resharpening
- J. marginal retouch on the upper face, distal posterior edge correction
- G. semi-flat removals on the upper face, distal posterior edge rejuvenation, surface thinning
- O. flat removals on the lower face near the tip, distal posterior edge correction
- F. semi-flat, long, regular removals on the upper face, distal posterior edge rejuvenation, and near-the-tip part thinning
- E, D. semi-steep removals on the upper face, cutting edge resharpening
- B. semi-flat removals on the upper face, surface thinning
- C, A. semi-flat removals on the upper face, surface/edge formation
- N. flat, small, marginal removals on the lower face, cutting edge correction
- M, L, K. flat, broad removals on the lower face, surface formation
- H. steep removals on the cortical surface of base/back, decorticating, base formation



# Plate 292 Königsau 28.5

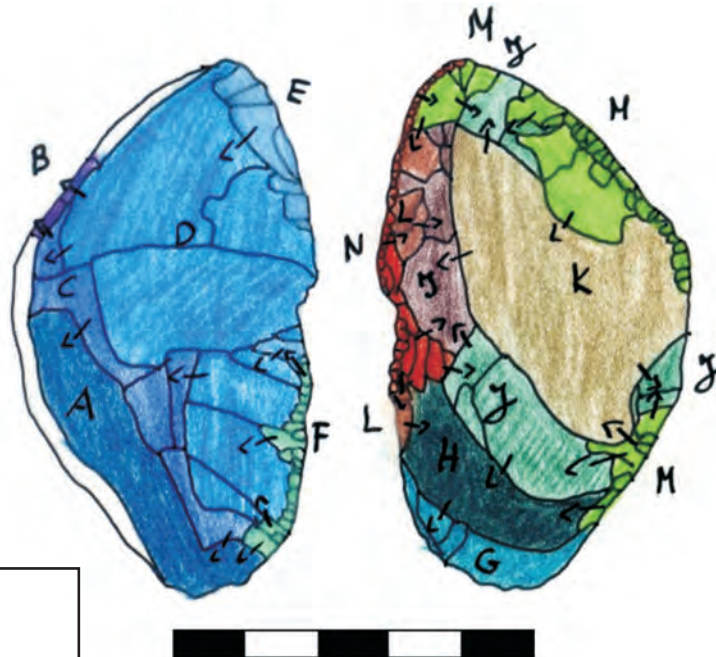


Plano-convex knife with cortical, thick back surface, vertical cutting edge, exposed tip and short distal posterior edge. Cutting edge was resharpened several times on the upper face.

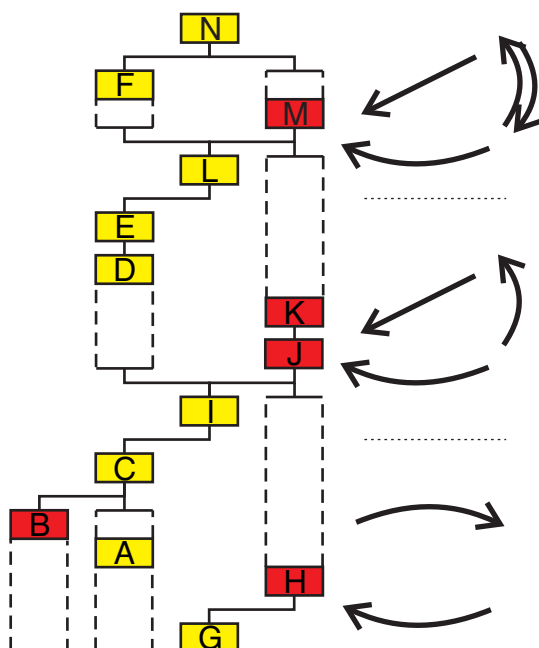


- F. semi-steep, marginal removals on the upper face near the tip, cutting edge resharpener
- E. semi-steep, marginal removals on the upper face, cutting edge resharpener
- D. semi-flat removals on the upper face, surface/edge formation
- B. semi-flat removals on the upper face, surface formation
- C. semi-flat removals on the upper face, distal posterior edge formation
- G. single, flat removal on the upper face, derived from the base, decortication, surface formation
- I. single, flat long removal on the lower face near the tip and at the tip, derived angularly from distal posterior edge along the cutting edge, cutting edge angle correction
- H, K, J. flat removals on the lower face, surface formation, thinning

# Plate 293 Königsau 29.3

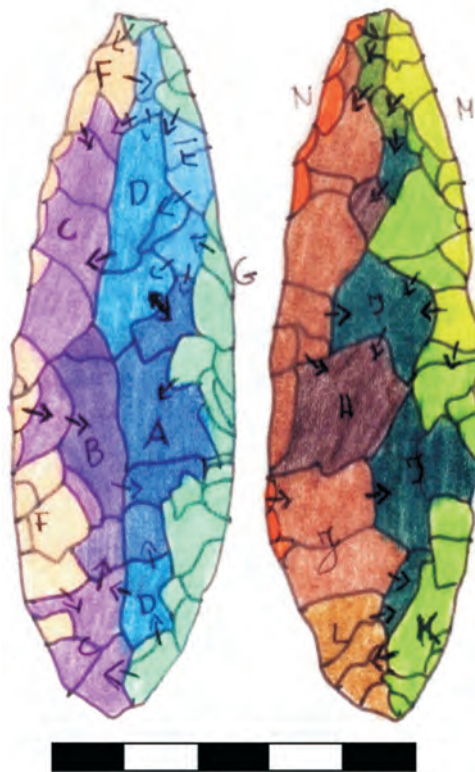


Plano-convex knife without exposed tip, but with abrupt, convex surface along the whole edge opposite to cutting edge. The abrupt surface prevented from deriving any removals on the upper face from distal posterior edge; therefore, the tip could not be exposed. The tool was subsequently rejuvenated by flat removals on the lower face derived from distal posterior edge, and sequences of retouches derived on the upper face of cutting edge.

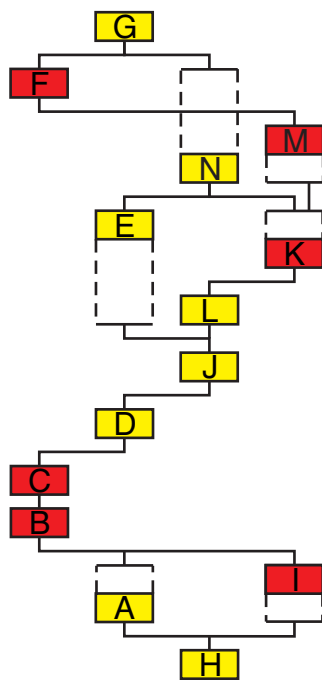


- N. extremely small, marginal retouch on the lower face, created a notch in the middle part of edge, cutting edge resharpening and usewear
- F. very fine, small, marginal retouch on the upper face near the base, cutting edge resharpening, perhaps a trace of orientation change
- M. flat, small removals on the lower face along the distal posterior edge, the removal derived near the tip goes along the cutting edge, edge and cutting edge angle correction
- L. single, flat removal on the lower face, cutting edge angle correction
- E. flat removals on the upper face near the tip, cutting edge resharpening
- D, C. flat, broad removals on the upper face, surface rejuvenation, thinning
- A. single, flat removal on the upper face, surface formation
- K, J, H, G. flat, deep removals on the lower face derived from the distal posterior edge, surface thinning, rejuvenation
- I. flat removal on the lower face, cutting edge angle correction or surface formation
- B. steep removals, decortication, back formation

# Plate 294 Szeleta Pb70

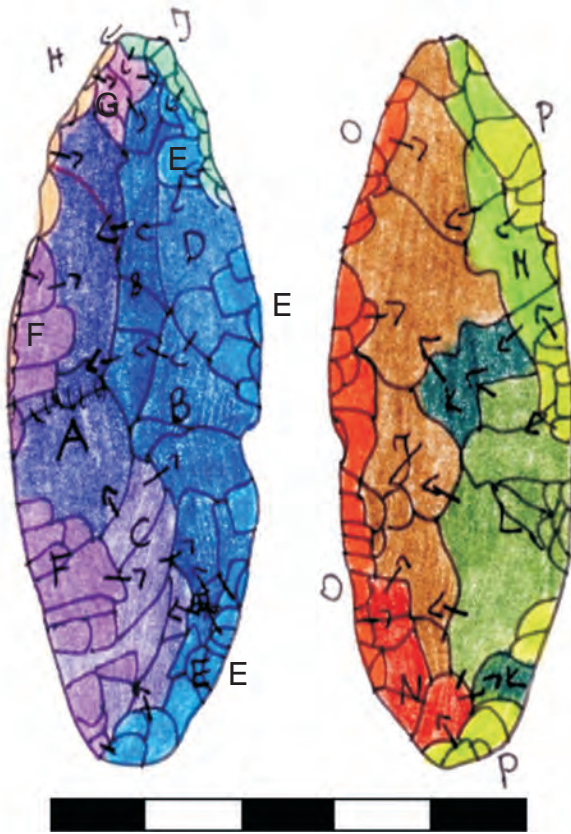


Biconvex, elongated leafpoint with no traces of edge resharpening. Most sequences aimed at tool shaping and thinning.

