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STUDIES IN HUMAN EVOLUTION

Laminar technology and the onset of the Upper Paleolithic in the Altai, Siberia

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We are top-of-the-water adventurers,
who limit our opinions of icebergs
to what we can see

John Irving, *Other people's dreams*

To Camille

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Foreword

During the last several decades, the demise of Neandertals and the emergence and dispersal of modern humans (MH) in Europe have been the subject of numerous studies and intense debate. For mostly historical reasons, Europe has been a natural case study for addressing fundamental issues regarding the origins of biological and behavioral modernity. In Europe, which was occupied by Neandertals since the Middle Pleistocene, a biological replacement occurred at about the same time as the appearance and systematization of new technologies associated with material evidence suggesting a significant development of symbolic behaviors. This shift from the Middle to Upper Paleolithic occurs at the end of a so-called transition period that is marked by the presence of archeological assemblages which combine aspects of the Middle Paleolithic with innovations of the Upper Paleolithic.

It is understood that the analysis of material culture is an important complement to physical anthropology and genetic studies to tackle issues related to the Paleolithic peopling of Europe. The dispersal of MH, however, is a worldwide event, and it is now clear that models of emergence and dispersal built on the European record are not universally applicable. For instance, early MH occur first in Africa with a different anatomical and behavioral package than the one that characterizes the subsequent European Upper Paleolithic. With this in mind, this thesis turns the focus to Asia and examines the processes associated with the Middle to Upper Paleolithic transition there.

In Asia, genetic and paleontological data suggest the existence of two dispersal routes, one north and one south of the Himalayas. The Altai occupies a strategic position along the northern route where recent archeological, anthropological and genetic discoveries suggest a complex history of peopling events. Recent genetic and paleontological data do not support a model of an independent regional emergence of MH that was built on the archeological data set. Through an analysis of the lithic technology of some of the key Altai sequences, the present study tries to reconcile the archeological record with the genetic and paleontological data by proposing an alternative model explaining the emergence of the Upper Paleolithic in Siberia.

1 – Introduction

This chapter is an introduction to the history of research in the Altai, to the geographical setting and to the paleo-climatic records of the region. Also, a brief summary of the human remains from Central Asia and Northeast Asia is presented although more precise descriptions are provided in the following chapters. It is followed by a summary of the recent scenarios explaining the emergence of the Upper Paleolithic behavior and the appearance and spread of MH across the Asian continent. The introduction chapter ends with a presentation of the hypotheses that will be tested and with the proposed alternative model.

1.1 A BRIEF HISTORY OF PALEOLITHIC ARCHEOLOGY IN THE ALTAI

Ethnographic studies in Siberia are known since the 18th century (Dolitsky *et al.*, 1985), but interest in Paleolithic studies in Central and Northeast Asia is deeply rooted in the dynamic context of the second half of the 19th century. In the autumn of 1871, while digging the foundation of the Irkustk Military Hospital, workers uncovered bone and stone artifacts associated with remains of extinct animal species. They were quickly recognized as such by I.D. Chersky and A.L. Chekanovskiy, who identified some bone artifacts as anthropic, probably produced with the help of the associated stone tools (Chersky, 1874). Stimulated by the Irkustk findings, I.T. Savenkov discovered in 1883 the Afontova Gora locality, along the Yenissei river banks, close to Krasnoyarsk (Savenkov, 1886). In 1892, his report in the International Anthropological Congress in Moscow (Savenkov, 1892) led G. de Baye to visit the Yenissei sites. De Baye subsequently presented a report to the French Academy of Sciences and to the Geographical Society of Paris (de Baye, 1894). A second phase of investigation in Yenissei started in 1911, and was pursued after Savenkov's death in September 1914. G. Von Merhart, an Austrian archeologist captured at the beginning of the First World War, participated in the diffusion of these results into Europe (von Merhart, 1923). In 1889, A.V. Eliseev found stone tools on the ridge of Lake Khanka and compared them with knives of the Saint-Acheul type (Eliseev, 1890). In 1918, close to Vladivostok, Joseph Forkash discovered a stone point which was later published by H. Breuil as 'Early Aurignacian' (Breuil, 1925). In the Trans-Baikal region, Savenko's students A.P. Mostits and U.D. Talko-Grintsevitch collected material during surveys along the Selenga river and tributaries (Mostits, 1896; Tal'ko-Grintsevich, 1900). In 1896, N.F. Kashchenko (1896) discovered a Paleolithic site on the outskirt of the city of Tomsk.

According to Derevianko and colleagues (Derevianko, Markin, *et al.*, 2001), the history of Paleolithic studies in the Altai started as early as 1911, when M.D. Kopytov found Paleolithic remains at the confluence of the Katun and Biya River. He gave encouragement to scholars such as A.P. Markov and S.M. Sergeev. In the 1920s and 1930s, they collected isolated artifacts and started small scale excavation at a site close to the city of Biysk. They discovered a concentration of knapped flint elements associated with a hearth (see Derevianko, Shimkin, *et al.*, 1998). After carrying out excavations in the Angara river basin, B.E. Petri created in 1919 in Irkutsk the Chair of Primitive Culture. Among his students, one can recognize future famous scientists such as G.P. Sosnovskiy, M.M. Gerasimov and A.P. Okladnikov (Figure 1) who became major contributors to the development of Siberian Paleolithic archeology during more than 30 years. In the 1930s, Sosnovsky studied the material from the Strostki site, in the Byisk area. Referring to previous work, he assigned this material to the final stages of Paleolithic, underlining similarities with assemblages from the Yenissei and Angara

basins and from the Trans-Baikal area (Sosnovsky, 1941 quoted after Derevianko *et al.*, 2001).

After the Second World War, in 1954, S.I. Rudenko discovered evidence of Paleolithic human occupation in the Ust-Kanskaya Cave, along the Charysh River (Rudenko, 1961). Rudenko considers Paleolithic studies as belonging to natural sciences rather than humanities. In the study of the Ust-Kanskaya assemblage, he combined typological lithic analysis with raw material procurement strategies and tried to reconstruct environmental conditions based on large mammals remains (Vereshchagin, 1956; Rudenko, 1961). In his opinion, the discovered fauna reflects warm and dry conditions and precedes the last glaciation. As a result, Ust-Kanskaya was considered for a long time as the earliest human settlement in Altai (*e.g.* Anisutkin and Astakhov, 1970). Rudenko quickly noted Mousterian features in the lithic assemblage (Rudenko, 1960, 1961) followed by Okladnikov (1961) who emphasized similarities with Mousterian assemblages of Western Europe and Central Asia. At the end of 1950's, the Karaturuk site and Iskra Cave were discovered in the Katun basin and Anuy River valley (Kadikov, 1959; Lapshin, 1982 quoted after Derevianko *et al.*, 2001) and excavations were conducted at the Mayminskaya site (Lapshin and Kadikov, 1981 quoted after Derevianko *et al.*, 2001) and soon after, at the Ust-Soma site (Kungurov and Kadikov, 1985 quoted after Derevianko *et al.*, 2001).

In the early 1960s, sites were discovered during geological surveys and engineering works at a time when natural sciences started to play a greater role in Paleolithic studies. Among others, lithological description of deposits, study of small and large mammals, pollen analysis and malacological-faunal studies were used to assess the age of artifacts and cultural layers. According to Derevianko *et al.*, (2001), the discovery of a Levallois blade in a section near Bobkovskaya led scholars to consider the initial peopling of Siberia during the Middle Pleistocene. It was then seen as a population movement originating from either Iran or from the Near-East (Okladnikov and Adamenko, 1966). The terraces of the Anuy were assigned to the Middle Pleistocene although Tseitlin (Tseitlin, 1974) instead associated the Anuy second terrace with the beginning of the Sartan glaciation. The Ulalinka site was discovered in 1961 by Okladnikov and was intensively investigated starting in 1969. The dating of human occupation at theses sites varies depending of the authors (Maloletko, 1972; Okladnikov, 1972; Gayduk, 1973; Okladnikov and Pospelova, 1982; Ragozin and Shliukov, 1984; Tseitlin, 1986) and doubts have been raised regarding the authenticity of the lithic assemblage (Mochanov, 1976; Medvedev, 1983 quoted after Derevianko *et al.*, 2001). Okladnikov admitted that evidence of percussion is not clear (Okladnikov, 1972) but other scholars observed and described nearly a hundred artifacts (Abramova, 1989). Among other projects, Okladnikov started excavations at Strashnaya Cave (1969-1970) (Okladnikov *et al.*, 1973).



Figure 1: A.P. Okladnikov (photo credits: Institute for the History of Material Culture. Russian Academy of Sciences. St. Petersburg)

During the 1960s, the archeological historical-cultural approach prevailed. Okladnikov considered the existence of a vast Sibero-Mongolian Levallois entity marking the transition between the Mousterian

and the Upper Paleolithic (Okladnikov, 1978, 1981). He noted the existence of differences between assemblages as evidence for variability within a vast Siberian-Mongolian Levallois entity, probably inspired by the Sino-Siberian cultural area defined by Zamiatnin (1951). Similar views were applied to the later UP by Z.A. Abramova to define a south Siberian cultural entity (Abramova, 1979).

In the 1970s, the multiplication of discoveries increased the variability of lithic assemblages. Kadikov and Lapshin classified assemblages according to their blank production and secondary treatment (Kadikov, Lapshin, 1978 quoted after Derevianko *et al.*, 2001). They distinguished a complex dominated by tools on blades and small size artifacts (Karaturuk, Maymanskaya, Ust-Kuyum) as opposed to another complex dominated by pebble tools (Srotski, Urozhainaya). Although these sites suffer from a lack of geo-chronological data, they were attributed to the final UP (Lapshin and Kadikov, 1981). The end of 1970s was characterized by the discovery and investigation of new sites in the central Altai. Excavations of the Tiumechin complex (I-IV) yielded evidence of Pre-UP settlements. Starting from 1974, the site of Kara-Tenesh was excavated by Kadikov and later by Okladnikov between 1979 and 1981. In the meantime, Okladnikov started excavating Denisova Cave in 1977. Surface finds were spotted in the highland zone of Chuiskaya Hollow (e.g Kubarev *et al.*, 1978). Starting in the 1980s, the piedmont yielded sites such as Tytkesken 3-5 and 7-9, Ust-Sema 2 and 3 in the Katun basin, and Cheremshanka and Ulus I along the Chumysh River. Previously known sites such as Ust-Sema and Ust-Kuyum were excavated (Kungurov, 1993). Within the Solontskaya depression, stratified and surface materials were discovered in Ushlep 1-8 site (Kiriushin and Kungurov, 1983; Kungurov, 1993, 1996) .

During this period, the typological approach prevailed and variations in toolkit composition were seen as reflecting cultural differences. Scholars distinguished two main cultures along the Katun River (Kungurov, 1993). The Nizhnekatunskaya culture (Srotski, Urozhainaya, Kamenuk, Iulchak Iogach among others) occurs in the northeast, along the Biya River and on the ridge of Teletskoye Lake. The Kuyumskaya culture (Ust-Kuyum, Ust-Sema lower strata, Tytkesken 3, Maymanskaya) extended to the Chuya River basin (Yustyd I, Boguty I) in southeastern Altai. These two cultures were differentiated by the presence/absence of pebble tools and bifacial elements.



Figure 2: A.P. Derevianko (photo credits: Institute of Archeology and Ethnography, Siberian Branch of the Russian Academy of Sciences. Novosibirsk)

In 1980, the site of Kara-Bom was discovered in the Yelo basin and excavated by Okladnikov (1983). A. P. Derevianko (Figure 2) and V.I. Molodin discovered the Anuy I open-air site in 1983 (Derevianko, Shimkin, *et al.*, 1998) and Okladnikov Cave in 1984 (Derevianko and Markin, 1992). At about the same time, the excavation at Maloyalomanskaya Cave in the Katun basin started and Derevianko discovered the site of Ust-Karakol 1 at the confluence of the Karakol and Anuy Rivers. The latter was first excavated in 1986 (sector 1) (Derevianko *et al.*, 1987) whereas excavations at the nearby site of Anuy II started in 1989 (Derevianko, Markin, *et al.*, 2001;

Derevianko and Rybin, 2003). Since the beginning of the 1990s, a few sites were discovered, such as the Lower Paleolithic site of Karama (Derevianko, Ulyanov, and Shunkov, 2001), the stratified site of Anuy III (Derevianko, Shunkov, *et al.*, 2000), and more recently, the Mousterian site of Chagyrskaya (Derevianko, Markin, *et al.*, 2009, 2010; Derevianko and Markin, 2011).

To summarize, the history of research in Siberia reflects a constant enthousiasm since the earliest stages of the discipline (for more details, see also Shunkov, 1990; Derevianko, Shimkin, *et al.*, 1998; Derevianko, Markin, *et al.*, 2001). Pioneer work was carried out since the end of the 19th century and attracted the attention of European scientists. Systematic investigations in the Altai started from the second half of the 20th century, with active researchers such as Rudenko, Kadikov or Okladnikov. The latter had a major influence in the Altai but also more generally on Central Asian Paleolithic studies with his work in Uzbekistan (*e.g.* Teshik-Tash) and in Mongolia (*e.g.* Molty-Nam). Since the 1990s the number of systematic multidisciplinary studies of Paleolithic sites has increased, mainly due to the tremendous efforts of Derevianko and his team from the Institute for Archeology and Ethnography at the Siberian branch of the Russian Academy of Science in Novosibirsk.

1.2 GEOGRAPHICAL SETTING

The Altai range is located at the cross-roads between Central and Northeast Asia, between 49 and 52° of latitude north and 32° to 88° longitude east (Figure 3). It is bordered in the north by the Altai plain and the Ob River Basin opening on the west Siberian plain. On the northwest border stand the Salair and the Alatau ranges and in the southwest, the western Sayan range. In the south, the Mongolian Altai



Figure 3: Location of the Altai range

runs east to the Gobi Desert. To the west, the Altai joins the Kazakh steppe. In the southwest, the Altai is separated from the Central Tian-Shan by the plains of eastern Balkash, the Tarbaghatay range and by the Zaisan surrounding. The plains reach the Xinjang and the Takla-Makan desert via the Turpan-Ami depression and southern and Inner-Mongolia via the western edge of the Gobi desert.

The Altai Mountains are the result of a complex and contrasted history. The Upper-Cambrian bedrock is overlaid by Ordovician, Silurian and Devonian sandstone and quartzite. Cretaceous deposits are sandy-silts and during the Mesozoic, there is an accumulation of sedimentary rocks. Several periods of complete flattening (early Mesozoic, Late Paleozoic) of the landscape have been recorded and the current setting is initiated during the late Jurassic. The formation of the Siberian Mountains is seen as a continuous process starting from the Baikal region, progressing from east to west and reaching the Altai-Sayan during the late Pliocene (Chlachula, 2001). Tectonic activity during the end of the Middle Pleistocene is said to be responsible for a deepening of the valley system (Agatova, 2005; Agatova and Nepop, 2010) of about 100 m in the Anuy valley and about 200m in the Katun valley. The earliest deposits in the Anuy river valley were attributed to the last interglacial, when karsts were then formed due to the exposure of carboniferous formations, circa 120-110 ka (Baryshnikov and Maloletko, 1997 quoted after Chlachula, 2001).

This view has been challenged on the basis of radio-thermoluminesence (RTL) dates of circa 225 ka obtained on layers of pebble and gravel at the base of the Anuy alluvial plain (Derevianko *et al.*, 2003). The large standard deviation of 40 ka, the chronological gap with the first sedimentary layers at Ust-Karakol 1 (sector 2) and the RTL date of 163 ± 40 ka (Derevianko *et al.*, 2003) obtained on a sandy layer below Denisova Cave, do not rule out the assignment of the first terraces to OIS5e. This could have major implications for understanding the chronology of Paleolithic human settlements. The Altai alpine ridges such as the Chuya, Saylugem, Katun and Kuray, include peaks with a maximum elevation of 4506 m asl. The high plateau of more than 2000 m in elevation (*e.g.* Ukok, Chulyshman, Ulugan) represents a third of the Altai territory and intermediate mountain landscapes, ranging between 800 to 2000 m asl, account for about half of it. They are mainly located in the northern and western regions and their relief is shaped by active hydrographic networks and by selective erosion. Intermediated mountain landscapes are believed to be formed by the erosion of the peneplains of large plateaus (Shahgedanova, 2003). Two main lakes, the Markakol and the Teletskoe, are located respectively in the southern and northern edges of the Altai range. The Teletskoe is currently the sixth deepest lake (circa 325 m) in the world and was formed around 36 ka ^{14}C BP. The current climate is continental with contrasting seasonal climatic inversions. The winters are generally cold with mean temperatures ranging from -16°C in the foothills to -36°C in the high mountains (Shahgedanova, 2003), with a minimum temperature recorded in the Chuya depression reaching -60°C. Precipitation is stronger in the northwestern part of the Altai, as the southeast is more arid (Chlachula, 2001).

Paleolithic sites are mostly located in the northwestern and in the central part of Gorny-Altai, between the Alpine relief and the northern plain (Figure 4). They lie in intermediate mountain zones, generally between 300-1200 m asl. In the northwest, sites of Strashnaya Cave and Chagirskaya Cave are located in the Charysh Basin. Okladnikov Cave, Isrkra Cave, Karama, Anuy I-III, Denisova Cave, Ust-Karakol and Kamminaya Cave are located in the Anuy basin and Ust-Kanskaya is located further south along the Charysh, in the Central Altai. Ulalinka was found near the city of Gorno-Altaisk, and the Biyka Cave complex and the site of Kara-Tenesh lie upstream along the Katun River. The Tiumechin complex and the Kara-Bom site are located near the Ursul river, and Maloyalomanskaya is along the Mala Yaloman, a small tributary of the Katun. Only a few sites such as Barbughazy, Torgun and Yustid are found in the southeast, and they are mainly assigned to the Final Paleolithic.

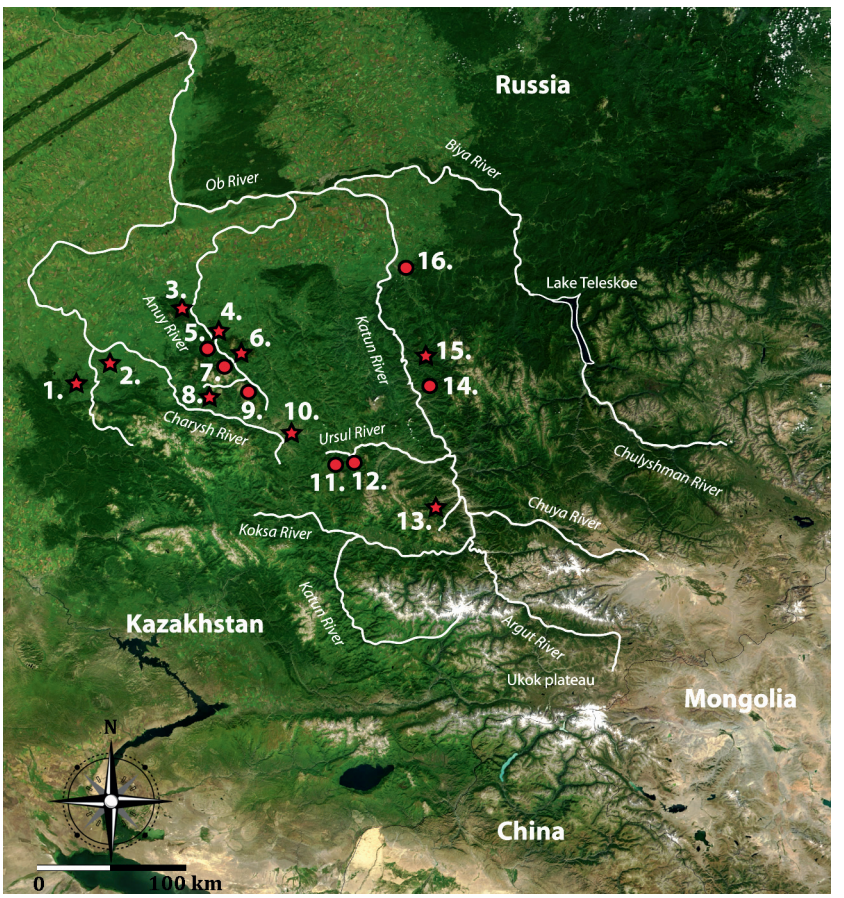


Figure 4: Distribution of the Paleolithic sites in Gorny-Altai. Stars are Cave sites, dots are open-air sites. 1. Strashnaya Cave, 2. Chagyrskaya Cave, 3. Okladnikov Cave, 4. Iskra Cave, 5. Karama, 6. Anuy I-III, 7. Denisova Cave, 8. Kamminaya Cave, 9. Ust-Karakol 1, 10. Ust-Kanskaya, 11. Kara-Bom, 12. Tiumechin 1-4, 13. Maloyalomanskya Cave, 14. Kara-Tenesh, 15. Biyka Caves, 16. Ulalinka. (modified after NASA Visible Earth)

1.3 PALEO-CLIMATE AND ENVIRONMENT

As stressed by several authors, the Altai represents a mosaic of different environments. In the following section, only the main lines of the Siberian paleo-climatic records are summarized. The main stages of Siberian chrono-climatic sequence as defined by Kind (1974) are still widely used (Arkhipov, 1999; Arkhipov *et al.*, 2005) (Figure 6). According to this system, the Late Pleistocene is divided into four stages: Kazantsevo, Ermakovo, Karga and Sartan (see below):

- The *Kazantsevo* stage is the last interglacial, correlating with the OIS5e in the marine records. The maximum transgression was dated by ESR in the Pur River and in the Puyasina River Basin to around 134.8 ka (Arkhipov *et al.*, 2005). In the Yenissei, deposits of the Karginsky cape were used by Kind (1974) to define the Karginian interstadial on the basis of radiocarbon dates. ESR results of 121.9 ka suggest, (Arkhipov *et al.*, 2005), however, that these deposits should be assigned to the Kazantsevo. In southwestern Siberia, the Bersky complex has been dated by TL from 130 ± 31 to 110 ± 27 ka. The Blake magnetic excursion is attributed to this period (Arkhipov *et al.*, 2005). Based on paleo-pedological, palynological and paleontological evidence, the climate of the interglacial is evaluated as humid and warmer than to-

day (Agadjanian and Serdyuk, 2005; Arkhipov *et al.*, 2005). In southwestern Siberia and in the Altai, a vegetation of meadow steppe coexists with a forest environment. Coniferous trees occur but are associated with an expansion of broadleaf species. According to Chlachula (2001), the last interglacial deposits are not well documented in the Altai and occur mainly in the northern plain.

- The *Ermakovo* stage is documented in the tills of the lower Ob basin, at Kashgorskaya and Kormuziganskaya, and dated by TL to between 110 ± 15 and 80 ± 11 ka (Arkhipov, 1989; Arkhipov *et al.*, 2005). It is also represented by the Tulinsky loess and by the formation of glacial-fluvial deposits along the Chuya River. Pollen data from the Katun River points to an expansion of dwarf-birch and indicate cold climatic conditions. Cold snaps occur during periods corresponding to OIS5d-c and to OIS4 and corresponding to an increase of coniferous and dry steppe and a decrease of broadleaf species, whereas OIS5a-b is considered as a warmer period. A large glacier that dammed the Chuya River and the formation of a glacial lake are associated with OIS4 (Devyatkin, 1965 quoted after Chlachula, 2001). Based on the chemical composition of sediments, Fedeneva and Dergacheva (2003) identify two possible warming events within the Zyriansk (Ermakovo) stage.

- The *Karginian interstadial* is represented by alluvial and lacustrine deposits and dated by radiocarbon to between 50 and 23 ka which corresponds to OIS3. It consists of three warm and two cold events. The first warm event is dated circa 55-50 to 44-43 ka and corresponds to the maximum transgression, when the sea entered the lower course of the Ob. The Malaya Kheta and Lipovka-Novoselovo warm stages are comparable to the modern climate and generally speaking, the Karginian interstadial is seen as a temperate period. At Denisova Cave, paleontological analyses have detected fluctuations within Karginian layers, however, in an unclear sedimentary context (Agadjanian and Serdyuk, 2005). This period is marked by changes between broadleaf and coniferous species, with cool to warm indicators and humid to moderately humid indicators (Wrinn, 2010).

- The *Sartan* glaciation is considered as the beginning of the climatic degradation that leads to the Late Glacial Maximum and the maximum advance of the ice-sheet. The climatic conditions are cold and dry and marked by the retreat of forests. Geomorphological evidence suggests a multiplication of lake formations during the last glacial period (Chlachula, 2001). At the beginning of the Sartan, two large interconnected glacial lakes start to expand due to the blockage of rivers by the extending glaciers, covering the Chuya and the Kuray depression. The beginning of the process is dated by radiocarbon to 25,300 ± 600 ^{14}C BP (MGU-IO-65) in the Chuya section, and the middle part of the lake formation is dated from the Inya section to 23,250 ± 400 ^{14}C BP (SOAN 2239) and 22,275 ± 370 ^{14}C BP (SOAN 2240). At the end of the Pleistocene, the retreat of the glacier blocking the Chuya River presumably caused catastrophic floods through the drainage network of the Katun and the Biya rivers (Grosswald, 1980; Rudoy, 1984, 2002; Baker *et al.*, 1993; Rudoy and Baker, 1993; Grosswald and Rudoy, 1996). Although the last flood is dated by radiocarbon to 13 ka, it is assumed that several filling/drainage cycles occurred during the Late Pleistocene (Zolnikov, 2008), but geomorphological evidence of this is poorly preserved (Chlachula, 2001). Currently, the existence of such phenomena is widely accepted (Shahgedanova, 2003), even though some scholars tend to minimize its intensity (Velichko, 1984).

Criticisms of Kind's chrono-climatic division have been recently raised. Some of the stages and substages eponymous sections, such as Karginsk Cape or Malaya Kheta, have been erroneously dated by radiocarbon to OIS3 (Astakhov, 2006). In fact, OSL, TL and ESR dates indicate that radiocarbon dates provided only minimum ages for these deposits, and that they should be assigned to the Kazantsevo interglacial (Arkhipov *et al.*, 2005; Astakhov, 2006). New reference sequences for the Upper Pleistocene have been described from Marresale polar station (Astakhov, 2006) and from the Laptev and east Sibe-

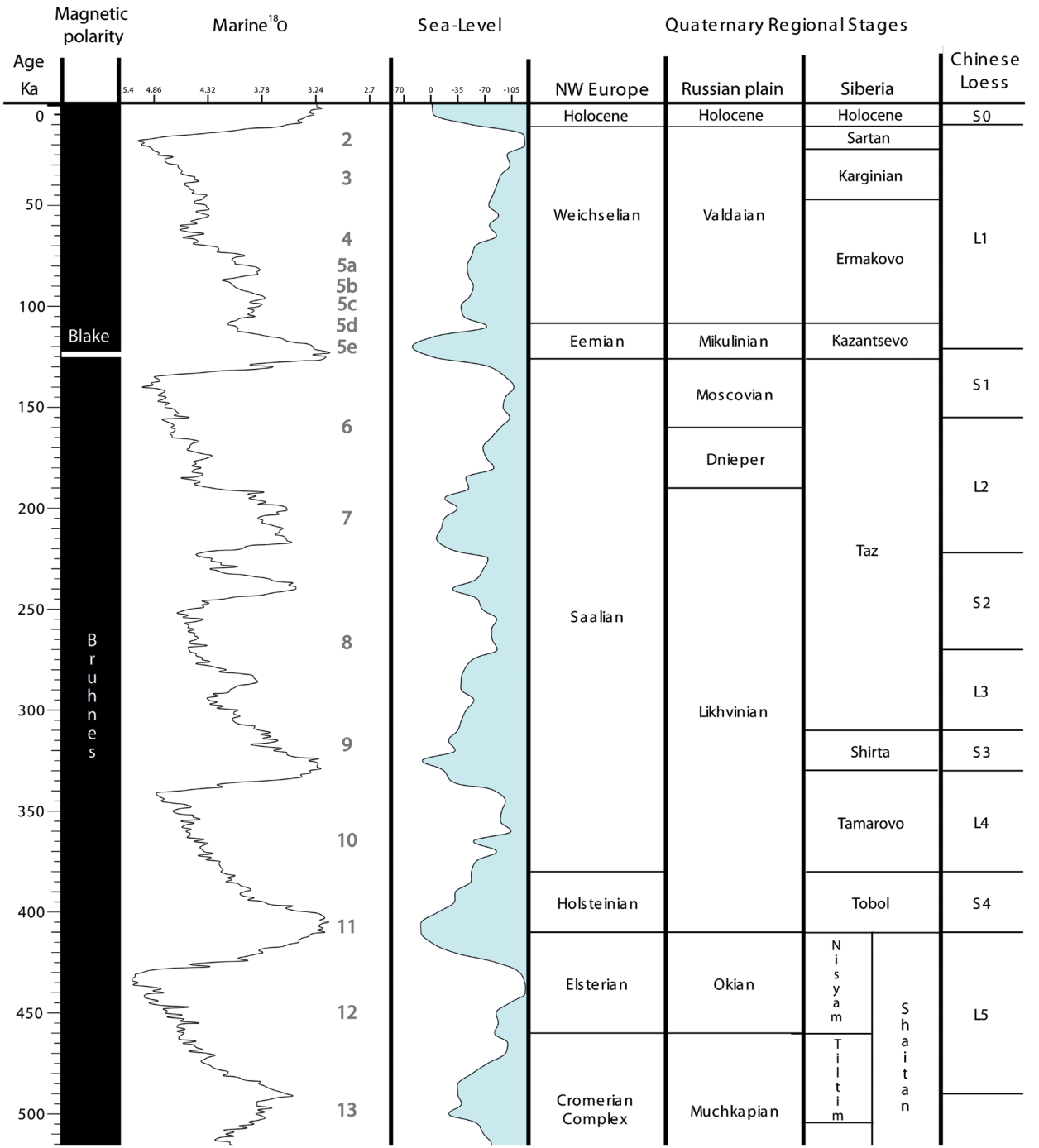


Figure 5: Correlation of the main chrono-stratigraphic stages from Siberia, with the Oxygene Isotopic Stages, the sea-level fluctuations (in meters relative to present), and other quaternary regional stages (adapted from Time-Scale Creator 5.4, Lugowski and Ogg, 2005 – 2009)

rian seas (Sher *et al.*, 2005). The alternative chrono-climatic scale, however, does not differ much from the traditional one. The division in four main stages is preserved but with new names. The Kazantsevo (OIS5e) is named Malokhetsky or Karginsky, and the former Karginsky (OIS3) is renamed Varyakha interstadial. The latter takes place between 50 and 30 ka BP (Astakhov, 2006; Astakhov and Nazarov, 2010). OIS5e is seen as a genuine interglacial climate, but the climatic improvement of OIS3 is regarded as less significant than previously thought. Climatic differences between OIS3 and OIS2 tend to be minimized, and the whole period is believed to be rather cold and dry with a persisting steppe tundra environment and permafrost (Scher *et al.*, 2005). The Sartan, renamed Syoyakha stage, would start circa 30 ka BP (Astakhov, 2006).

In spite the confusing denomination of climatic events, recent dating seemingly confirmed a relatively good agreement between Kind's regional chronostratigraphy and the global record based on Oxygene Isotopic Stages. Beyond the general stages, however, the definition and the correlation of sub-stages is a more delicate matter.