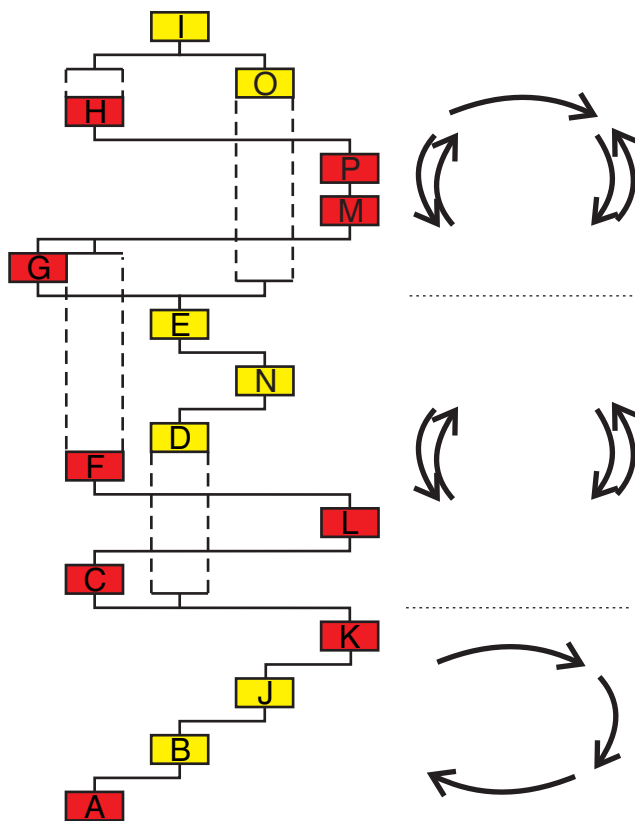


- G. semi-flat, partly hinged, marginal retouch on the upper face, edge line correction, sharpening
- E. semi-flat removals on the upper face, shaping
- F. semi-flat, partly hinged near the tip, marginal retouch on the upper face, edge line correction
- M. semi-flat, marginal retouch on the lower face near the tip, shaping
- K. semi-flat removals on the lower face, shaping
- N. small, marginal retouch on the lower face, edge line correction
- L. flat removals on the lower face near the base, shaping
- J. semi-flat removals on the lower face, edge formation, thinning, shaping
- D, C. semi-flat removals on the upper face near the tip and the base, shaping
- A, B. semi-flat, broad removals on the upper face, surface formation, thinning
- H, I. flat, broad removals on the lower face, surface formation thinning

# Plate 295 Szeleta Pb72



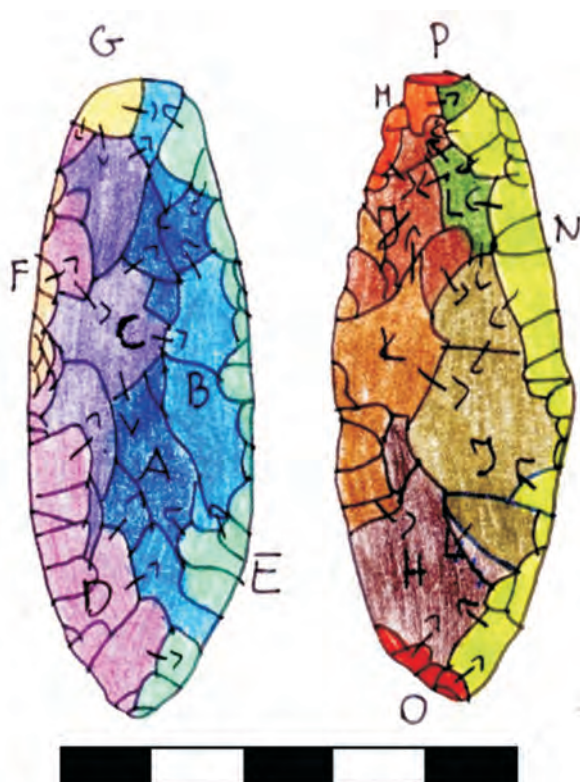
Biconvex leafpoint with both edges and both ends treated similarly, thinned and shaped, poorly exposed tip, no rejuvenation retouches.



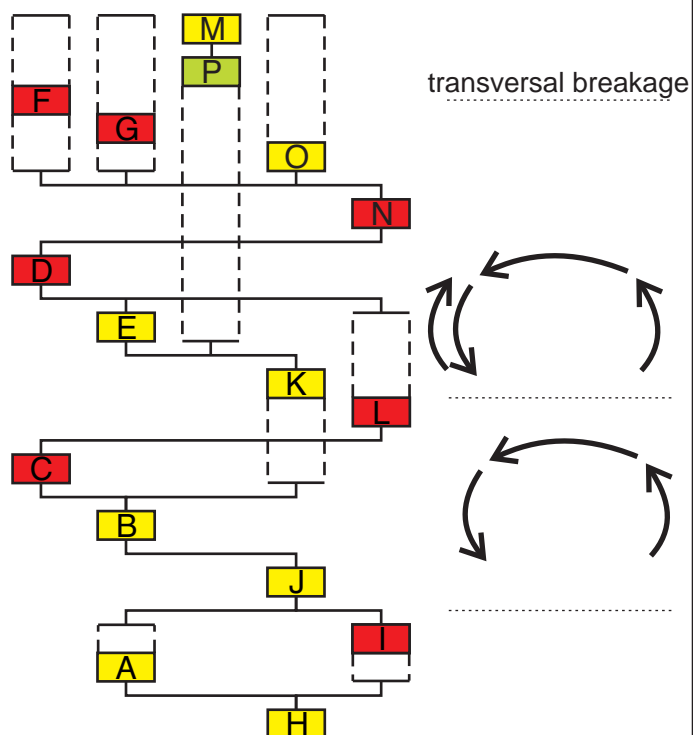
- I. steep, marginal retouch on the upper face near the tip, shaping and probably usewear
- H. semi-steep, marginal retouch on the upper face near the tip, shaping and probably usewear
- O. semi-steep/semi-flat retouch on the lower face, edge formation, sharpening
- P. semi-flat retouch on the lower face, edge formation, sharpening, shaping
- M. flat removals on the lower face near the tip, shaping, edge thinning
- G. semi-flat removals on the upper face near the tip, edge thinning, shaping
- E. semi-flat retouch on the upper face, more precise near the base, base formation, shaping, edge sharpening
- N. flat/semi-flat removals on the lower face near the base, shaping, edge thinning
- F. semi-flat removals on the upper face, near-the-base part shaping
- C. flat removals on the upper face, near-the-base part shaping
- D. semi-flat removals on the upper face, near-the-tip part shaping
- L. flat removals on the lower face, surface thinning, edge angle formation
- K. flat removals on the lower face, surface formation, thinning
- J. semi-flat removals on the lower face, surface formation, thinning
- A, B. semi-flat removals on the upper face, surface formation, thinning



## Plate 296 Szeleta Pb73



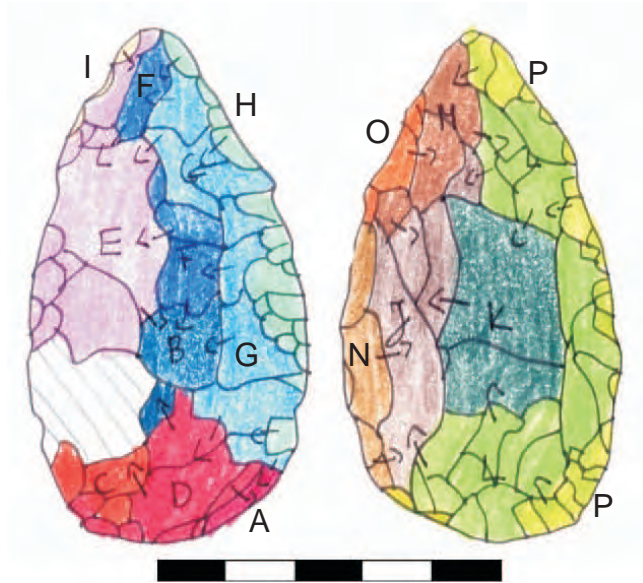
Biconvex leafpoint with broken tip. Near-the-tip part was rejuvenated after breakage, but the tip was not fully exposed probably due to care for symmetry. The tool was carefully shaped near the base and near the tip; almost all sequences were aimed at shaping. It bears no traces of edge resharpening.



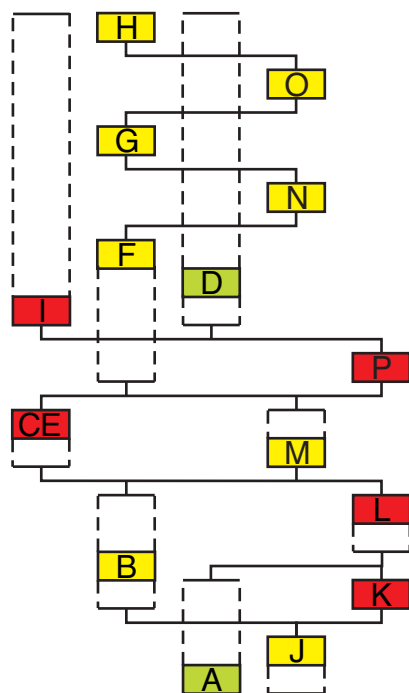
- P. transversal breakage at the tip
- M. semi-steep, marginal removals on the lower face, edge rejuvenation, shaping near breakage, aimed at tip exposing
- G. semi-flat removals on the upper face, shaping near breakage, aimed at tip exposing
- F. semi-flat, marginal retouch on the upper face, edge correction
- O. semi-flat, marginal retouch on the lower face near the base, edge shaping
- N. flat, regular retouch on the lower face, edge shaping, line correction
- D. semi-flat, partly hinged removals on the upper face, mostly concentrated near the base, shaping
- E. semi-flat retouch on the upper face, edge shaping
- K. flat, partly hinged removals on the lower face, edge angle formation, thinning
- L, J. flat removals on the lower face near the tip, shaping, near-the-tip part thinning
- C, B. semi-flat removals on the upper face, thinning, shaping
- I, H. flat, broad removals on the lower face, surface formation, thinning
- A. semi-flat removals on the upper face, surface formation, thinning



## Plate 297 Szeleta Pb83

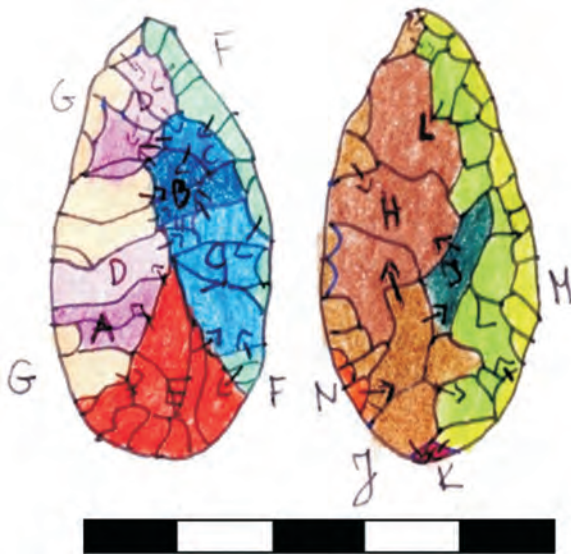


Flat, biplan tool with exposed tip and one edge subsequently resharpened by flat, edge angle correcting sequences derived on the lower face, and sharpening retouch on the upper face. Base was precisely formed by separate sequences of removals.

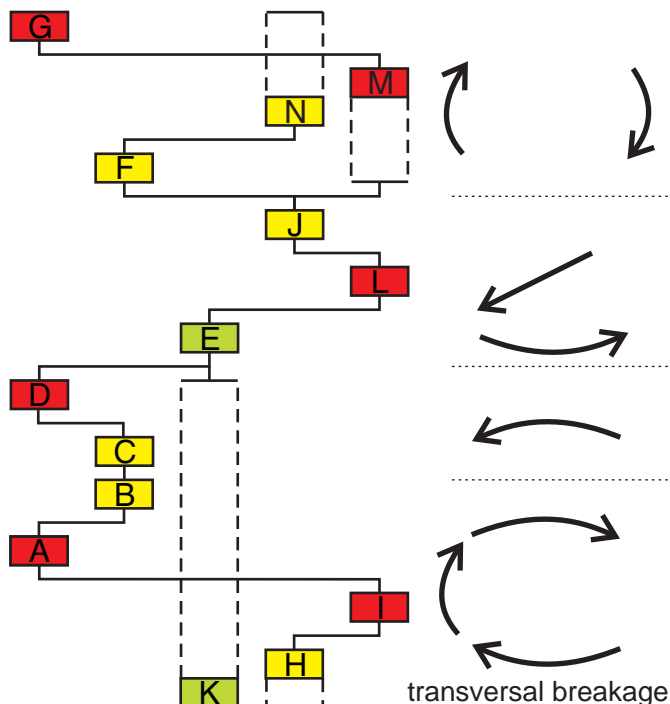


- H. semi-steep, marginal retouch on the upper face, edge resharpening, partly usewear
- I. semi-steep, marginal removals on the upper face, probably partly usewear
- O. semi-steep/semi-flat, marginal removals on the lower face, edge angle correction
- G. semi-flat and flat removals on the upper face, edge sharpening
- N. flat removals on the lower face, edge angle correction
- F. flat removals on the upper face near the tip, edge formation, sharpening (?)
- M. semi-flat removals on the lower face near the tip, edge thinning, edge angle formation
- D. semi-flat removals on the upper face derived from the base, base formation, thinning
- P. semi-flat, irregular, marginal retouch on the lower face, edge correction
- E, C. semi-flat removals on the upper face, edge formation, thinning
- L. flat removals on the lower face, edge formation, thinning, shaping
- B. flat removals on the upper face, surface formation, thinning
- A. single, steep removal at the base, earlier stage of manufacturing process
- K. flat, broad removals on the lower face, surface formation, thinning
- J. semi-flat, broad removals on the lower face, surface formation, thinning

# Plate 298 Szeleta Pb84



Plano-convex, small, not fully symmetrical leafpoint, with exposed tip. It was remodeled, probably after base breakage; its near-the-base part was precisely shaped after breakage, with the use of several sequences.

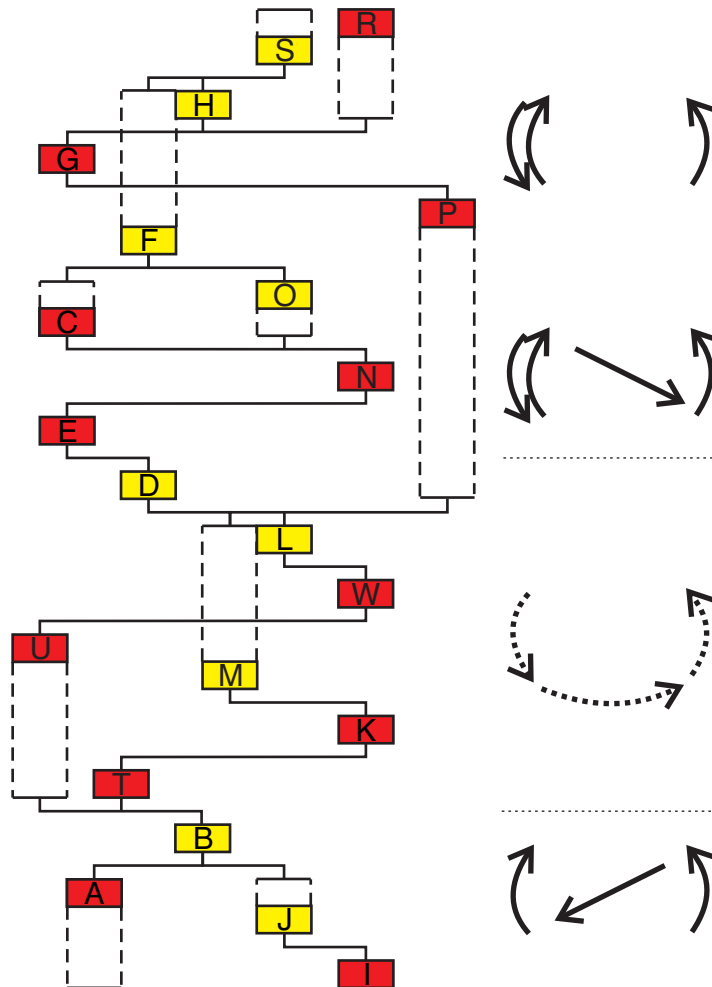


- G. semi-flat removals on the lower face, edge sharpening, correction
- M. flat, regular marginal retouch on the lower face, edge correction, edge angle formation
- N. small truncations on the lower face near the base, edge line correction
- F. semi-steep near the tip and semi-flat near the base, marginal retouch on the upper face, edge sharpening, formation
- J. flat removals on the lower face, edge angle correction and base thinning, shaping
- L. flat removals on the lower face, edge formation, shaping
- E. flat removals on the upper face derived from the base, base formation, thinning, remodeling after transversal breakage (sequence K)
- D, C. semi-flat removals on the upper face, shaping, thinning
- B, A. semi-flat removals on the upper face, surface formation, thinning or earlier stages of manufacturing process
- I, H. flat removals, surface formation, thinning or earlier stages of manufacturing process
- K. transversal breakage at the base, or natural surface