The Kurtak loess paleosol succession is recognized as the best-studied reference sequence for OIS3 in Siberia (Astakhov, 2006) (Figure 7). The Kurtak complex and Chani-Bay complex are located along the western slope of the Yenissei valley, in southcentral Siberia. The high-resolution sequence does not contradict Kind's division but provides a more precise picture of the Late Pleistocene climatic succession with OIS3 being particularly well documented. Fragmentary data obtained from the Berezhekovo P29 sections (Chlachula, 1997; Haesaerts *et al.*, 2005) provide an overview of OIS5 and OIS4 records dated by luminescence (Zander *et al.*, 2003). Pedological observations show several episodes of pedogenesis, with the Kamenny Log soil attributed to OIS5e, and with the Sukhoy-Log Pedocomplex attributed the OIS5a-d. The Chaninsky loess represents the full development of the Ermakovo (or Murukta) cold stage

Climatic stage	OIS	Stade-Interstade	
Sartan	2	Norilsk Stade	11-10.3 ka
		Taymirian-Kokorovian	ca. 13 ka
		Nyapan	ca. 15.5 ka
		Early Interstade	ca. 16 ka
		Gydanian	ca. 24 ka
Karginian Interstadial	3	Lipovka-Novoselovo	30-25 ka
		Konoschelye	
		Malaya Kheta	42-35 ka
		Lokhpodgortian	
		Igarka-Zolotomysskian	ca.55-43 ka
Ermakovo	5a-d/4	Murukta	110 - ca.55ka
		Interstade	
		Lower Tungunska	
Kazantsevo Interglacial	5e		130-110 ka

Warm oscillation

Figure 6: Siberian late Pleistocene chrono-climatic divisions (modified after Kind, 1974 and Vasiliev, 2001)

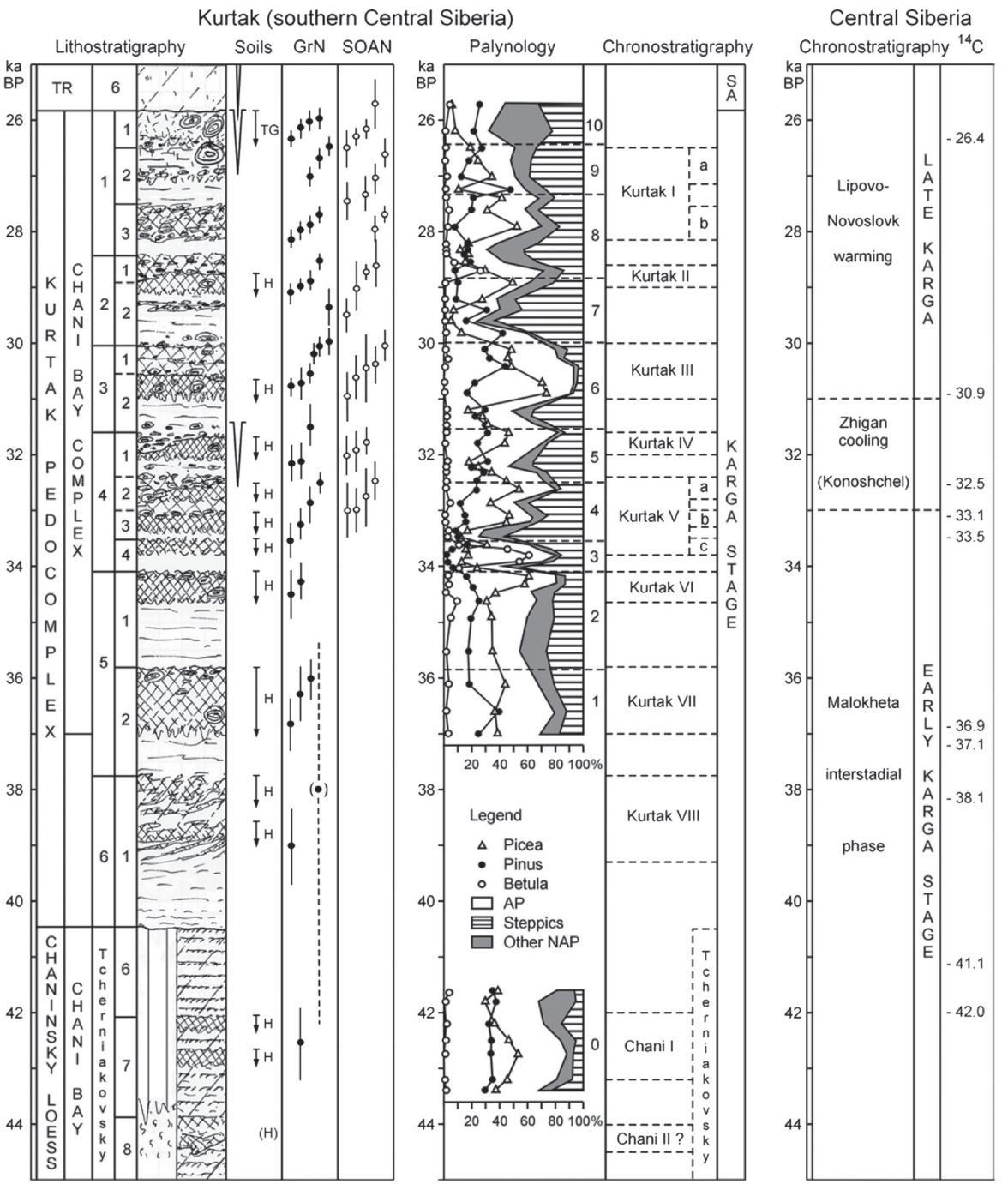


Figure 7: Kurtak sequence correlated with the Siberian chrono-climatic sequence (after Haesaerts *et al.*, 2005)

during OIS4. Magnetic susceptibility studies yielded an inverted signal attributed to a re-deposition of eolian and alluvial sandy particles (Chlachula, 1997; Evans *et al.*, 2003).

Kurtak and Chani-Bay sequences provided a detailed record of climatic fluctuations during OIS3. Pedological and palynological data document a succession of 14 short interstadial periods dated by more than 100 radiocarbon dates on charcoal and wood remains to between 42,520 and 25,710 ^{14}C BP (Haesaerts *et al.*, 2005). The Malaya-Kheta sub-stage (or Malokheta) is dated from at least 44 ka ^{14}C BP to circa 33 ka ^{14}C BP. It includes six pedogenesis episodes marked by a stabilization of the surface and a diversification of the vegetation cover leading to development of a soil. Chani I to Chani III paleo-soils represent the Tchernakovsky soil which is associated with damp conditions. The upper part is dated circa 44 and 42 ka ^{14}C BP (Drozdov *et al.*, 1990; Haesaerts *et al.*, 2005). Kurtak VIII to V are short interstadial periods interrupted by loess deposition. Ice wedges are observed at the base of unit KP3 and are dated to 31.5 ka ^{14}C BP. A second series of wedges are visible in the P31 Chani Bay section in sub-unit 1-1, dated to around 26 ka ^{14}C BP. The first cold snap is interrupted by the Kurtak IV soil. It is followed by a warming that includes Kurtak III to I interstadials periods, ranging from 31 to 26 ka ^{14}C BP.

To summarize, the Kurtak sequence illustrates four main phases within the Karginian stage that can be correlated with the regional sub-stages (Figure 7). The first one, between 45 and 40 ka ^{14}C BP, corresponds to the Tchernakovsky soil, with a vegetation cover of spruce and pine and relatively humid conditions and could be correlated with the Igarka-Zolotomyskian sub-stage. The second phase, from 40 to 33.7 ka ^{14}C BP, is characterized by a rather unstable climate, less humid, associated with spruce vegetation, and represented by the warmer episodes of Kurtak VIII to VI. It can be correlated with the Malaya Kheta sub-stage. The third phase, between 33.7 and 31.7 ka ^{14}C BP, shows a succession of brief events such as Kurtak V and IV, with a global interstadial climate that can be correlated with Lipovo-Novoselovo sub-stage. The fourth phase shows a progressive climatic degradation between 31.5 to 26 ka ^{14}C BP, marked by two ice-wedge horizons. The first one can be correlated with the Konoschelye cooling and the second one marks the beginning of the Sartan stage.

The Kurtak OIS3 record is part of a general chronostratigraphic system that allows correlations with the Eastern European record. Combining east Carpathian sequences from Molodova V, Mitoc-Malu Galben and Cosautsi, Haesaerts *et al.* (2010) proposed a correlation with the Central Siberian record based on the Kurtak and Afontova Gora sequences. The reconstructed sequence is then correlated with the Greenland climatic record (GISP2) (Haesaerts *et al.*, 2009) and with the pollen sequence from the Dinkel valley, in the Netherlands (Figure 8). The inter-regional sequence covers entirely the period between 42.5 ka ^{14}C BP and 10 ka ^{14}C BP. One of the matches is illustrated by the tundra-gley indicating intense permafrost across regions around 26 ka ^{14}C BP. This episode corresponds to the Heinrich 3 event. Kurtak III/ Molodova 1-II/Malu-Galben 11 are associated with the Greenland Interstadial (GI) 7 and Kurtak II, Ib and Ia with the GI6, 5 and 5b. Another clear landmark is the Tchernakovsky soil, dated to circa 42.5 ka ^{14}C BP, which is represented in the east Carpathian sequence by the Molodova lower complex (sub-unit 8-1) and by the Bohunice soil and the Willendorf interstadial in Central Europe (Haesaerts *et al.*, 1996, 2010).

Heinrich events are a series of brief cold oscillations originally identified in the sea cores from the North Atlantic (Heinrich, 1988) which have also been recorded in Asia. The Late Pleistocene climatic records of the stalagmites from Hulu Cave, in China, display a clear correspondence with the GISP2 marine record. Heinrich events 6 to 1 are recorded and warmer events are linked with an increase of the east Asian monsoon intensity (Wang *et al.*, 2001, 2008). In northern Mongolia, the Dorolj 1 and the Moltynam sequences have yielded crytoturbated gleys that are associated by Bertran and colleagues (2003) with the Heinrich 2 episode, circa 21 ka ^{14}C BP. In the lake Baikal, the sedimentary core BDP-93-2 records seem to illustrate a response to Heinrich events, with a decrease in diatoms production in the delta of the Selenga River. During the Holocene, strong erosion

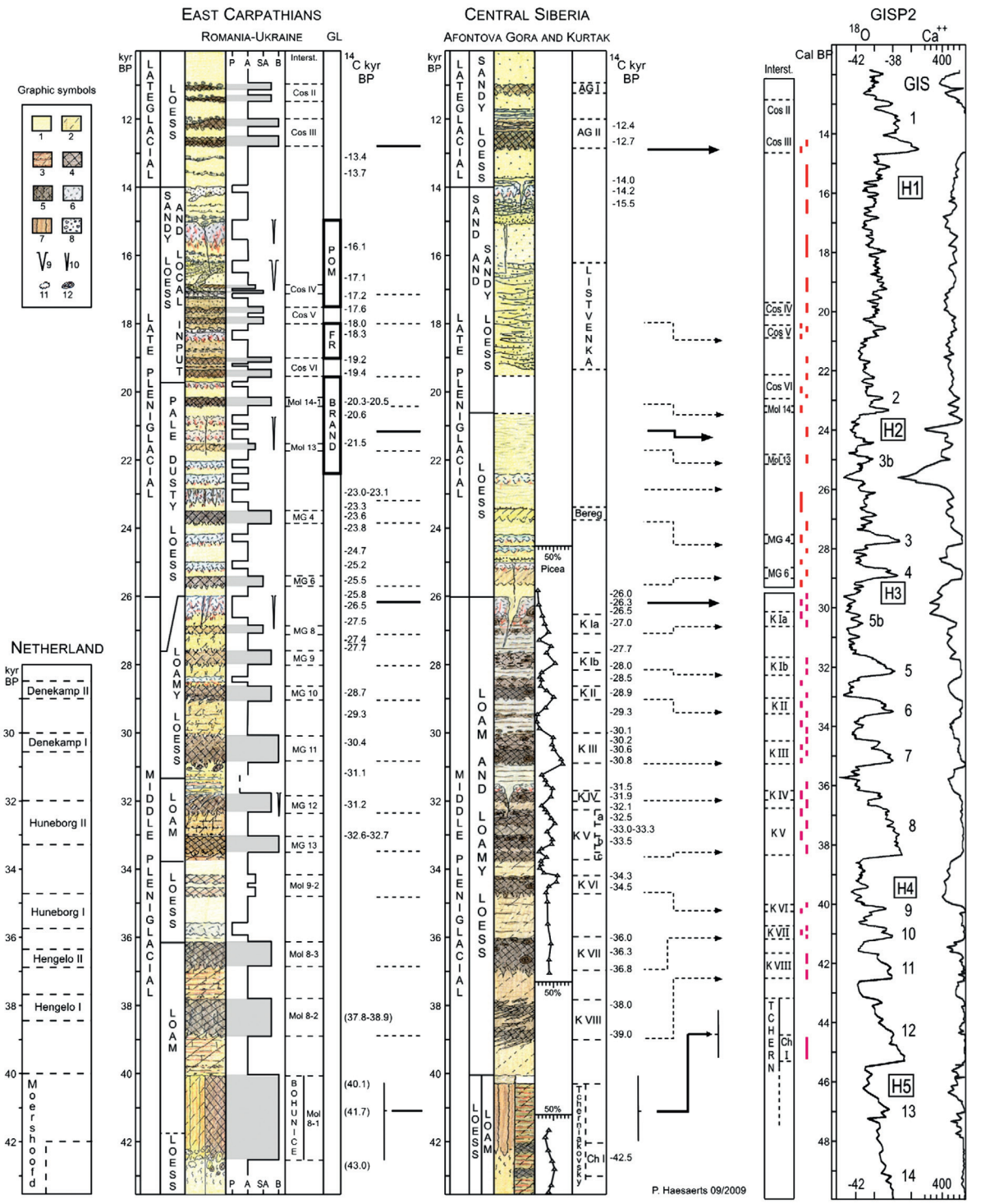


Figure 8: Correlation between the east Carpathian and the Central Siberian sequences, the Dinkel valley pollen record and the Greenland core GISP2 (after Haesaerts *et al.*, 2010)

is associated with the Bond cycles and with the so-called 'Kuzmin effect' (Prokopenko *et al.*, 2001). In central Siberia, the Henrich 4 event is recorded at Kurtak as a loess-like silt horizon (Haesaerts *et al.*, 2009) and marks the end of the Malaya Kheta substage. Heinrich 3 corresponds to the beginning of the Sartan stage and is particularly well marked by a loess-like silt with ice-wedges developing at the base (Haesaerts *et al.*, 2005, 2010). In the Altai, Heinrich events are recorded by magnetic susceptibility in the loess sequences from the Katun and the Biya Rivers (Evans *et al.*, 2003). These events have an climatic impact recognized throughout Eurasia although the nature of the responses is still unclear and may depend on local environmental settings.

All in all, the Late Pleistocene Siberian chronostratigraphy matches with the Northern Hemisphere global climatic record. Sequences from the Altai, Yenisei basin, Baikal Lake and Selenga River delta appear to be in phase with the Oxygen Isotopic Stages. Sub-stage definitions are more problematic; however, Kurtak high-resolution sequence demonstrates that climatic oscillations that correlate with Greenland Interstadials or Heinrich events take place during the OIS3 in Central Siberia. The broad geographic representation of Heinrich events is reinforced by evidence from diatom analysis, magnetic susceptibility and speleothem records. Although environmental responses are expected to show regional or micro-regional variations, synchronous climatic changes are detected from Europe to Central China.

1.4 HUMAN REMAINS

Central and Northeast Asia is vast territory for which a relatively poor fossil record is available for the Pleistocene. This section is a summary and more precise descriptions can be found in the forthcoming chapters. The review of the relevant fossils is presented from west to east, surveying the record from Uzbekistan, Kirghistan and from the Altai.