Plate 299 Szeleta Pb88

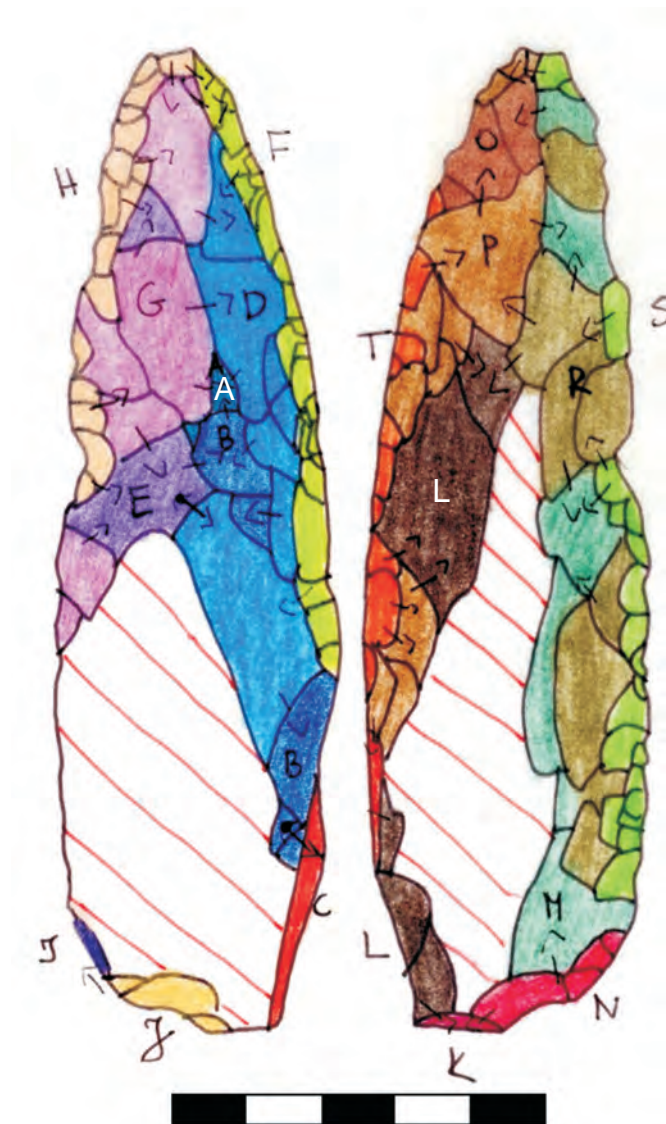


## Plate 299 Szeleta Pb88



- R. small, marginal truncations on the lower face near the tip
- S. semi-steep removals on the lower face created notches
- H. single, semi-steep removal on the upper face at the tip, tip blunting
- G. semi-flat, marginal retouch on the upper face near the tip, edge resharpening
- P, W. flat removals on the lower face near the tip, edge angle correction, near-the-tip part thinning
- F. semi-steep, irregular retouch on the upper face, edge correction
- O. semi-flat removals on the lower face, edge angle correction
- C. semi-flat, partly hinged removals on the upper face near the base, shaping
- N. semi-flat removals on the lower face, edge angle correction
- E, U. flat, far going removals on the upper face near the tip, shaping, thinning
- D. semi-flat removals on the upper face, edge formation, thinning
- L. flat removals on the lower face, edge angle correction, thinning
- M, K. flat removals on the lower face near the base, shaping, near-the-base part thinning
- T. single, flat removal on the upper face, surface formation
- J. flat, broad removals on the lower face, surface formation, thinning
- I. semi-flat removals on the lower face, surface formation, thinning
- A. semi-flat removals on the upper face, earlier stages of edge formation
- B. flat, broad removals on the upper face, surface formation, thinning

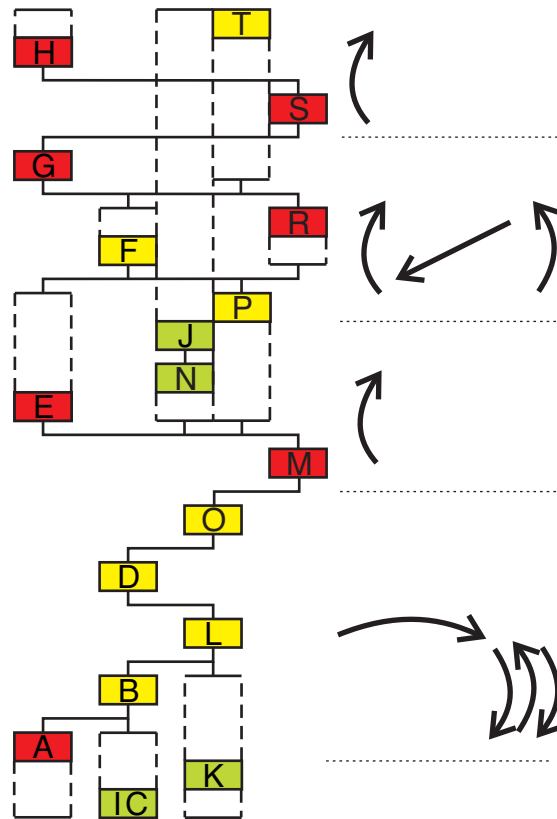
# Plate 300 Szeleta Pb92



Flat, elongated tool made on a slab, with cortical near-the-base part. Probably unsuccessful decortication near the base caused change in manufacturing process. Edge I was knapped and shaped (until sequence O one can see some attention devoted to shaping and thinning). Later sequences are aimed mostly at sharpening and resharpening. Tip is unexposed and additionally, during last rejuvenation stage it was partly blunted by semi-steep, marginal retouch derived from the tip.