In Uzbekistan, the site of Anghilak has yielded a human fifth metatarsal (AH-1). The fossil was found in the screens and is derived from a horizon dated to 43,900 ± 2000 ^{14}C BP and 38,100 ± 200 ^{14}C BP (Glantz *et al.*, 2008). It is not diagnostic of a particular taxon but described as relatively gracile. The associated lithic material has Mousterian affinities. At Teshik-Tash, in southern Uzbekistan, human remains (a cranium, a mandible, an atlas, a fragmented axis, clavicles, rib fragments, a left humerus shaft, a partial left femur and fragmented fibula) (Sinelinikov and Gremiatskyi, 1949) have been discovered in a Mousterian context (Okladnikov, 1949). The original hypothesis of a burial could not be confirmed. The sequencing of mitochondrial DNA (mtDNA) extracted from Teshik-Tash remains has confirmed the presence of Neandertals in Central Asia. Further evidence was discovered in 2003 at Obi-Rakhmat, in northwestern Tian-Shan. Six isolated, permanent, maxillary teeth and 121 cranial fragments were uncovered in stratum 16 (Glantz *et al.*, 2008; Glantz, 2010). They are assigned to a single juvenile individual between 9-12 years of age. Although some descriptions of OR-1 underline a mosaic of morphological features, the comparison of discrete attributes from the set of teeth (28 non-metric dental traits scored from Neandertals, UP, and MP modern humans) together with a morphometric analysis of the first-upper molar result in OR-1 being assigned to Neandertals (Bailey *et al.*, 2008). This attribution is reinforced by the study of the bony labyrinth and of the semi-circular canal (Glantz *et al.*, 2008). At the Kulbulak open-air site, an isolated tooth was found in 2009 (Flas *et al.*, 2010). It is associated with an undated UP assemblage from layer 2.1. Mentioned as a worn lower left pre-molar in the first descriptions, it is still under study.

The cave of Sel-Ungur is located in the Fergana valley, in Kirghizstan. Human remains from this site are six teeth and a fragment of humerus. The teeth were tentatively attributed to *Homo erectus* (Islamov *et al.*, 1988). So far, no detailed analysis has been published and the interpretation of some of these remains as human is still to be confirmed. The associated fauna and the 230Th/U date of 126 ± 5 ka (LU-936), obtained on the overlying deposits, assign these finds to the Middle Pleistocene. Although reported as Acheulean, the lithic assemblage is better associated with the pebble assemblages from Tajikistan (Vishnyatsky, 1999). In Tajikistan, recent excavations at Kuhdji have yielded an isolated deciduous tooth

from the bottom of a Mousterian level (horizon 8) dated to 42,100+2,440/–1,870 ^{14}C BP (GrN-23686) by radiocarbon on a charcoal sample. The tooth is worn and not diagnostic of any taxa (Trinkaus *et al.*, 2000). It has been attributed to a juvenile individual of 3 to 5 years old.

At Okladnikov Cave, in the Altai, dental remains occur in stratum 2 with a left lower molar, and in stratum 3 with left lower premolar, a left lower molar and a right lower molar. Post-cranial remains are found in stratum 2, with an adult humerus, and in stratum 3 with a sub-adult humerus and a hand phalanx (Viola *et al.*, 2011). The good preservation of the collagen extracted from the phalanx, from the sub-adult humerus, the femur, and from the adult humerus has led to the reconstruction of the mtDNA sequence which has been identified as Neandertal (Krause *et al.*, 2007). The archeological assemblage is Mousterian but the dating of the human occupation is far from clear (see also Chapter 7). Direct dates would indicate a Neandertal presence in the area lasted until at least 37 ka ^{14}C BP (Krause *et al.*, 2007).

At Strashnaya Cave, eight deciduous teeth were found that presumably belong to a single individual (Viola *et al.*, 2011) from an unclear stratigraphic context that can be attributed to the UP. The specimens could not be assigned to a clear taxon. At Maloyalomanskaya Cave, the discovery of a single human tooth has been reported (Alekseeva and Maloletko, 1984), but no descriptions have been published (Goebel, 2004).

At Denisova Cave, two teeth have been found in the 1984 collection from the central chamber. Denisova 1 is an upper central incisor found in layer 12. Although it has been repeatedly published as a human tooth (Turner, 1990; Shpakova and Derevianko, 2000), Viola *et al.* (2011) assign it to a worn incisor from a large bovid. Denisova 2 is a deciduous molar (right first lower) found in layer 22.1 that would

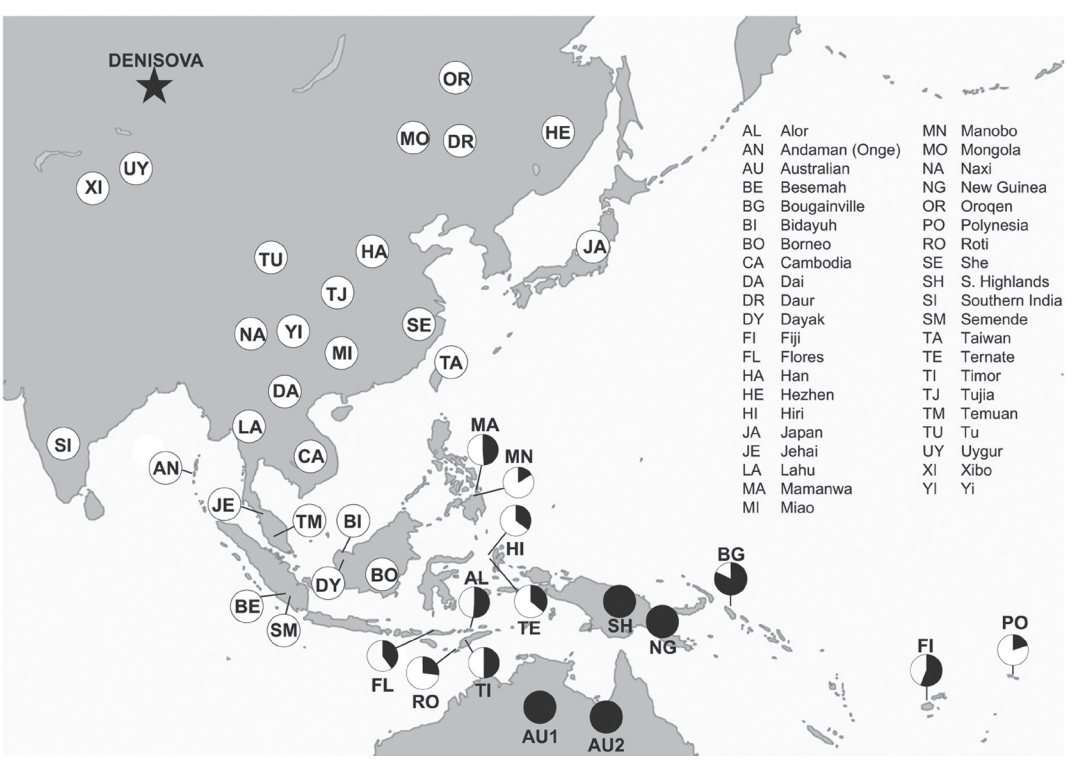


Figure 9: Denisovan genetic material as a fraction of that in New Guineans. The pie-charts show the relative proportions of admixture (after Reich *et al.*, 2011)

date to at least OIS 5e. In 2000, layer 11.1 of the south gallery yielded a tooth in square G2 belonging to a young adult and identified as a third or second upper molar (Reich *et al.*, 2010; Viola *et al.*, 2011). Denisova 3 is the proximal epiphysis of a juvenile manual phalanx uncovered in layer 11.2 of square D2 of the east gallery (Krause, Fu, *et al.*, 2010; Reich *et al.*, 2010; Viola *et al.*, 2011). The phalanx belongs to a distinct individual with an age evaluated at around 6-7 years old. Both mtDNA and nuclear DNA were extracted from these remains resulting in the identification of a hitherto unknown archaic hominin (Krause, Fu, *et al.*, 2010; Reich *et al.*, 2010). The nuclear DNA indicates that these hominins, referred to as 'Denisovans', belong to a lineage sharing a common origin with Neandertals that post-dates the split with MH ancestors. First morphological descriptions of the tooth noted a set of archaic features not seen in Neandertals or in early modern humans, further suggesting a distinct evolutionary history. It was suggested that Denisovans did not contribute significantly to the genome of Eurasian populations except among some present day populations from Melanesia and Australia (Reich *et al.*, 2010, 2011). The geographical pattern observed among populations that presumably took part in the first MH dispersals suggests an encounter between the first MH and the Denisovans on the continent. The latter may have occured prior to the colonization of Melanesia and was likely followed by a population replacement. Genetic evidence appears clustered (Figure 9) but this view has been recently challenged suggesting a more widespread genomic contribution (Skoglund and Jakobsson, 2011).

The fossils from Denisova have not been directly dated but new radiocarbon dates produced on cut-marked bones and bone tools from level 11 show post-depositional mixing from the subsequent level 9 and from underlying levels (Reich *et al.*, 2010). The chronological and cultural attributions of the Denisova hominins remain, therefore, unclear.

At the recently discovered Chagysrkaya Cave, Viola and colleagues (2011) described human fossils associated with layers 6b and 6c. Chargyrskaya 1 is a worn upper deciduous canine and Chagyrskaya 2 is an atlas fragment. Both fossils are associated with layer 6b. Chagyrskaya 3 is an upper premolar and Chagyrskaya 4 is a lower incisor. Both are worn and small and would fall outside the range of Neandertals. However, mtDNA was extracted and, although the results are not fully published, they seem to indicate an attribution to Neandertals (Viola *et al.*, 2011). The rich lithic and fauna assemblage is assigned to the Mousterian and the excavation is still ongoing. Unpublished radiocarbon dates indicate an age circa 45 ka ^{14}C BP and older.

Only a few fossils testify to the presence of MH in Siberia and Mongolia, with the earliest being a frontal bone from Pokrovka/Maly Log dated to around 28 ka ^{14}C BP (Akimova *et al.*, 2010). In western Siberia, a talus bone from the locality of Baigara, dating to over 40,300 ^{14}C BP (Kuzmin *et al.*, 2009), is morphologically close to MH. Human remains from Malta are dated to around 19 ka ^{14}C BP (Richards *et al.*, 2001). In Mongolia, the skull from Salkhit has been described as bearing a mosaic of archaic and modern features (Coppens *et al.*, 2008).

1.5 THE MIDDLE TO UPPER PALEOLITHIC TRANSITION IN THE ALTAI AND THE DISPERSAL OF MH IN ASIA

The following section is a summary of the current models explaining the first appearance of the UP and the appearance and dispersal of MH throughout Asia. The models usually follow a paradigm of local transition sometimes combined with elements of dispersal scenarios.

A local transition model has been repeatedly proposed to explain the emergence of the UP in the Altai. Derevianko (2011) suggested that the Altai was first colonized by small populations of *Homo erectus/ergaster* starting from circa 800 ka, which subsequently disappeared from the region circa 500 ka. The site that represents this first wave is Karama, along the Anuy River (Derevianko and Shunkov, 2009). The lower portion of the sequence has yielded cultural layers (layers 8-14) associated with RTL dates of 643 ± 130 ka and 542 ± 110 ka. The diversity of the exotic flora is said to fit with a Middle Pleistocene at-

tribution (Bolikhovskaya *et al.*, 2006). Although the identifiable artifacts do not include handaxes, Derevianko and Shunkov (2009) underlined elements that would fit with an Acheulean attribution.

Based on the assemblages from the lowermost layers of Denisova Cave, Derevianko (2011) suggests that a new population then settled in the Altai during the Middle Pleistocene at around 300 ka. These newcomers bring the first evidence of Levallois and blade technology. Although first mentioned as Mousterian (Derevianko and Shunkov, 1992; Escutenaire, 1994), they are seen as derived either from a Late Acheuleo-Yabrudian (Derevianko and Postnov, 2004; Derevianko, 2011a) or from a Kazakh/Mongolian MP background (Shunkov, 2005). The Altai MP includes mainly two variants. Based on low Levallois indexes and on high frequencies of Mousterian elements, Shunkov (Shunkov, 1990, 2005) recognizes a Mousterian variant opposed to a Levallois-Mousterian variant. These two variants were interpreted as possibly reflecting different settlement patterns of a single MP tradition (Derevianko and Shunkov, 2002; Shunkov, 2005). Mousterian assemblages which are only represented in cave sites would represent long-term occupations as opposed to the Levallois-Mousterian seasonal occupations from open-air contexts. A behavioral ecology approach was further developed by Wrinn (2010). Based on the occurrence/absence of formal tools or chips testifying to tool rejuvenation or raw material management (Kuhn, 1995; Adler and Tushabramishvili, 2004), he classifies these MP occupations into three main categories: ephemeral/task specific, ephemeral generalized and intermittent generalized occupations. His analysis of the fauna and of the lithic frequencies suggests a low intensity of occupation of the region which could have served as a refugium for hominins during cold phases (Wrinn, 2010).

Recently, Derevianko and Markin (2011) suggested that Okladnikov Cave and the newly discovered Chagyrskaya Cave illustrate the existence of a distinct MP facies which they call the Sibiryachinsky variant. The described characters correspond to the above mentioned Mousterian variant, and this facies is seen as relatively late and intrusive. The Sibiryachinsky assemblages are said to represent Neandertal populations moving into Central Asia (*e.g.* Teshik-Tash) and subsequently to the Altai under the pressure of the spreading MH populations (Derevianko, 2011a).

The local Levallois-Mousterian is said to have gradually evolves into two main UP variants, the Ust-Karakol and the Kara-Bom variants (Derevianko and Volkov, 2004). Both UP trends are seen as the result of an incipient evolution from a local Middle Paleolithic background and are contemporaneous with the Sibiryachikha Mousterian tradition (Derevianko, 2011a). These variants can be described as follows:

- The *Ust-Karakol* variant emerged at the beginning of OIS3 from a Levallois background assigned to OIS5e at Ust-Karakol 1, sector 2, (layers 19-18), with preferential and orthogonal unidirectional flaking and a unidirectional and volumetric blade production. The late phase of the process sees the parallel invention of microblades detached by pressure flaking, circa 60-50 ka (Derevianko and Volkov, 2004; Derevianko, 2011). Other assemblages from Anuy I-III, Strashnaya upper levels, Tyumechin-4 and Ushlep 6 are associated with the Ust-Karakol trend. Due to the presence of Dufour retouched bladelets and of carinated endscrapers, scholars have suggested that the Ust-Karakol assemblages represent the early developments of the Aurignacian techno-complex (Otte and Derevianko, 2001; Otte and Kozlowski, 2003; Otte, 2004) while other authors found some analogies with the UP of western Siberia (Zenin, 2002) or Mongolia (Jaubert *et al.*, 2004; Derevianko and Kandyba, 2009a; Gladyshev, Olsen, *et al.*, 2010). Although the use of pressure flaking is reported by Derevianko and Volkov (2004), other authors do not formally recognized this technology in any of the Ust-Karakol assemblages. Kuzmin (2007) and Keates (2007) suggested that the Ust-Karakol trend could be seen as the origin of microblade technology.

- The *Kara-Bom* variant from the eponymous site is said to follow a different evolutionary path. In the MPH1 and MPH2 layers of this site, convergent and unidirectional Levallois following the recurrent method was used to produce elongated

pointed blanks (Derevianko, Petrin, *et al.*, 1998; Derevianko, Petrin, and Rybin, 2000; Derevianko and Markin, 1999; Rybin, 2004). Rybin (2004) considers that this technology lacks antecedents in the region and could correspond to a migration of populations from the Levant. It is represented in Central Asia by laminar MP assemblages such as Kuhdji in Tajikistan or Obi-Rakhmat in Uzbekistan. In Kara-Bom levels OH5 and OH6, blade cores were reduced by bidirectional flaking from a broad surface with a use of a narrow face tentatively associated to the end of the reduction process (Derevianko and Volkov, 2004). The upper layers testify to a UP reduction in which cores are reduced from the narrow face. This variant illustrates a distinct technological transition process, from a surface to a volumetric conception of the core.