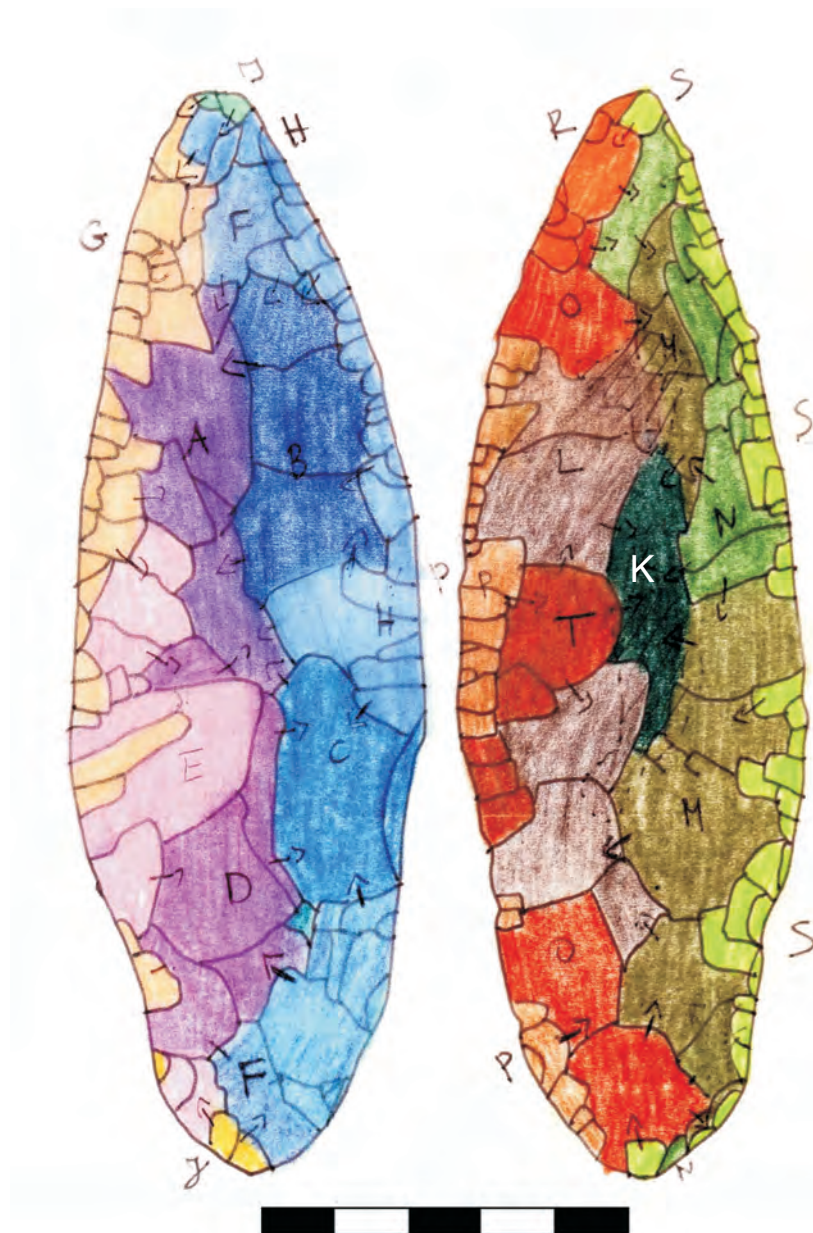


## Plate 300 Szeleta Pb92



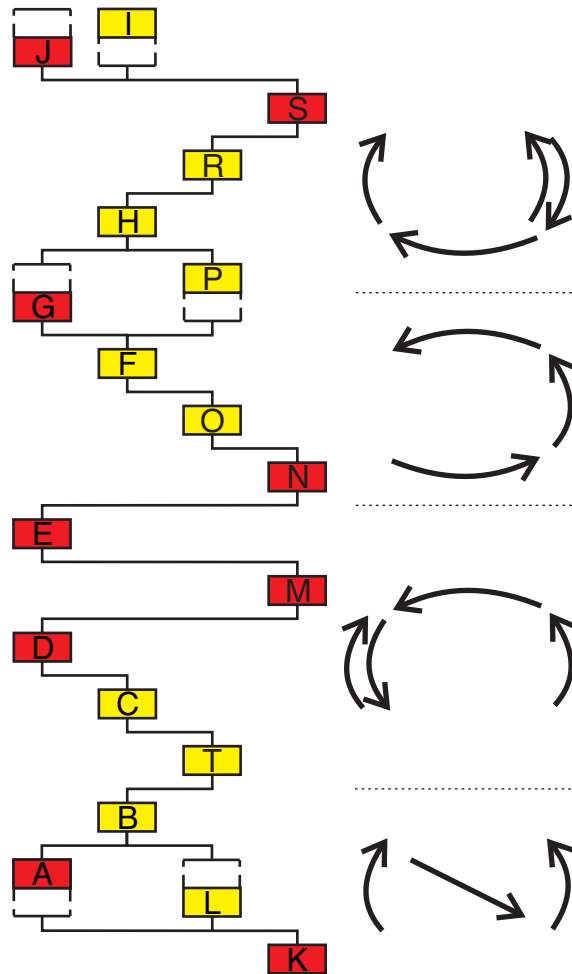
- T. semi-flat, marginal retouch on the lower face, edge correction
- H. semi-steep, marginal retouch on the upper face near the tip and at the tip, edge resharpening
- S. semi-flat/semi-steep retouch on the lower face, edge angle correction, edge resharpening
- G. semi-flat removals on the upper face near the tip, surface thinning
- R. semi-flat removals on the lower face, edge thinning, edge angle correction
- F. semi-flat, marginal retouch on the upper face, edge resharpening
- P. semi-flat removals on the lower face, edge angle correction, thinning
- J. flat removals on the upper face at the base, base formation, unsuccessful decortication
- N. semi-flat removals on the lower face at the base, edge angle formation, base formation
- K. steep surface, probably natural surface, at the base
- C. transversal breakage located angularly along the edge near the base
- I. semi-steep surface at the base, probably natural
- E. semi-flat removals on the upper face, surface formation, thinning
- D. semi-flat removals on the upper face, edge sharpening, thinning
- B. semi-flat removals on the upper face, surface formation
- O. semi-flat removals on the lower face near the tip, near-the-tip part thinning
- L. semi-flat removals on the lower face, surface formation, thinning, decortication
- M. flat removals on the lower face, surface formation, decortication
- A. flat scar, earlier stage of manufacturing process

# Plate 301 Szeleta Pb93



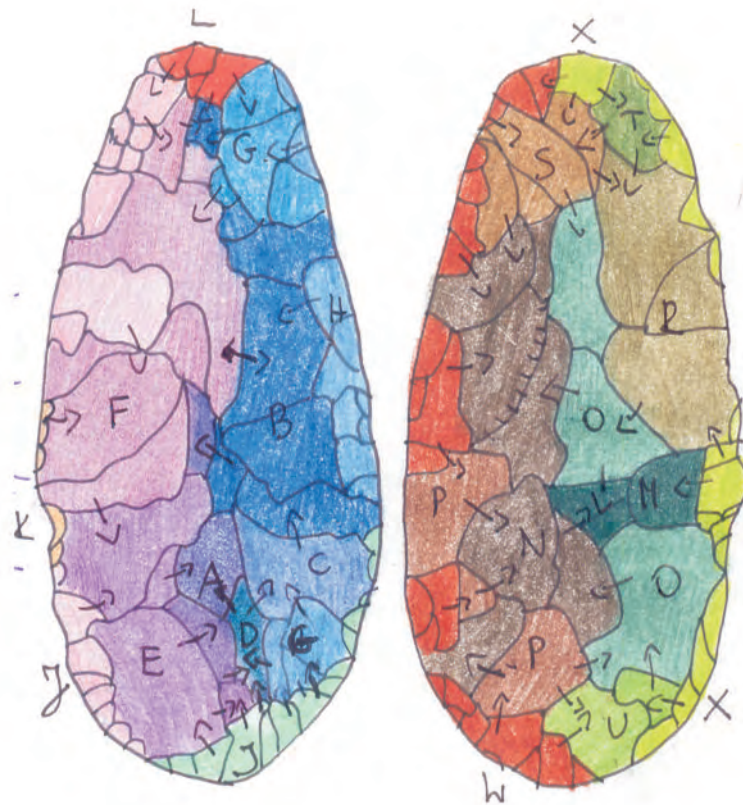
Biconvex, elongated leafpoint with exposed tip. One of edges (edge I) was damaged by high, hinged removal. Further manufacturing process was aimed at tool shaping on the opposite edge so as to symmetrize the tool. The tool bears no traces of resharpening or edge rejuvenation.

## Plate 301 Szeleta Pb93



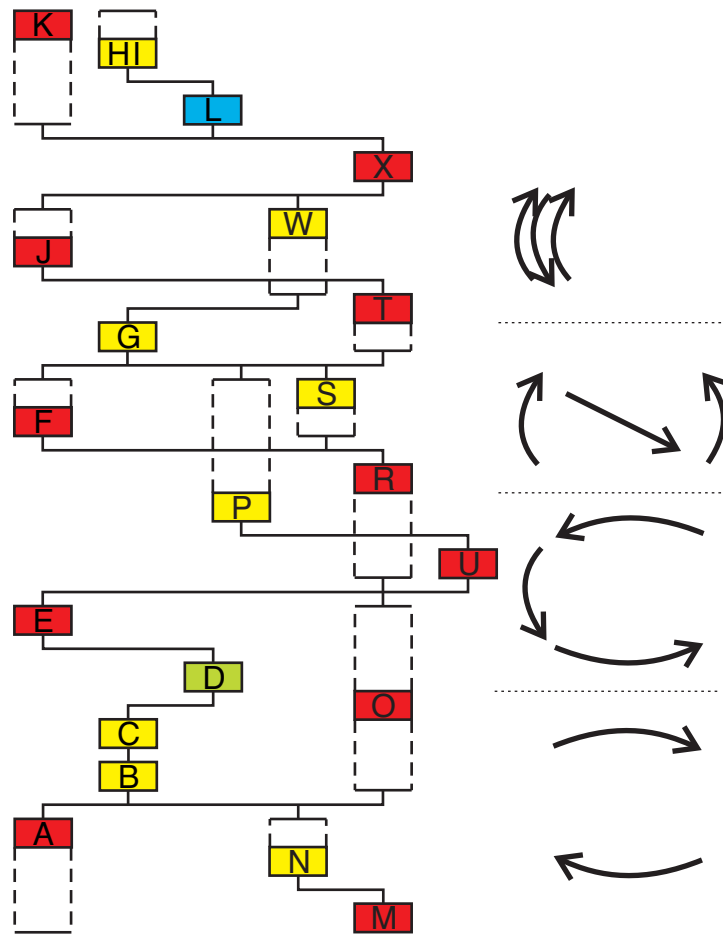
- I. semi-flat, marginal truncations on the upper face at the tip, probably usewear
- J. flat, marginal removals on the upper face at the base, edge correction
- S. semi-flat, marginal retouch on the lower face, more flat and partly hinged near the tip, edge sharpening
- R. flat removals on the lower face near the tip, near-the-tip part shaping, thinning
- H. semi-flat removals and marginal retouch on the upper face, edge formation, sharpening, line correction
- P. flat, marginal removals on the lower face, edge angle correction
- G. semi-flat removals on the upper face, analogical to sequence H, mostly concentrated near the tip, edge shaping, sharpening and line correction
- F. semi-flat removals on the upper face near the tip and the base, shaping, thinning
- O. semi-flat removals on the lower face near the tip and the base, shaping, edge angle formation
- N. flat removals on the lower face near the tip, shaping, thinning
- E, D. flat removals on the upper face, shaping, thinning
- M. semi-flat removals on the lower face, shaping, surface thinning
- C. flat removals on the upper face and single hinged removal which created a high hinge near the edge and blunted it, thus preventing further shaping and thinning. Created a notch on the edge
- T. flat removals on the lower face, edge angle formation, thinning
- B, A. semi-flat removals on the upper face, surface formation, thinning
- K, L. semi-flat and flat, broad removals on the lower face, surface formation, thinning

Plate 302 Szeleta Pb96



Biconvex tool with unexposed and partly blunted base and precisely shaped tip. Sharpening retouch was derived along edges, but the tool bears no traces of intensive resharpener sequences.