The central chamber of Denisova Cave was repeatedly described as non-Levallois (*e.g.* Derevianko, Markin, *et al.*, 2001; Derevianko *et al.*, 2003; Derevianko and Shunkov, 2005) but later was said to illustrate the gradual developement of the 'Ust-Karakol trend' (layers 20-12), between 100 ka and 30 ka, toward genuine UP (layers 11 and 9) (Derevianko, 2011a). The late phase includes the early appearance of bone tools, and fully developed forms of ornaments made of bone and stone (Derevianko and Rybin, 2003; Derevianko *et al.*, 2003; Derevianko, Shunkov, *et al.*, 2008). The Kara-Bom variant is also described in Kara-Tenesh, Maloyalomanskaya Cave or in the Byike complex. Numerous authors have suggested analogies with sites from Central Asia (Obi-Rakhmat, Kuhdji), the Cis-Baikal (*e.g.* Makarovo-4, Kistenevo 9), Trans-Baikal (*e.g.* Khenger Tyn 2, Barun-Alan, Khotyk, Kamenka A and C, Varvarina Gora, Podzvonkaya) or Mongolia. Although he underlined that UP 'culture' spread all over Siberia around 40 ka, Derevianko (2011) also states that the Altai MP cannot be excluded as its possible source.

Regarding the origin of MH, Derevianko (2011) recently stated that if the Late Pleistocene humans were members of the *Homo sapiens species sensu lato,* they consists of sub-species such as *H. sapiens africanensis* (Africa), *H. sapiens neandertalensis* (Europe), *H. sapiens altaiensis* (Siberia, Mongolia, Central Asia) and *H. sapiens orientalensis* (Southeast Asia) (see also Derevianko and Shunkov, 2011). The developing *H. sapiens altaiensis* represented by the Denisovans (Krause, Fu, *et al.*, 2010; Reich *et al.*, 2010) descend from unknown migrating populations coming from the Near-East at around 300 ka. They would eventually evolve independently into MH, represented by the remains from Pokrovka/Maly Log (Akimova *et al.*, 2010). *H. sapiens altaiensis* is also assigned to southern Siberia as a whole, to Central Asia, and to Mongolia but is seen as independent from Southeast Asian evolution. By arguing for a local biological and cultural evolution toward modernity, Derevianko's view can be seen as part of the multi-regionalist model (Thorne and Wolpoff, 1981; Wolpoff *et al.*, 1984):

> '…archeological data demonstrate that the appearance of *Homo sapiens sapiens* in Eurasia in general was not caused by a long-range migration from Africa, although some amount of gene flow from Africa to the Near-East and to Europe during various periods cannot be denied.' (Derevianko, 2011a, p.479)

Regarding the origin of *H. sapiens altaiensis*, Derevianko tends to emphazise gene flows between the Denisovans and the ancestor of modern Melanasian populations. He argues that there is no evidence consistent with a MH migration from Africa. Instead, he suggests an uninterrupted regional development of MH with a rather limited migration-range (Derevianko, 2011b). The multi-regional hypothesis as defined by Wolpoff *et al.* (1984), however, combines local drifts and multidirectional gene flows. As opposed to Coon's interpretation (1962) which implies a polyphyletic model of independent evolutionary trends, the candelabra hypothesis (Weidenreich, 1947) originally suggested a monophyletic, multiregional model that includes contacts and interbreeding between populations. The apparent continuity of the local archeological sequence plays an important role in Derevianko's model which considers no signs of long-range migrations (Derevianko, 2011b). Multi-regionalist views have been frequently expressed to explain the emergence of MH in southeast Asia (Wolpoff *et al.*, 1984; Wang and Tobias, 2001; Etler,

2004) and its possible subsequent dispersal from east to west (Otte, 2007).

The Out-of-Africa model posits that MH originated in Africa and subsequently dispersed around the globe. This model is supported by a significant body of chronological (Clark *et al.*, 2004; Grün *et al.*, 2005), morphological (*e.g.* Brauer, 1984; Stringer *et al.*, 1984; Schwarz and Tattersall, 1996; Tattersall, 2006) and genetic data (see review in Krause *et al.*, 2007; Green *et al.*, 2010; Krause, Briggs, *et al.*, 2010; Rasmussen *et al.*, 2011) and is one of the most popular models to explain the appearance of MH in Europe and in the Near-East. According to this model, two routes have been proposed to explain the peopling of Asia by MH.

The 'northern route' crosses through Central Asia reaching the Altai by following the northwestern Tian-Shan. Based on the archeological material, Goebel (Goebel, 1999, 2006) argues for a quick dispersal of MH during the initial phase of the UP. He also suggests analogies with assemblages from the Near-East. A similar scenario was proposed by Rybin (2004) to explain the sudden emergence of the Levallois blade-based assemblages in the Altai (see also Krivoshapkin *et al.*, 2006). Hoffecker (2005) proposed that the northern route was also followed earlier by Neandertal populations when migrating into Asia. In China, numerous fossils dating to the late Middle Pleistocene have been described as "Archaic *H. sapiens*" (*e.g.* Bae, 2010). However, some authors have underlined the ambiguities of such a taxon arguing that it is used as a kind of "wastebasket" (Tattersall and Schwartz, 2008). The recent publication of the Zhirendong, mandible which shows a mosaic of modern and archaic morphologies, is dated to more than 100 kyr, and was discovered outside of a UP context, illustrates this equivocal situation (Dennell, 2010; Liu *et al.*, 2010). Early blade industries are rare in China, with some of the earliest examples of Shuidonguou dated to 29 ka ^{14}C BP (Madsen *et al.*, 2001; Brantingham *et al.*, 2004)

Another route of MH dispersal possibly pre-dates the northern route. The so-called 'southern route' (Stringer et al, 2000; Oppenheimer, 2004, 2009; Field and Lahr, 2005; James and Petraglia, 2005; Oppenheimer *et al.*, 2006; Field *et al.*, 2007). MH would have left Africa through the Bab-el-Mandeb strait to Arabia and Iran and then followed the Indian coasts down to Southeast Asia. The recently published material from Jebel-Faya has been used to suggest that southern Arabia was colonized during OIS6-5e but also during OIS5a. A land bridge was open between Arabia and Iran via the Hormuz strait for a period ranging from 75 to 14 ka (Armitage *et al.*, 2011; Rosenberg *et al.* 2011). So far, the described Arabian lithic assemblages (*e.g.* Amirkhanov, 2006; Rose and Usik, 20010; Petraglia *et al.*, 2010; Petraglia *et al.*, 2011) seem to differ from the Zagros UP (Olszewski and Dibble, 1994; Olszewki and Dibble, 2006; Otte and Kozlowski, 2007; Otte *et al.*, 2007, 2011) or MP (Dibble, 1984; Dibble and Holdaway, 1990, 1993; Olszewski *et al.*, 1993). Petraglia *et al.* (2007) have tried to show that MP human occupation persists at Jwalapuram through the Youngest Toba Tuff eruption that occurred at circa 74 ka (see also Haslam *et al.*, 2011; Petraglia, Ditchfield, *et al.*, 2011). This view, however, has been recently challenged (see Balter, 2010). The latter assemblages are not associated with human remains, but based on analogies with MSA lithics it has been suggested that they might represent the first evidence for MH dispersal (Clarkson *et al.*, 2011). Based on the sequence from the Jwalapuram locality 9 rockshelter (India) (Haslam *et al.*, 2010), Clarkson *et al.* (2011) documented the occurence of microliths at around 35-30 ka. The appearance of this technology has been interpreted as a response to the increasing aridity leading up to the LGM (Petraglia *et al.*, 2009) and seen as continuity with the local MP. However, Mellars (2006) underlined the similarities with the backed microliths of Howiesons Poort assemblages from South Africa and suggested that the first appearance of microliths represents evidence for the migration of MH out of Africa. Earliest evidence of archeological occupations found in Fa Hien Cave, Sri-Lanka, is dated to 38-36 ka and is associated with microblades and MH remains (Petraglia *et al.*, 2009). MH remains are directly dated to circa 42 ka at Niah Cave, in Borneo (Barker *et al.*, 2007). Australia is reached by at least 45 ka, as shown by luminescence dates and human remains from Lake Mungo (*e.g.* Bowler *et al.*, 2003; O'Connell and Allen, 2004). Hoffecker (2005) suggested that MH diffusion through Asia along the southern route might

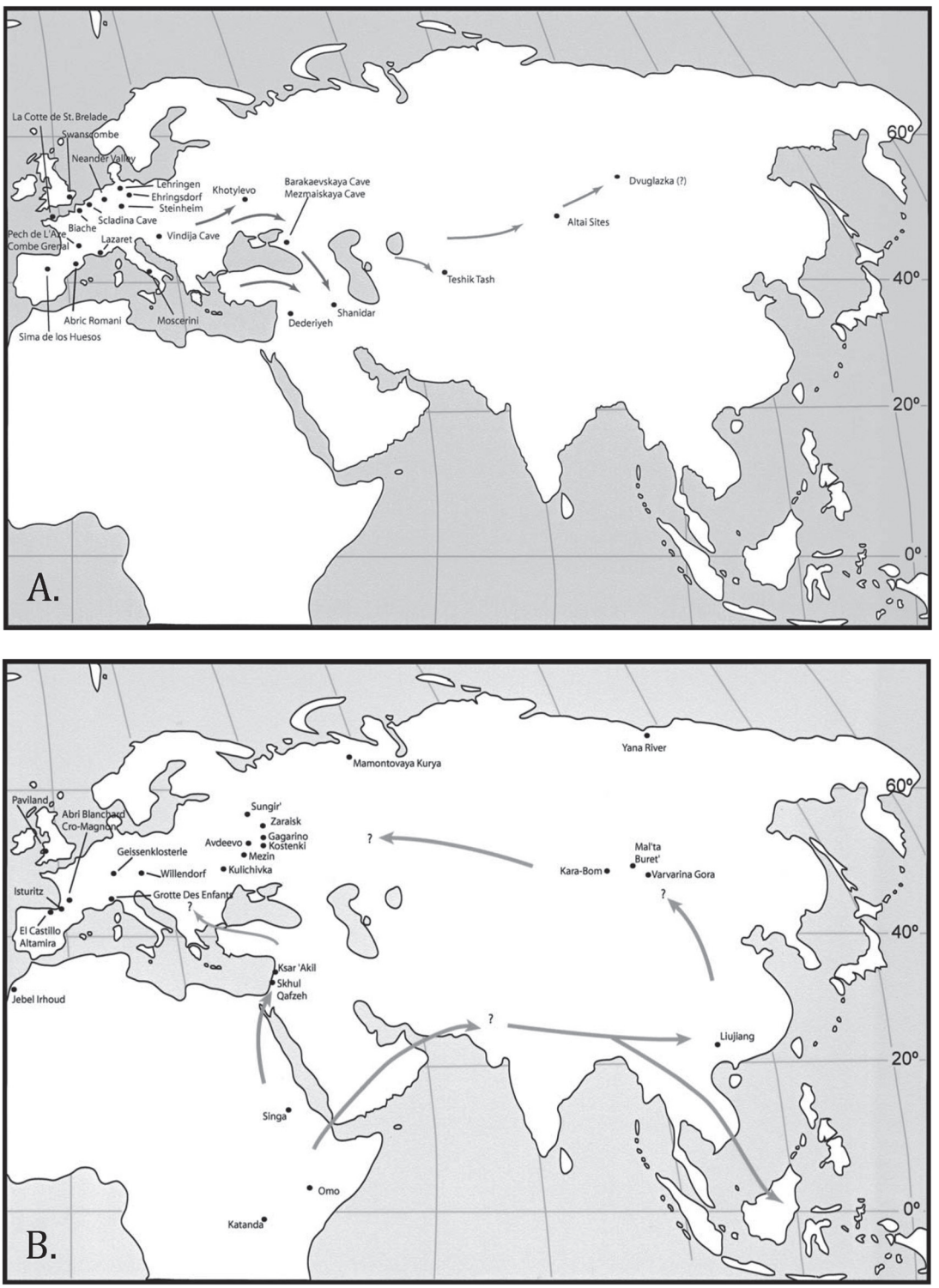


Figure 10: Schema of Neandertal (A) and MH (B) dispersals through Asia (after Hoffecker, 2005)

be followed by a colonization of Northeast Asia through northern China, Mongolia and then Siberia (Figure 10).

1.6 SUMMARY

The Altai region has yielded a cluster of MP and UP stratified sites that have been recently excavated using a multidisciplinary approach. These sequences provide key-evidence illustrating changes in material culture corresponding to the shift from the MP to UP. In Europe, this phenomenon is associated with the replacement of Neandertals by MH. Based on the Altai data set, scholars have put forward different scenarios regarding the transition processes, ranging from hypotheses of local evolution to migrations. The most developed model proposes a parallel development of two distinct UP traditions that both emerged from a local MP background (Derevianko, 2010). In this model, the MP strata from Denisova Cave show a locally-developed Levallois blade-based UP tradition which also occurrs at the open-air site of Kara-Bom. Simultaneously, the Ust-Karakol tradition testifies to a different path leading to the Upper Paleolithic, with some techno-typological similarities with the European Early Upper Paleolithic. In addition, the Chargirskaya tradition represents an intrusive late Mousterian facies, overlapping chronologically with the first occurrence of the Upper Paleolithic in the area. This model of local continuity is, however, contradicted by paleontological and genetic evidence.

Questions remain regarding who was responsible for making these tool technologies. Recent developments in ancient DNA studies have shown that Neandertals were present in the Altai around 40 ka (Krause *et al.*, 2007), associated with Mousterian assemblages. However, a previously unknown genome was sequenced, demonstrating the presence of another type of hominin in the region, the so-called 'Denisovans' (Krause, Fu, *et al.*, 2010; Reich *et al.*, 2010). The presence of MH is confirmed by at least 28 ka in Siberia (Akimova *et al.*, 2010).

1.7 TRANSITIONAL, INITIAL OR EARLY UPPER PALEOLITHIC: WHY IT MATTERS

Assemblages displaying a combination of MP and UP technological and typological features represent a taxonomical challenge. In the Near-East, they were recognized in the first half of the 20th century in the Northern Levant from sites such as, Ksar-Akil, Antalia shelter, Abu-Halka or Emireh Cave (Neuville, 1934; Haller, 1946; Garrod, 1951, 1955). Early excavated sites did not provide sufficient stratigraphic resolution for detailed interpretation (Kuhn, 2003), however, similar assemblages have been recently documented at Üçagizli, Umm el-Tlel (*Paleolithique intermédiaire*)(Boëda and Muhesen, 1993; Bourguignon, 1998), and as Jerf-al-Ajla and also in the Southern Levant at Boker Tachtit, Tor Sadaf (Fox, 2003) and Tor Fawaz (see also Belfer-Cohen and Goring-Morris, 2003). Some authors (*e.g.* Azoury, 1986; Marks and Ferring, 1988; Gilead, 1991) considered these assemblages as 'transitional', not only in the sense that they occur in an intermediate chrono-stratigraphic and taxonomic position between the MP and UP technocomplexes, but furthermore that they clearly indicate a local development toward UP from a MP substrate. Yet, the presence of transitional assemblages implies *de facto* that the transition happened in the region. Some other authors have underlined this latter assumption as problematic and have suggested that it should not be stipulated in a given typological name (Kuhn, 2003).

Although stressing that transitional assemblages should not be merely studied for themselves, Marks (1990, p.71) suggests the term of Initial Upper Paleolithic (IUP) to describe an arbitrary stage within the transition continuum:

> '… Therefore, the Ksar-Akil sequence, with all its problems, provides the best view we have of what I would consider as Initial Upper Paleolithic. After all, in any continuum the breaks are arbitrary and imposed by those studying it. Where better to begin the Upper Palaeolithic than with a technology where virtually all core reduction is pointed toward blade production? The Levallois-like points

> of Boker Tachtit, Level 4, and Ksar-Akil, 25-21, are really no more than pointed, symmetrically converging blades …'

It is clear that a transition defined as a continuum implies a continuity in the human occupation and the documentation of a gradual technological shift. On the one hand, the difficulty in demonstrating continuity may reflect the discontinuous nature of the archeological record (Marks, 1990) and the chronological assignment of assemblages most often relies on radiometric data with large uncertainties (Kuhn, 2003). In the Levant, in spite of a rich record, UP continuity with the MP *sensu stricto* remains difficult to demonstrate (Kuhn, 2003). On the other hand, the Boker Tachtit sequence underlines the possibility of a gradual technological transition (Marks, 1983; Marks and Volkman, 1983) in this region. Apparent discontinuity is also the result of significant and observable behavioral changes. Compared to older blade assemblages (*i.e.* Tabun D type), IUP technology is chiefly blade based at the expense of other reduction methods (Meignen, 2007). Convergent blanks tend to be laminar and the toolkit presents a majority of UP types. Although less frequent than in the subsequent EUP, ornaments and bone tools appear for the first time in the archeological record during the IUP (Kuhn *et al.*, 2001). The combination of these changes justifies the use of an arbitrary label such as IUP. It is more descriptive than interpretative and does not imply (or exclude) a local emergence of the described behaviors.

The IUP differs from the EUP as the latter exhibits consistent technological characteristics of UP behaviors such as volumetric blade and bladelet production but also a more abundant production of formal bone tools and ornaments. Bladelets may represent a behavioral shift toward the adoption of composite projectiles (Bon, 2005; Teyssandier *et al.*, 2010). In Europe and in the Near-East, this stage is represented by the Proto-Aurignacian/Early Ahmarian and by the Aurignacian (Le Brun-Ricalens *et al.*, 2009; Tsanova *et al.*, 2012). In these regions, EUP assemblages show only rare evidence of MP traits, if present at all.

It is understood that the IUP show regional variations and the use of this terminology in the present study does not necessarily imply a cultural connection between assemblages. How the different forms of IUP are related is still unclear and this specific issue should be the subject of additional research. The need to identify the initial occurrence of UP in a given regional sequence is reinforced by the idea that MH first dispersed through Europe (*e.g.* Tostevin, 2000, 2003; Bar-Yosef, 2003, 2007; Hoffecker, 2009; Müller *et al.*, 2011) or Asia (Rybin, 2004; Armitage *et al.*, 2011; Clarkson *et al.*, 2011; Haslam *et al.*, 2011; Rose *et al.*, 2011) before developing the whole set of UP behaviors. The use of the IUP terminology becomes even more relevant outside of the Near-East where evidence of MP to UP continuity is more disputable (Tostevin, 2000, 2003; Nigst, in press). The variability observed among assemblages can no longer be seen exclusively as evidence for various regional transitional processes as it could also reflect distinct dispersal events taking place during a narrow time span. In this context, it is crucial to rely on a more precise, clearly defined and neutral terminology.

These assignment of assemblages to a particular type will be further discussed in Chapter 9 as 'Transitional', IUP and EUP labels have been used to describe some of the assemblages in question (*e.g.* Dereviankо, Petrin, and Rybin, 2000; Brantingham *et al.*, 2001; Rybin, 2004; Zwyns *et al.*, 2011).

1.8 FORMULATING RESEARCH QUESTIONS

The model of local transition proposed by Dereviankо is a scenario in which two populations confined in a closed environment following parallel biological and cultural evolutionary paths toward modernity is unique. Archeological data play a major role in the construction of the model which is articulated around three main ideas. First, two blade-based UP variants have been defined in the region based on their laminar technology. Second, two different and contemporaneous gradual transition processes were described in the eponymous sequenses of Kara-Bom and Ust-Karakol 1. The third key idea is that interregional comparisons based on lithic assemblages

and chronological data support a local-evolution scenario but may also indicate a spread of the UP variants across Northeast Asia. Having formulated these three statements, it appears that the proposed model can be tested through the study of laminar technology of relevant assemblages.

The present analysis is based on a sample of lithic material from the two main eponymous sequences where the variants have been defined, the open-air sites of Kara-Bom and Ust-Karakol 1. Additional assemblages of Anuy II and Anuy III have been studied in order to enlarge the sample. Only open-air sites have been selected in order to facilitate the taphonomic analysis and to obtain comparable results. The study follows a three-tiered approach designed to test three hypothesis but also to propose an alternative model. First, the integrity of the sample is assessed based on a taphonomic analysis. Second, the lithic material is described using a combination of quantitative and qualitative methods. Third, the data set is used to support a reconstruction of the laminar reduction sequences with a special emphazises on features that may illustrate technical traditions rather than strict economic factors.

This study addresses three main research questions derived from the current model:

- *Question 1 – are there two distinct UP variants in the region:* a taphonomic assessement and a detailed technological analysis on selected assemblages would provide a better understanding of their similarities and differences. A technological analysis of blade reduction systems is applied but with a focus on small laminar elements. This allows a refined definition of the variants and a test of the validity of a division in two variants as defined in the published material.

- *Question 2 – is there a chronological overlap between of these UP variants:* While transitional assemblages have often been described in different parts of the world, convincing examples of sequences illustrating long term gradual transition are rare. Therefore, the claim of parallel developments of two distinct UP traditions in the same region needs to be tested as it does not appear parsimonious. Transitional assemblages are often defined as presenting features from both the MP and UP, underlining the need for a taphonomic assessment of their integrity in stratified sequences. Chronological and chrono-cultural issues can then be addressed.

- *Question 3 – what is the geographical distribution of the variants?* Although the UP traditions are said to be the result of a local development, long distance comparisons are proposed with the neighboring regions to the west (Central Asia) and further east (Baikal area, Mongolia). These analogies are said to support the absence of long-range migrations. In light of the refined definitions of the UP variants, the geographic limits of the techno-complexes are discussed. The idea is to test whether inter-regional comparisons are consistent with a model of UP local development or if they could support other models of diffusion.

1.9 PROPOSING AN ALTERNATIVE MODEL

Archeological data have been used to support a local development of UP behavior but also an independent biological development of MH which is at odd with the genetic and paleontological data. Based on the results obtained from addressing the three above-listed questions, an alternative model is proposed. The present study confirms the existence of two significantly different UP techno-complexes but it does not support the idea of a synchronous and parallel development. Instead, the data are consistent with a chrono-cultural model of diachronic succession. It is argued that the current data support the existence of an Initial Upper Paleolithic (IUP), or Kara-Bom variant that may overlap with the end of the Altai Mousterian and with both techno-complexes disappearing from the region prior or during the Heinrich 4 climatic event. The Early Upper Paleolithic (EUP), or Ust-Karakol variant, occurs for the first time in the region, during or soon after Heinrich 4. This regional model can be tested easily with the acquisition of new chronometric data. Regional and inter-regional comparisons do not support the idea of a local

transition *sensu stricto*. It is instead consistent with several intrusions from the Central Asian lowlands, even if some of them may have developed regional differences. The striking analogies between the Altai IUP and assemblages from the Baikal shores and from northern Mongolia suggest a model in which long distance population movements/contacts were established by the beginning of OIS3. Although the chronology is still coarse-grained, the timing of the first appearance of the IUP in Northeast Asia is contemporaneous with the apparent dispersal of the Bohunician throughout Europe and also with the first appearance of MH in Southeast Asia.

1.10 STRUCTURE OF THE STUDY

Following this introductory chapter, the study is organized around three main chapters:

In Chapter 2, a detailed presentation of the methodology used in the analysis is presented. It provides definitions and references that will help the reader to understand the terminology used in the analysis, in the presentation of the results and in the subsequent discussion.

Chapters 3 and 4 present the data analysis. The data set is analyzed quantitatively and qualitatively and the raw results are presented with the help of a minimum of references. In other words, the results discussed are specific to the present analysis. Chapter 3 deals with the material assigned to the Kara-Bom Upper Paleolithic variant and Chapter 4, with the Ust-Karakol Upper Paleolithic variant.

Chapter 5 compares the obtained results with the previously published analyses. The Kara-Bom variants and the Ust-Karakol variants are then respectively assigned to Initial Upper Paleolithic and Early Upper Paleolithic. Arguments to support this analytical classification are presented in Chapter 6 and are discussed in Chapter 9.

Chapters 6, 7 and 8 address questions formulated above. In Chapter 6, a research question is addressed by comparing the main characters of the two technical traditions. The latter support the assignement of the Upper Paleolithic variants to IUP and EUP. Chapter 7 addresses the second research question. An alternative model is formulated and tested with a critical review of the regional record based on publications and personal observations. Finally, a third research question in Chapter 8 by a more general review of the inter-regional context that also includes personal observations.

The last part, Chapter 9 consists of a general discussion summarizing and interpreting the results in the frame of broader debates. It is followed by a brief conclusion and by some suggestions regarding future directions of research.

2 – Terminology and data recording

In this chapter, the methodology used to record and interpret the data is described. The technological analysis is based on an attribute analysis supporting a reconstruction of the reduction sequences. Attributes recorded on blanks and on cores are selected in order to describe specific technical decisions that can lead to the identification of technical traditions. Regarding the terminology, appropriate references or definitions are provided when they are specific to the presented study. Some methods of classification have been designed for the purpose of this work, and require some additional explanation.

2.1 TAPHONOMIC APPROACH

One of the main concerns of the present study is to obtain reliable technological and chronological data that would allow testing historical-cultural hypotheses. In the framework of a discussion involving so-called 'transitions', taphonomic issues are particularly important as they can explain the coexistence of MP and UP features in a given assemblage (*e.g.* Tsanova, 2008). For these reasons, a conservative taphonomic approach is applied to a selection of the material studied and to the interpretation of the results. Assemblages for which a taphonomic assessment was possible have been studied in a quantitative and qualitative fashion. Practically, the methods used were adapted to the assemblages and mainly consist of technological and breakage refits and spatial distribution of artifacts (Tixier, 1978; Cahen *et al.*, 1980; Cziesla, 1990; Bordes, 2000; Morin *et al.*, 2005; Tsanova, 2008). Assemblages for which the integrity could not be assessed are described qualitatively, and the results are interpreted accordingly.

2.2 THE SAMPLING

The lithic analyses presented here focus on laminar elements, trying to reconstruct the production systems and the observable relationships between other systems of blank and tool production. Assemblages have been selected when laminar elements are described as dominant in the original publications. The analysis is performed on a sample of material selected from stratified and recently excavated sites for which artifacts were individually piece-plotted. Thus, samples may show differences with the previously published artifact counts. Retouched and unretouched blades and bladelets are recognized, following definitions from Tixier (1967) and Tixier *et al.* (1980). Are considered as blades and bladelets elongated flakes with parallel/sub-parallel edges for which the length is at least equal to twice their width. Bladelets are arbitrary characterized by a width of less than 12 mm. All identifiable fragments were included. All forms of identifiable blade and bladelet cores were selected for this study. In all cases, the goal was to obtain attribute values from a representative sample depending on the availability of the material at the time of the study. It was not always possible to reach a sample size significant enough to allow a quantitative attribute analysis. Thus, some of the samples are described in more general and qualitative terms. In light of the results obtained by the attribute analyses performed on significant samples, some additional material may be discussed. In this way, artifacts that may first appear more problematic (*e.g.* taphonomy, layer attribution) can sometimes be re-introduced into the discussion. In such situations, they will not be included in the sample but rather considered separately.

2.3 ATTRIBUTE ANALYSIS AND REDUCTION SEQUENCE

To describe the material, a combination of two main approaches is used: attribute analysis and reduction sequence approach.

2.3.1 ATTRIBUTE ANALYSIS

Attribute analysis describes quantitatively and qualitatively independent features observed on the artifacts in order to build a representative dataset with respect to the variability in the assemblage. The onset of this approach can be traced back to the post-second world war period. From 1945 to the late 60's, human sciences showed a general interest in statistical and mathematic methods. Some archeologists followed the movement and tried to apply quantitative methods to artifact analysis (Bordes and Bourgon 1951; Heinzelin 1960; Laplace 1966; Hodson 1966, 1970). At the beginning of the 1960s, the development and spread of computers in the academic world contributed to the success of quantitative analysis (for more details see also Djindjian, 2009) which was also promoted by processual archeology (Binford and Binford, 1966; Clarke, 1973, 1978; Binford, 1979). Based on the idea of numerical taxonomy, this method can be applied following either a typometric approach (*e.g.* Spaulding, 1953; Movius *et al.*, 1968; Hahn, 1977; Djindjian and Vigneron, 1980; Gob *et al.*, 1987; Noiret, 2009) or a technological approach (*e.g.* Dibble, 1995; McPherron, 1999; Tostevin, 2000). Statistical and typometric analyses applied to Paleolithic artifacts are also known in the Eastern European and Central Asian literature since at least the 1940s (*e.g.* Bonch-Osmolowski, 1940; Suleimanov, 1972; Medvedev, 1981; Medvedev *et al.*, 1981; Kaikhunova, 1985). Based mostly on metric measurement, this method significantly improved the objectivity of lithic analyses which previously relied on poorly defined categories.

When following a technological approach, attributes may be recorded on all artifacts from a given archeological level. In doing so, the analyst tries to avoid considering a priori one type of blank as the goal of the production, without rejecting the idea of a distinction between intentional blanks and by-products. As Dibble notes (1995: 112-113), one cannot understand a core reduction by looking only at the cores, as they represent only the final stages of the process. Following the same reasoning, it would be difficult to tackle the issue of blank selection by looking only at the tools. In this situation, one option is to include some of the flakes usually described as 'by-products' or to record attributes on all elements from the assemblage.

However, in the context of a blade-based assemblage, such an approach sometimes leads to a practical dilemma. Considering all artifacts as potentially intentional seem more objective (Dibble, 1995a) and supported by a more robust theoretical background. Depending of the research goals, it can also be misleading. Considering all categories of lithic artifacts equally could underline economic factors that would mask specific features of the technical tradition. As a matter of fact, artifacts are not equally informative regarding the reduction sequence and some can be clearly ubiquitous. For example, in the case of a blade production on a raw material site, it is likely that shaping flakes would be numerous compared to the blades or cores that would be exported. Their frequency could lead the analyst to consider the sample as reflecting a 'flake-based' assemblage but blade cores or blades, although less numerous, would remain esantial for the reduction sequence reconstruction. Moreover, a single artifact can sometimes be considered as 'precocious' (Tostevin, 2003) but it may also be a key for understanding the rest of the assemblage. On the contrary, flakes are often well represented but are ubiquitous elements. In fact, based on blank frequencies, one can expect that no matter the period considered, most of lithic assemblages may come out as 'flake-based'.

Yet, in looking at a limited sample of such an assemblage, the probability of obtaining reliable economic reconstructions is very low. Archeological assemblages are samples, as the spatial extension of a 'site' often remains unknown and as most of the lithic accumulations reflect palimpsests. Whether the poor representation of a given type of artifact is the result of an 'invention' which failed to become

an 'innovation' (Hovers, 1998; Tostevin, 2003) can rarely be determined only based on intra-assemblage variability.

The described methodology is adapted to a technological analysis of the laminar productions. Given the nature of the archeological record, issues related to technical traditions are addressed instead of testing techno-economic models. This approach allows a certain degree of flexibility in the attribute analysis requirement. For these reasons, it was judged unecessary to include all blanks in the database. Assuming that laminar production will show technological traditions, a targeted attribute analysis is adopted, focusing on laminar elements that support further reconstructions of reduction sequences. Mixed, too small and too large assemblages have been studied only qualitatively. This was done so that a maximum of the existing assemblages could be included in the analysis.