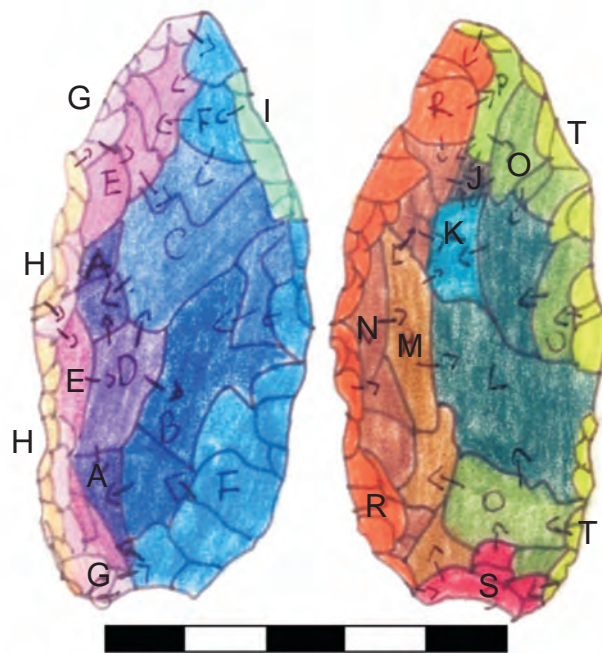
## Plate 302 Szeleta Pb96



- K. marginal truncations on the upper face, usewear retouch
- H. semi-flat/semi-steep, marginal retouch on the upper face, edge resharpening, created a notch
- I. semi-steep, marginal retouch on the upper face at the base, edge formation, resharpening (?)
- L. semi-steep removals on the upper face at the tip, tip blunting, tip edge formation
- X. flat removal on the lower face at the tip and semi-steep near the base, edge angle correction, edge resharpening
- W. semi-flat, marginal retouch on the lower face along the edge, edge resharpening
- J. semi-flat, marginal retouch on the upper face, edge resharpening
- T. single, flat removal on the lower face near the tip, edge angle correction
- G. semi-flat removals on the upper face near the base and the tip, shaping, edge angle correction, thinning
- S. semi-flat removals on the lower face near the tip, shaping
- F. flat removals on the upper face near the tip, shaping, thinning
- R. flat removals on the lower face near the tip, shaping, thinning
- P. semi-flat removals on the lower face near the base, shaping, thinning
- U. flat removals on the lower face near the base, shaping, thinning
- O. flat removals on the lower face, thinning
- E. flat removals on the upper face, surface formation
- A, D. flat removals on the upper face near the base, surface formation, thinning
- B, C. semi-flat removals on the upper face near the base, surface formation, thinning
- N. semi-flat, broad removals on the lower face near the base, surface formation, thinning
- M. flat removals on the lower face near the base, surface formation, thinning

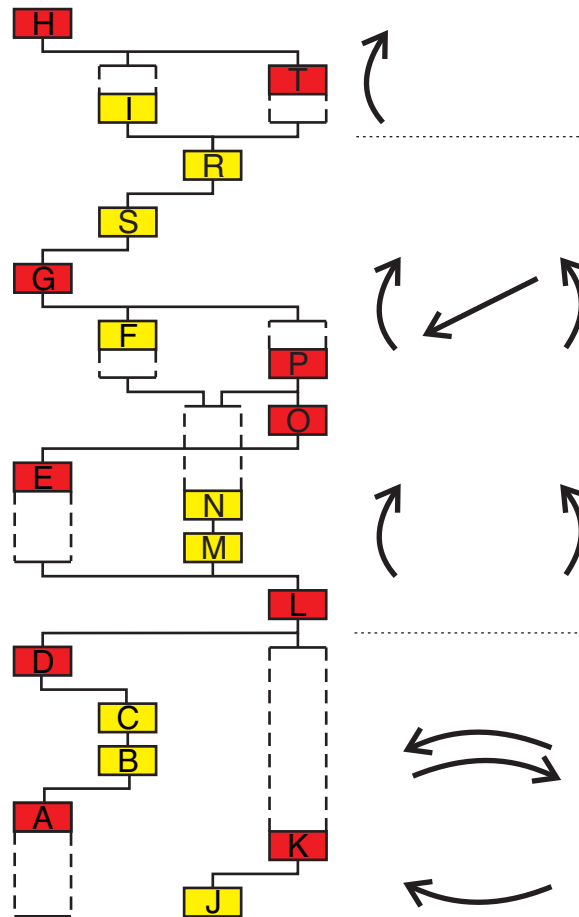


# Plate 303 Szeleta Pb97



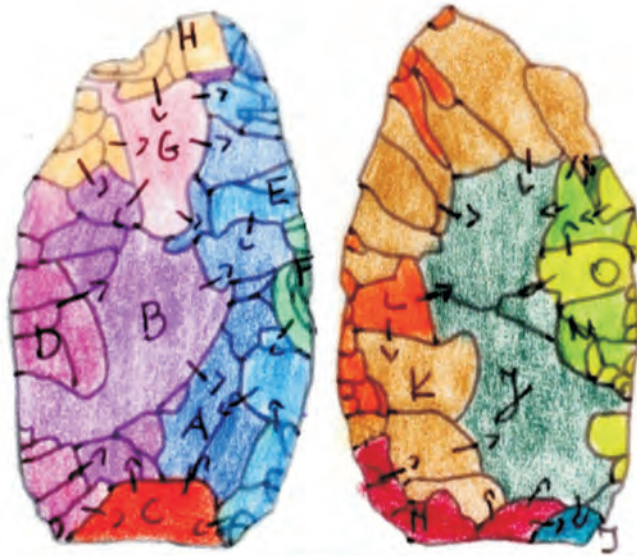
Heavily exhausted tool with no care for the poorly exposed tip and both edges intensively resharpened and blunted at last rejuvenation stage. Steep notch was created at the base. During earlier manufacturing stages, the tool bears traces of shaping sequences (sequence O, C).

## Plate 303 Szeleta Pb97

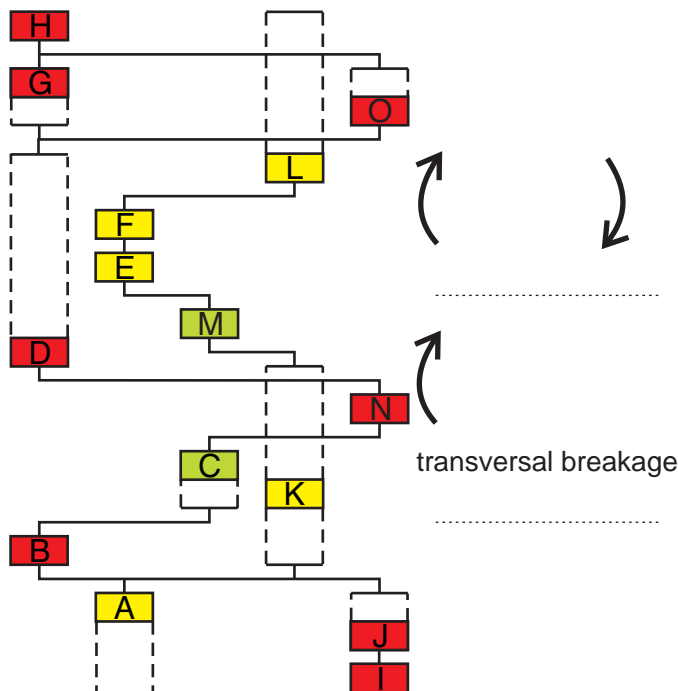


- H. steep, marginal retouch on the upper face, edge resharpening, created notches along the edge
- T. semi-flat, marginal retouch on the lower face, edge angle correction
- I. semi-steep, marginal retouch on the upper face, created a notch
- R. semi-flat, partly hinged removals on the lower face, edge thinning, edge angle correction and usewear
- S. semi-steep removals on the lower face derived from the base, create a notch at the base
- G, F. semi-flat, marginal retouch on the upper face, edge resharpening
- P, O, M, N. flat removals on the lower face, edge angle correction
- E. flat, partly hinged removals on the upper face, edge sharpening
- L. flat removals on the lower face, surface formation, thinning
- D. flat removals on the upper face, surface formation, thinning
- B, C, A. semi-flat removals on the upper face, surface formation, thinning
- J, K. flat scar, earlier stages of manufacturing process

# Plate 304 Szeleta 53.4.25

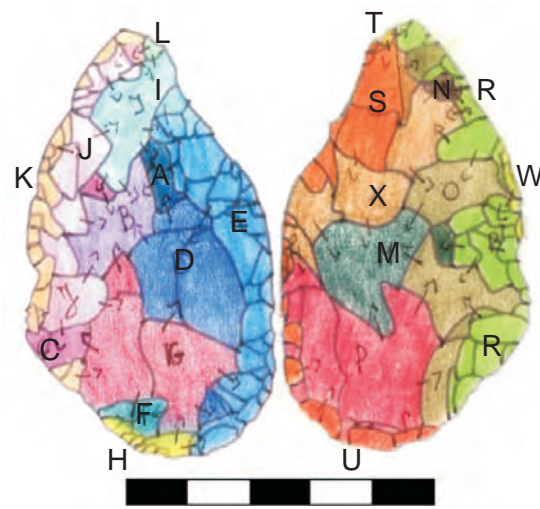


Plano-convex tool with poorly exposed tip located out of vertical axis, and borer exposed on edge. Both edges were retouched and resharpened several times; edge I was resharpened the most, whereas edge II was used less intensively. Base was broken.



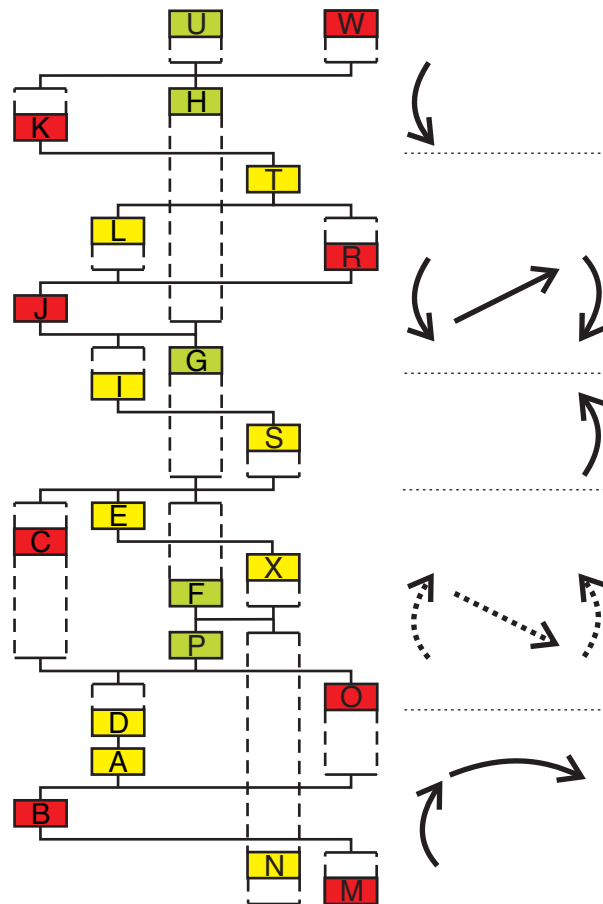
- H. steep and semi-steep, marginal removals on the upper face, created two notches and a borer on the edge near the tip
- G. single, flat removal on the upper face, thinning, remodeling, rejuvenation
- O, N, L. semi-flat, marginal removals on the lower face, edge angle correction
- F. flat, hinged, marginal retouch on the upper face, unsuccessful edge resharpening
- E. semi-flat/flat, marginal retouch on the upper face, edge resharpening
- M. flat removals on the lower face, derived from the base, edge correction
- D. semi-flat retouch on the upper face, edge resharpening
- C. steep removal derived from the base or transversal breakage on the upper face, base blunting
- K. flat removals on the lower face, edge angle formation, thinning
- B. flat, broad removals on the upper face, surface thinning
- A. semi-flat removals on the upper face, edge sharpening
- J. flat, broad removals on the lower face, surface formation, thinning
- I. flat scar on the lower face, earlier stages of manufacturing process

Plate 305 Szeleta 53.6.4



Biplan tool with near-the-tip part intensively resharpened on both edges. Lower face was used for edge angle correction.

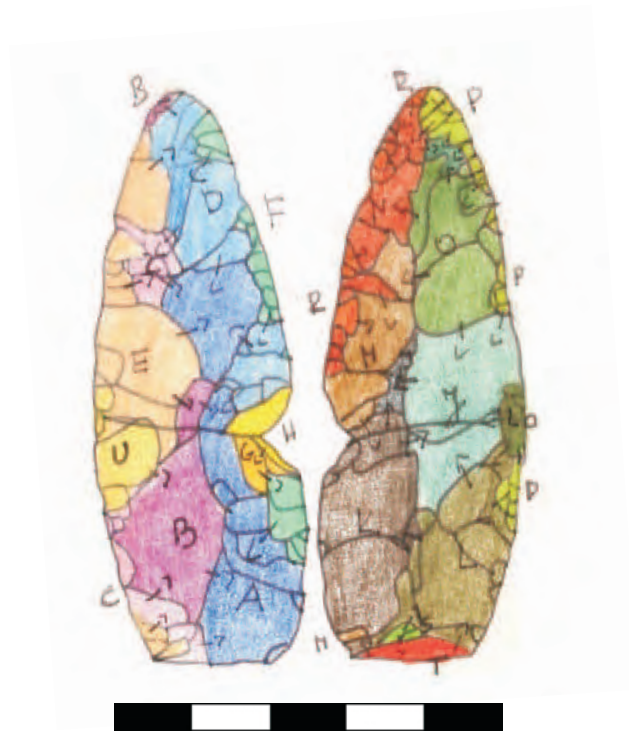
## Plate 305 Szeleta 53.6.4



- W. steep, marginal truncations on the lower face
- K. semi-steep, marginal retouch on the upper face, edge resharpening
- U. semi-steep, marginal retouch on the lower face at the base, edge resharpening
- H. semi-flat, marginal retouch on the upper face at the base, edge resharpening
- T. single, semi-steep, marginal truncation at the tip
- L. single, semi-flat, marginal truncation on the upper face near the tip
- R. semi-flat removals on the lower face, edge rejuvenation, edge angle correction, created a notch near the base
- J. semi-flat retouch on the upper face near the tip, edge resharpening
- I. single, flat, long removal on the upper face near the tip and marginal removals, edge thinning, near-the-tip part rejuvenation
- S. semi-flat removals on the lower face near the tip, edge angle correction
- G. flat, broad removals on the upper face derived from the base, surface formation, thinning
- F. flat removals on the upper face derived from the base, base formation
- P. flat, broad removals on the lower face derived from the base, surface formation, thinning
- E. semi-steep, marginal retouch on the upper face, a few phases of edge resharpening
- X. flat removals on the lower face near the tip, edge angle correction, thinning
- C. semi-flat removals on the upper face, earlier stages of edge sharpening (?)
- O. flat removals on the lower face, edge angle correction
- B, D, A. flat removals on the upper face, earlier stages of manufacturing process, surface formation (?)
- N, M. flat removals on the lower face, earlier stages of manufacturing process, surface formation (?)

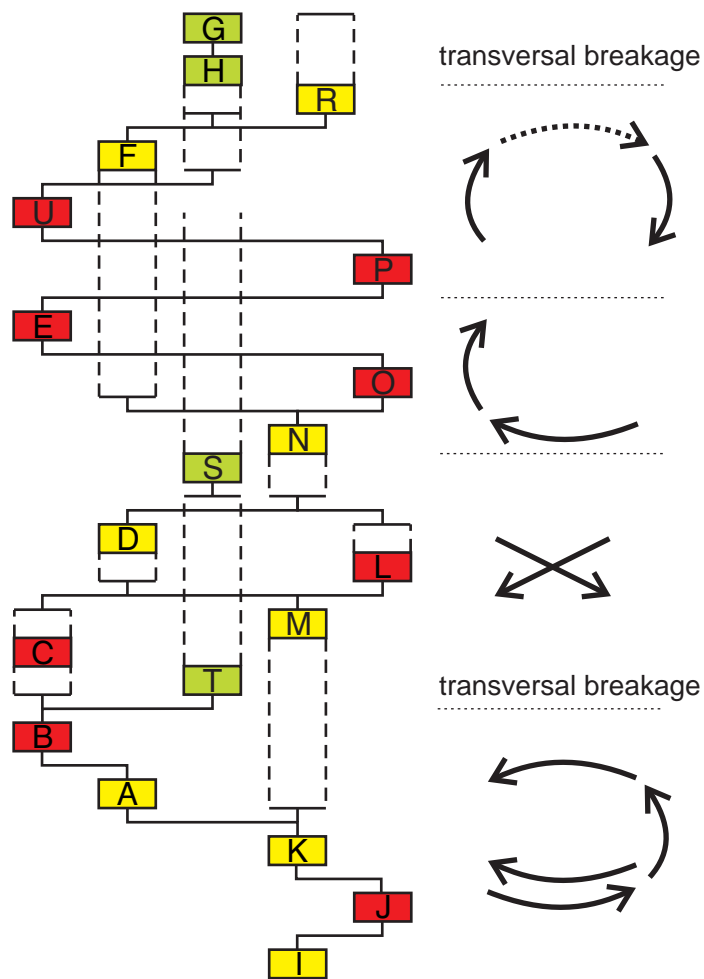


## Plate 306 Szeleta 53.8.2



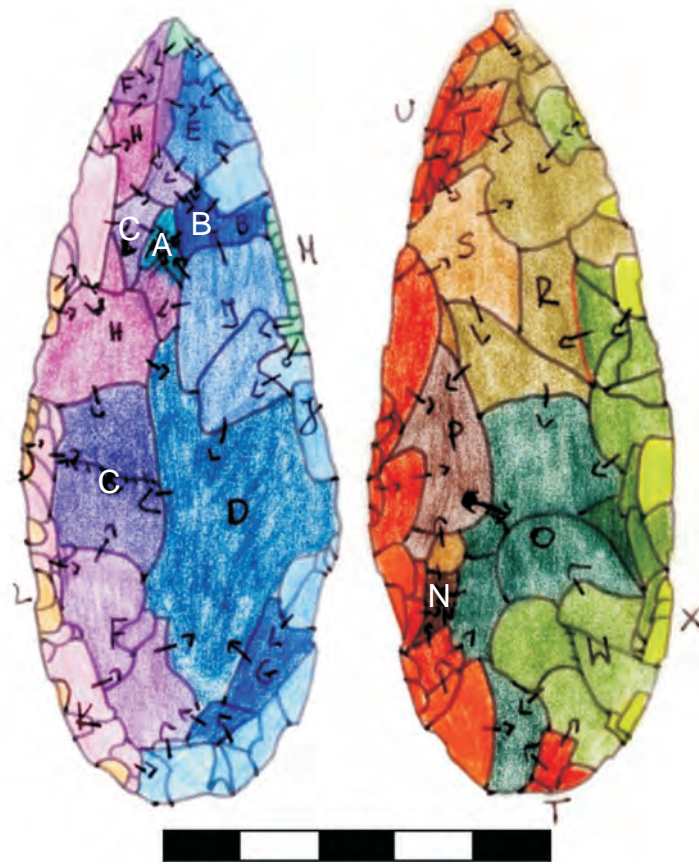
Elongated leafpoint with broken base and traces of shaping. The tool was refitted from 2 pieces, broken in the middle. It bears no traces of rejuvenation after last breakage (sequence H), although the tool was reshaped after base breakage (sequence T). Orientation could have been changed after T breakage, which would explain intensive shaping in near-the-tip part after breakage at the base.