2.3.2 REDUCTION SEQUENCE

The reduction sequence approach is used to propose an analytical reconstruction of the blank production processes. The concept of operational sequence *(chaine operatoire)* was introduced in Western European archeology by the work of Leroi-Gourhan (1943, 1945), himself inspired by Mauss (Mauss, 1967) (see also Schlanger, 1990). Reduction sequence analysis became popular among French Paleolithic archeologist (*e.g.* Geneste, 1985; Pigeot, 1987; Boëda, 1988, 1990, 1994; Boëda *et al.*, 1990; Pelegrin, 1995) but also elsewhere (*e.g.* Schiffer, 1975; Jelinek, 1991; Bar-Yosef and Meignen, 1992; Van Peer, 1992; Marks and Monigal, 1995; for more see also Bar-Yosef and Van Peer, 2009), and it offers an alternative to the classic typological approach. Interestingly, the concept seems to rise by convergence, independently in the English and in the French-speaking world (Sellet, 1993; Shott, 2003). It can be summarized as follow: if one considers that an artifact when uncovered represents the last stage of its uselife, by reconstructing the steps taken from the selection of the raw material through to discard of that artifact, the material constraints encountered and the technical options followed by the knapper can be analyzed (Pelegrin *et al.*, 1988). Due to raw material physical properties, conchoidal fractures are printed in stone artifacts, leaving characteristic traits (Cotterell and Kaminga, 1986; Bertouille, 1989). Traces of percussive events are then recorded through these observable traits. This set of features allows the determination of the point of origin of the percussion, the direction taken by the removal and the chronology of the previous removals (Dauvois, 1976; Boëda, 1984; Pelegrin, 2005). Basically, the reduction sequence approach relies on lithic technology but integrates the notion of a chronology between technological actions. Observations recorded on large series of artifacts may provide short sequences that represent fragments of one or more reduction sequences (Tixier *et al.*, 1980; Pigeot, 1987; Ploux, 1991; Karlin, 1992; Pelegrin, 1995, 2005) deciphered by reconstructing the chronology of removals (schema diacritique) (Dauvois, 1976; Boëda, 1986; Pigeot, 1990) or through refits (Volkman, 1983; Pigeot, 1987; Cziesla, 1990; Davidzon and Goring-Morris, 2003; Skrdla, 2003b). Practical experiments play an important role by proposing reconstructions of the techniques and methods used during the knapping process. According to Tixier (1967), the techniques include all physical factors involved in the flaking as the methods are assimilated to the systematization within a given assemblage of reduction sequences.

The French *chaine operatoire* concept differs from the American 'behavioral chain' (Schiffer, 1976) as it includes the notion of intentionality. During the reconstruction of the sequence, the analyst infers the goal of the production from the material he observes. This particular aspect of the concept has led researchers to investigate cognitive issues through technological analysis and is probably the most controversial (Sellet, 1993). The well-known case of Biache St. Vaast (level IIa) shows that Boëda's technological reading identified two main reduction strategies (Boëda, 1988) but fails to recognize the relationship between the two (Dibble, 1995a). Based on the same material, Dibble's combination of attribute analysis and reduction sequence analyisis establishes a direct relationship between stages of reduction and the strategy in use. For Boëda, the different strategies represent clear-cut mental templates whereas Dibble insists more on the flexibility of the process. The two

also differ in the degree of quantification with Boëda giving less importance to metric attributes.

Although in some cases, experimental by-products, end-products and cores seem highly consistent with archeological data, Dibble notes (1995: 107) that experimental knappers can use different techniques and methods to reach the same goal. Then, without the support of an attribute analysis, the accuracy of the reconstruction becomes a matter of chance, underlining the limits of the approach. Bar-Yosef and Van Peer (2009) provide another convincing example of discrepancies between the reconstructed reduction sequence and the refitted block from Taramsa 1. Among the points they underline, they suggest that the model based on the observation of technological attributes sometimes artificially isolate reduction sequences, which when observed on the refits, coexist on the same block. This situation is expected when one considers fragments of reduction sequences as evidence for strictly independent methods. Long refitted sequences provide another picture, demonstrating combinations and sometimes a hierarchy of methods on the same block. Unfortunately, the nature of the sample and more generally of the site rarely offer the optimal conditions required for refitting long sequences.

Some authors suggest that attribute analysis and reduction sequence approaches show strong and weak points and are more efficient when considered as complementary (Tostevin, 2003; Bar-Yosef and Van Peer, 2009; Torre and Mora, 2009; Stout *et al.*, 2010). When dealing with arbitrary samples, the risk to miss a part of the techno-economic system exists whatever the approach in use. Due to the nature of the sample considered, the present study follows the assumption that the laminar technology is representative (but not exclusive) of the selected assemblages and their technical traditions. A clearly defined set of attributes recorded on blanks, retouched tools and cores is used in order to support the reconstructed reduction sequences. An attempt is made to find a suitable balance between the requirements of the method and the necessity to deal with a representative sample. Ultimately, the goal is not to tackle cognitive issues, but rather to point out the recurring technological choices, which beyond environmental and economic constraints, may testify to a technical and social identity (Leroi-Gourhan, 1964; Pelegrin *et al.*, 1988; Lemonnier, 1992).

2.4 ARTIFACTS GENERAL CLASSIFICATION

Samples are described according to a general classification reference works such as Tixier *et al.* (1980) and Inizan *et al.* (1995) for technology and Brezillon (1968), Demars and Laurent (1992), Debenath and Dibble (1994) and Bordes (Bordes, 1961) for typology. The goal of this classification is to provide an overview of the assemblage prior to more detailed analysis. As here mainly laminar elements are considered, only a few arbitrary classes are used for analytical purposes. Artifacts are classified as blade (length= 2 x width and >12 mm width), bladelet (length= 2 x width and <12 mm width) and microblade (length= 2 x width and <6mm), core and retouched tools. Microblades are, therefore, classified based on their width and do not necessary imply pressure flaking. Occasionally, artifacts on flakes are recorded when they present a specific preparation of the platform or have a particular technological interest related to blade production (*e.g.* core tablet, fronto-lateral flake). Results obtained on the samples are later integrated into the research background and compared with the published material.

2.5 ATTRIBUTE ANALYSIS: BLANK ATTRIBUTES

Assemblages from open-air sites for which laminar elements have been described as dominant in the original publications are selected. Attribute analysis is applied in order to describe the laminar technology. Practical and controlled experiments have provided a set of qualitative and quantitative attributes which are considered useful for the identification of knapping techniques and methods, mainly by observing features on the archeological material (Tixier, 1967; Tixier *et al.*, 1980; Cotterell and Kaminga, 1986, 1987; Whittaker, 1994; Pelegrin, 1995;

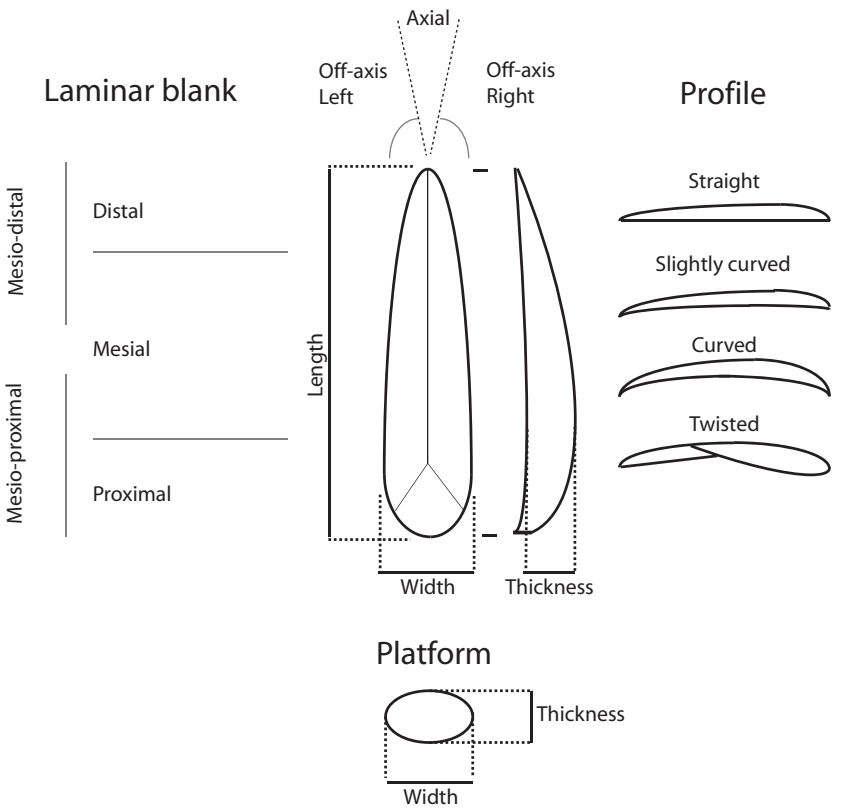


Figure 11: Breakage, size, platform size, orientation and profile attributes

Pelcin, 1997a, 1997b; Odell, 2000, 2001; Andrefsky, 2005; Dibble and Rezek, 2009; Rezek *et al.*, 2011). For the blanks, these attributes are recorded on each individual artifact. The description includes the state of preservation, size, cross-section, profile, platform size and morphology, dorsal scar patterns, orientation, retouch locations (on which face), retouch dorsal and ventral location (along which edges, on which parts), angle of retouch, morphology of retouch, type and additional attributes. In the following section, the attributes recorded are described in detail.

- Breakage: fragmentation of the blanks can occur during knapping activities (Inizan *et al.*, 1995) but can also reflect trampling or other taphonomic processes affecting the assemblage (McBrearty *et al.*, 1998). This attribute is recorded in order to infer the minimum number of individual (MNI) blanks in a given sample (Hiscock, 2002). The results of the attribute analysis can be compared between the MNI sample and the overall sample to detect possible repetition of measurements or dorsal scar pattern descriptions. Blanks are grouped in several categories according to their degree of breakage. Fragments are considered as proximal or distal when only the end of a blank is preserved. Mesio-distal and mesio-proximal fragments have one end preserved and additionally a significant part of the blank itself. Mesial fragment have neither end preserved. Complete elements are unbroken. The MNI corresponds to the sum of proximal, mesio-proximal and complete elements.

- Size: all measures are in millimeters and rounded to one decimal. Measurements are recorded using a Mitutoyo electronic caliper 500-17X-20 (150 mm) using E4 software linked to an MSaccess database (oldstoneage.com). The length, width and the thickness are measured at their maximum.

The length is measured only when the specimen is complete.

- Profile: profiles of laminar elements have been here classified qualitatively according to their general morphology. This description is based on previously published analysis of blade and bladelet assemblage (*e.g.* Brezillon, 1968; Bon, 2002; Bordes and Tixier, 2002; Le Brun-Ricalens and Brou, 2003; Le Brun-Ricalens, 2005; Chiotti, 2005; Teyssandier, 2006). Categories are mainly based on the degree of curvature of the blank and classified as curved, slightly curved or straight. One additional category groups blanks showing a twisted profile, where the torsion affects the proximal end of the blank and extends to at least the mesial part.

- Cross-section: the cross-section is characterized in order to determine if one or more ridges are guiding the removal (Tostevin, 2003). Combined with the dorsal scar patterns it provides insights into the general morphology of the core flaking surface. Sections are observed in the mesial part of the blank and are classified as flat, rectangular, triangular, trapezoidal or polyhedral.

- Platform size and preparation: platforms are described according to their size and to their preparation. Platform width is the distance between the two lateral platform edges. Platform thickness is the maximum platform thickness. Only complete and identifiable platforms have been measured. In addition, platforms have been grouped into formal categories such as plain, facetted, dihedral flat, dihedral convex and punctiform (Inizan *et al.*, 1995). Platforms are considered as highly informative from a technological point of view. Results of controlled experiments have demonstrated the existence of a linear relationship between the platform area (platform width x platform thickness) and the blank surface area (blank Length x Width) (Dibble, 1995b, 1997). According to controlled experiments, thickness of the platform may predict the morphology of blanks. A thick platform combined with an inward striking movement increases the probability of obtaining a overshot blank (Cotterell and Kaminga, 1986, 1987; Pelcin, 1997a). Knapping experiments suggest that in the case of direct percussion on flint, the thickness of the platform is linked to the type of hammer (Bordes, 1947; Pelegrin, 1995). A soft hammer (organic) catches the edge of the platform *(percussion tangentielle)* which is flattened by a thin abrasion prior to striking. The platform of the blank is therefore relatively thin. A lip is often observed when the platform is thicker, testifying to a more inward movement (Roche and Tixier, 1982; Pelegrin, 1995). By contrast, hard hammer percussion requires an inward movement *(percussion rentrante)* inducing a thicker platform. Softstone hammers (*e.g.* limestone, sandstone) seem to represent an intermediate technical solution for which the platform thickness seems to overlap with both hard and soft hammer percussion. A significant smoothing of the external platform edge by intensive abrasion, literally rounding the angle, seems to be required for the use of such hammers in producing blades (Pelegrin, 2000). However, as Pelegrin notes (1995: 67-68), only the combination of several criteria allows a discrimination between hard and soft hammer. The characteristics of hard hammer includes the occurrence of an impact point (hertzian cone), thick bulb (sometimes with ripples) and relatively thick platform (>4 mm). Soft hammer is more likely associated with a smooth and elongated bulb (especially when numerous ripples are visible), absence of a clear impact point on the platform, thin platform (<4 mm) and a thin abrasion of the external edge of the platform (1995: 67-68). More recently, experimental and archeological studies on bifacial tool production using limestone hammers have underlined the difficulty of quantifying such attributes (Roussel, 2009). An identification of the percussion technique is proposed here (when possible) as a hypothesis, based on the size and the morphology of the platform, the occurrence of a lip, and preparation of the external platform ridge. In addition, the presence of a percussion cone and flaking of the bulb are sometimes observed.

- Dorsal scar pattern: The dorsal scar patterns allow for a determination of the point of origin of the percussion, the direction taken by the removal and the chronology of the previous removals (Dau-

vois, 1976; Boëda, 1986; Pelegrin, 2005). When the dorsal face is cortical, has a crest or a secondary crest *(sous-crête),* the blank is associated with the initial stage of reduction. In the course of reduction, transversal or longitudinal bending may require core management operations. These can be identified by the presence of neo-crests *(néo-crête)* (Pelegrin, 1995). When visible, ripples and radial fissures *(lancettes)* show the direction taken by the previous removals. The chronology of removals *(schéma diacritique)* is based on the presence of radial fissures, which occur along both scars from the last removal, along one scar from the previous ones, or not at all (Inizan *et al.*, 1995). In addition, the last removal sometimes leaves a deeper negative. The superposition of removals can be more or less visible depending on the case, and it is not always possible to reconstruct their chronology. Considered as a whole, the set of dorsal features provides data regarding the reduction system in use, however, they are sometimes misleading. For example, if the blanks are produced by short, alternate, unidirectional sequences (*i.e.* switching to the opposed platform after a couple of removals), they will tend to appear as strictly unidirectional. Bidirectionality will be more likely visible if the sequence is of more than three removals per platform. In other words, as here we do not restrict bidirectionality to a platform switch after *each* removal (alternate platform), the frequency of bidirectional scars observed will under-estimate the number of blanks produced by such a system. As Pelegrin (1995: 122) notes, in the case of direct percussion, bidirectional removals can also testify of a hierarchy between a main platform, from which elongated blanks are removed, and a secondary one. The latter is interpreted as distal preparation for the production of straight blanks. These preparations are identified according to their morphology, to the context of the assemblage (*e.g.* frequent occurrence of similar preparation on the cores), and to the preparation of the platform from which they are removed. Moreover, as several reduction sequences can be in use on the same nodule, features observed on dorsal scar patterns have to be compared with the other recorded attributes.

- Orientation: orientation is described qualitatively in order to determine if the laminar reduction is oriented toward the production of axial, off-axis elements *(déjeté)*, or randomly orientated elements. Orientation is qualitatively recorded from a reconstructed axis drawn from the center of the platform. Blanks are then classified as off-axis on the right side, on the left side, or axial.

- Retouch location (face): retouch is located according its direction (Tixier *et al.*, 1980; Demars and Laurent, 1992) either dorsal (direct), ventral (inverse), both dorsal and ventral (alternate), or randomly distributed (sporadic).

- Dorsal retouch location (edge): when retouch is observed on the dorsal face, it is located according to its position along the edges. The terminology described for the breakage attribute is used, including all possible combinations. Right and left edges are identified with the percussion point observed or inferred (in the case of fragment) at the bottom.