## Plate 306 Szeleta 53.8.2



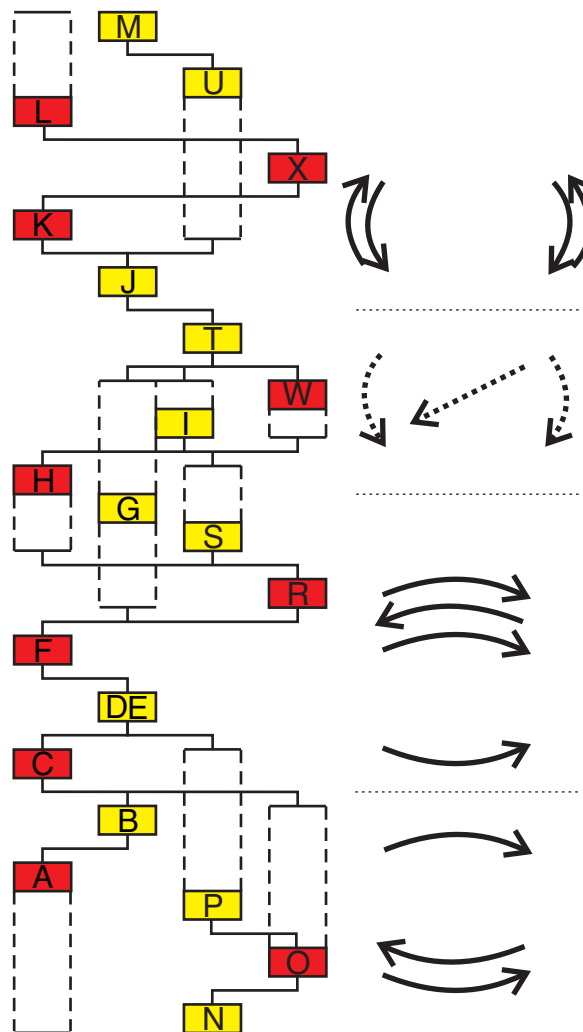
- G. unpatinated scar, probably postdepositional
- H. transversal breakage
- R. semi-flat, marginal truncations on the lower face
- F. semi-flat, marginal retouch on the upper face, edge correction
- U. semi-flat removals on the upper face, edge correction
- P. semi-flat, marginal retouch on the lower face near the tip and irregular along the edge, edge line correction, near-the-tip part symmetrization
- E, C, D. semi-flat removals on the upper face, shaping
- N, O. semi-flat removals on the lower face near the tip, edge thinning, shaping
- S. single, flat, marginal removal on the lower face derived from the breakage scar
- T. transversal breakage at the base
- L. semi-flat removals on the lower face near the base, near-the-base part shaping after breakage
- B. flat, broad removals on the upper face, surface formation, thinning
- A. semi-flat removals on the upper face, surface formation, thinning
- M. flat removals on the lower face near the tip, thinning, shaping
- J, K. flat removals on the lower face, surface formation, thinning
- I. flat scar on the lower face, earlier stage of manufacturing process

Plate 307 Szeleta 53.38.7



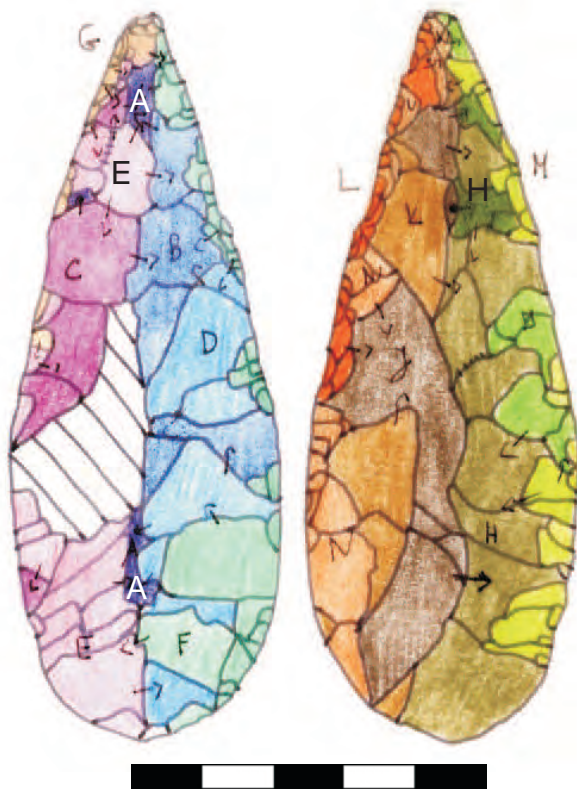
Biconvex leafpoint with rounded base and exposed tip, both edges treated equally; most sequences aimed at shaping. It bears no traces of resharpening.

# Plate 307 Szeleta 53.38.7

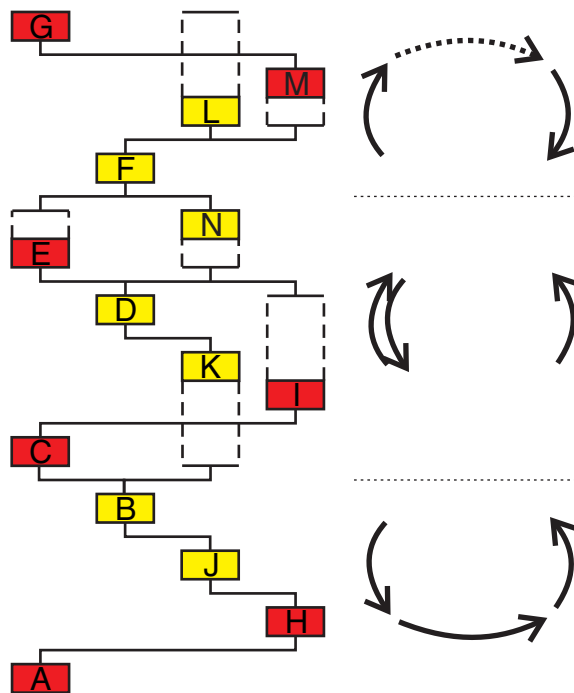


- M. semi-flat, small, marginal retouch on the upper face, edge correction
- U. flat, hinged removals on the lower face, edge line correction
- L. small, marginal removals on the upper face, edge correction
- X. marginal removals on the lower face, edge line correction
- K, J. semi-flat and flat, marginal removals on the upper face, shaping
- T. flat removals on the lower face, edge angle correction, shaping
- W. flat removals on the lower face mostly near the base, edge angle correction, shaping
- I. semi-flat, hinged removals on the upper face near the tip, shaping, thinning
- H. semi-flat removals on the upper face near the tip, shaping, thinning
- E. flat removals on the upper face near the tip, shaping
- F. flat removals on the upper face near the tip and the base, shaping
- G. flat removals on the upper face near the base, shaping
- S, R. flat removals on the lower face near the tip, shaping, thinning
- D. single, semi-flat, broad removal on the upper face, surface thinning
- C, B. semi-flat removals on the upper face, surface formation, thinning
- A. flat scar on the upper face, earlier stages of manufacturing process
- P. flat removals on the lower face, surface formation, thinning
- O. semi-flat removals on the lower face, surface formation, thinning
- N. flat scar on the lower face, earlier stage of manufacturing process

## Plate 308 Szeleta 53.38.8



Biconvex leafpoint with exposed tip and rounded base. Last marginal removals were partly hinged and aimed at maximal shape modification. Almost all sequences were aimed at shaping. The tool was worked alternately at surface formation stage of knapping, and at last marginal line correction stage of knapping.



- G. semi-flat, partly hinged, marginal retouch on the upper face near the tip, edge summarization
- M. semi-flat, marginal retouch on the lower face, edge line correction
- L. semi-flat, intensive, partly hinged, marginal retouch on the lower face, edge summarization, analogical to sequence G
- F. semi-flat, marginal retouch near the tip and long removals near the base, edge shaping
- N. semi-flat removals on the lower face, edge angle correction, shaping
- E. semi-flat removals on the upper face near the base and the tip, shaping
- D. semi-flat removals on the upper face, near-that-base part shaping and surface thinning
- K. semi-flat removals on the lower face, edge angle correction, shaping, thinning
- I. semi-flat removals on the lower face, edge correction
- C. flat removals on the upper face, surface thinning, shaping, partial decortication
- B. semi-flat removals on the upper face, surface formation
- J. flat, broad removals on the lower face, surface thinning, edge angle formation
- H. semi-flat removals on the lower face, surface formation, thinning
- A. flat scars on the upper face, probably surface and edge angle formation, thinning