- Ventral retouch locations (edge): when retouch is observed on the ventral face, it is located according to its position along the edges. As for the dorsal face, the terminology described for the breakage attribute is used, including all possible combinations. Right and left edges are identified from the dorsal face.

- Angle of retouch: retouch is described by the angle it takes with the section view of the artifact (Barnes and Kidder, 1936; Brezillon, 1968; Demars and Laurent, 1992). However, definitions vary depending of the authors. Here we use: flat (<30°), thin (30°-60°), semi-steep (60-80°), steep (90°), or possible combinations. Angles are not measured but rather evaluated.

- Morphology of retouch: the morphology follows Brezillon (1968) and is described as marginal, scalariform, notch (only when it bears several notche removals on the top of each others), denticulate, abrasion retouch (when it is linked with abrasive contact).

- Type and additional attributes: the above-listed attributes were recorded for all artifacts studied. However, depending on the context, general observations on the material may provide additional data. Features such as flaking on the bulb, the occurrence of percussion cone and of a macroscopic lip on the ventral face were recorded. When the sample was not significant enough to justify a quantitative data recording, a more general set of decriptive observations was used. Dealing here with partial samples, occurrence of cortex on the blanks is recorded but not quantified. When possible, retouched tools are typed using standard typology (Bordes, 1961; Brezillon, 1968; Demars and Laurent, 1992; Debénath and Dibble, 1994).

Attribute	Attribute value
Breakage	distal
	Mesio-distal
	Mesial
	Mesio-proximal
	Proximal
	Complete
	Undetermined
Size	Length
	Width
	Thickness
Profile	Straight
	Slightly curled
	Curved
	Twisted
	Undetermined
Cross-section	Flat
	Triangular
	Trapezoidal
	U-shaped
	Rectangular
	Polyhedric
	Undetermined
Platform size	Thickness
	Width
Platform preparation	Plain
	Facetted
	Dihedral Convex
	Dihedral flat
	Punctiforme
	Cortical
	Undetermined
Dorsal scar pattern	Unidirectional
	Unidirectional+cortex
	Unidirectional+distal crest
	Unidirectional parallel
	Unidirectional convergent
	Bidirectional
	Crest
	Neo-crest
	Second crest
	Undetermined
Orientation	None
	Right
	Left
Retouch location (face)	None
	Direct
	Inverse
	Alterne
	Sporadic
	Undetermined
Dorsal retouch location (edge)	Proximal
	Proximal right
	Proximal left
	Mesio-proximal
	Mesio-proximal right
	Mesio-proximal left
	Mesial
	Mesial right
	Mesial left
	Mesio-distal
	Mesio-distal left

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	Mesio-distal right
	Distal
	Distal right
	Distal left
	Undetermined
	Combinations
Ventral retouch location (edge)	Proximal
	Proximal right
	Proximal left
	Mesio-proximal
	Mesio-proximal right
	Mesio-proximal left
	Mesial
	Mesial right
	Mesial left
	Mesio-distal
	Mesio-distal left
	Mesio-distal right
	Distal
	Distal right
	Distal left
	Combinations
	Undetermined
Angle of retouch	Flat (<30°)
	Thin (30°-60°)
	Semi-steep (60°-80°)
	Steep (90°)
	Combinations
	Undetermined
Type of retouch	Marginal
	Scalariform
	Notch
	Denticulated
	Abrasion retouch
Type and additional attributes	

Figure 12: Blank attribute list

2.6 ATTRIBUTE ANALYSIS: CORE ATTRIBUTES

As for the blanks, cores are described following a series of technological and morphological attributes (Figure 15). Artifacts are considered as cores only when they display unambiguous signs of preparation or intentional removals.

For the cores, a list of attributes is established that may or may not be completely recorded, depending on the artifact. Core attributes include the type of blank, initial preparation, back, flaking surface, size (nodule), size (flaking surface), size (last removal), profile (last removal), orientation (last removal), striking platform/flaking surface angle (=External Platform Angle), striking platform preparation, external platform ridge preparation, flaking surface maintenance, maintenance removal location, lateral maintenance type, lateral maintenance orientation, reduction pattern, Mode, type and additional attributes. Core attributes can be divided in two main categories. A series of attributes is related to the general morphology of the core (type of blank, initial preparation, etc…). The other series is related to the flaking surface. In case of two flaking surface, both are described equally with all measurements and observations being done twice. When possible, up to two complete last removals per flaking surfaces are described independently.

- Type of blank: the type of blank on which the core is produced. Blocks are identified according to the general morphology of the blank and the occurrence of natural surface or primary cortex. Pebbles are identified by their rounded edges and the occurrence of neo-cortex. Slabs are flat nodules *(plaquette)*. Flakes are identified when the blank shows a length smaller than twice the width, blades show a length larger than twice the width and parallel edges, and laminar flake is an intermediate class with atypical specimens from the flake and blade category and includes elongated flakes. Crested elements are identified following Pelegrin's description (1995). Thick flakes bearing on their edge semi-circular traces of previous blade removals are considered as core tab-

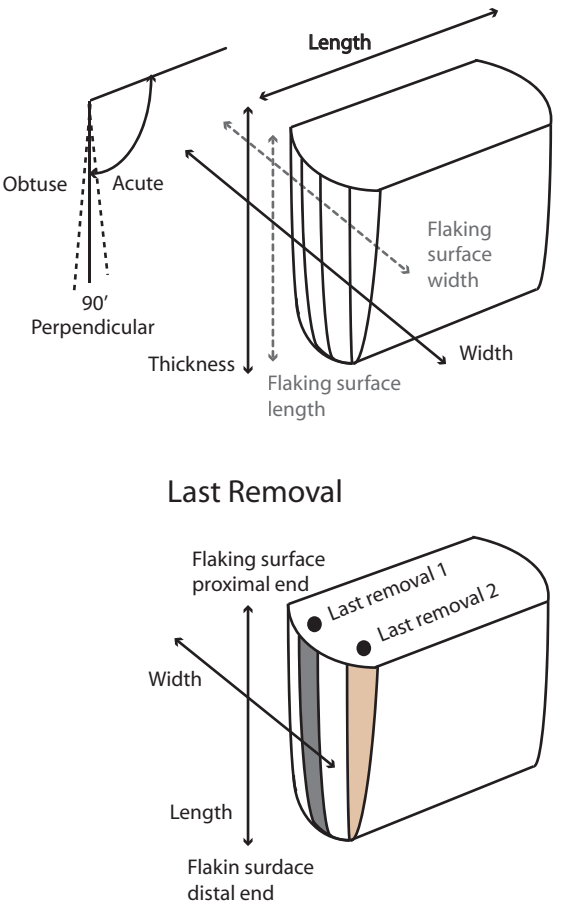


Figure 13: Core measurements

lets. Those negatives have to be relatively wide to avoid confusions with facetted platforms.

- Initial preparation: when visible, the first steps of the reduction are indentified, mainly decortification flaking, primary crests, primary flaking (removal exploiting natural crest or the convenient morphology of the nodule), and removals shaping the nodule in order to obtain a proper longitudinal or transversal convexity or angle to start the reduction process. This type of feature is not always preserved on the core at the point of discard but may be observed more easily on preforms and prepared nodules.

- Back: the back of the core corresponds to the face opposed to the striking surface. The preparation of the back may play a role in the management of the flaking surface convexities (Pigeot, 1987). In bidirectional cores, or cores bearing more than one flaking surface, the back may not be preserved. Natural (natural surface), cortical, prepared (shaped by flaking), crested (Pelegrin, 1995) and ventral (being the ventral face of the blank) are distinguished.

- Flaking surface: flaking is classified according to the scar patterning as unidirectional, bidirectional, two opposed striking platforms, two separated striking platforms (when two flaking surfaces are treated independently) and radial (removals turning around the periphery of the core and oriented toward the center of the flaking surface).

- Size: size is measured in millimeter and rounded at one decimal. Measures are recorded as illustrated in Figure 13.

- Size of the flaking surface: the flaking surface, when complete, is measured independently in mm (see Figure 13). Similar measures are recorded on the second flaking surface, when separated from the first one. In the case of two-opposed striking platforms, the flaking surface is treated as a whole

- Size of the last removal: when a complete last removal is preserved, length and width are measured (see Figure 13).

- Profile of the last removal: if a complete last removal is preserved, profiles are recorded according to the standards used for the blanks (see Figure 13).

- Last removal orientation: in case a complete last removal is preserved, orientation is recorded following the standard applied to the blanks (see Figure 13).

- Striking platform/flaking surface angle: the angle created by these two surfaces is qualitatively characterized. An angle of more than 95° is described as obtuse, between 95° to 85° as perpendicular, and less than 85° as acute. Angles are not measured but evaluated.

- Striking platform preparation: the qualitative values used here are borrowed from previous studies and defined following Inizian *et al.* (1995). Reshaped platforms correspond to striking platforms for which a tablet or partial tablet can be observed.

- External platform ridge preparation: this attribute describes the type of macroscopic modifications occurring at the intersection between the flaking surface and the striking platform. Abrasion is recognized as a light smoothing on the proximal part of the flaking surface (Pelegrin, 1995), flaking corresponds to the removal of small flakes perpendicular to the flaking surface *(facettage)*, and bladelet corresponds to negative(s) of laminar removal(s) observed on the flaking surface itself.

- Flaking surface maintenance: corresponds to a negative which can be clearly associated to a management operation. This interpretation is based on a combination of attributes, such as the marginal location of a removal or a major morphological difference (large and thick flake removed after/during a blade reduction process or an overshot removal) or the production of a neo-crest to reshape the longitudinal or transversal convexities of the flaking surface (cfr. supra). Taking into account the subjectivity of this observation, it is recorded only when a combination of two criteria is observed. In this case, we classify the type of removal based on the morphology of the negatives, as a flake, a blade, a bladelet, a laminar overshot, a crest or a partial crest.

- Maintenance removal location: corresponds to the location of the maintenance removal negative on the flaking surface, on the distal or proximal part. In addition, the removal is qualified as axial, oblique or perpendicular to the flaking surface.

- Lateral maintenance: as for the flaking surface, some lateral removals appear clearly involved in the maintenance of convexities. In this case, we classify the type of removal, based on the morphology of the negatives, as a flake, a blade, a bladelet, or as laminar overshot.

- Lateral maintenance location: removals are placed on the right or the left side (from the striking platform), and as proximal, distal or perpendicular.

- General reduction pattern: the general reduction pattern is an overall observation of the reduction orientation, qualified as parallel, convergent, or a combination of both based on the flaking surface morphology.

- Mode: cores are classified into descriptive modes according their general morphology (Figure 14). Mode A is groups all cores produced on blocks, nodules, slabs or flakes. Modes A1 and A2 are cores showing a flaking surface on their narrow face, A3 and A4 on their broad face, A5 and A6 two independent flaking surfaces, A7 and A8 two-independent and perpendicular flaking surfaces,

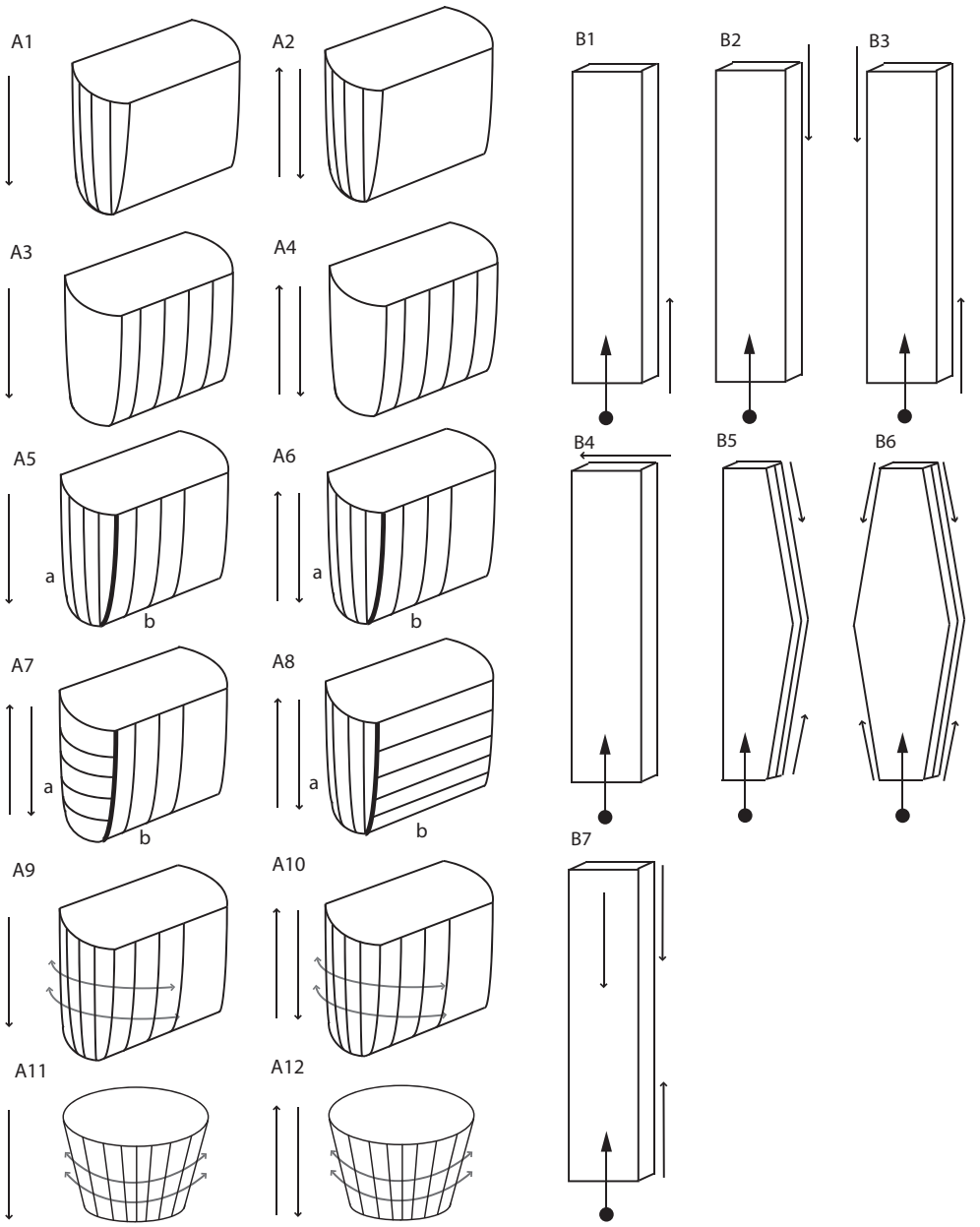


Figure 14: Classification of cores by Modes

A9 and A10 showing a semi-turning *(semi-tournant)* flaking surface (see *e.g.* Pigeot, 1987), and A11 and A12 show flaking surface turning around the core. Mode B groups the cores produced on blades. B1 and B2 show unidirectional removals following the longitudinal axis of the blank along a single edge and struck from a single platform, and B3 shows bi-directional longitudinal removals along two independent edges and struck from two different platforms. B4 show a flaking surface perpendicular to the axis of the core blank. B5 and B6 show respectively a sinle or two bidirectional

Attribute	Attribute value
Type of blank	Block
	Pebble
	Slab
	Flake
	Laminar flake
	Blade
	Crested blade
	Neo-crested blade
	Second-crest
	Tablet
	Other
	Undetermined
Initial preparation	Decortification
	Primary crest
	Primary flaking
	Primary shaping
	None
	Combinations
	Undetermined
Back	Natural
	Cortical
	Prepared
	Crest
	Ventral
	Combinations
	Undetermined
Flaking surface	Unidirectional
	Bidirectional
	Two opposed platforms
	Two separated platforms
	Radial
	Others
Size	Length
	Width
	Thickness
Size flaking surface	Length
	Width
Size last removal	Length
	Width
Profile last removal	Straight
	Slightly curved
	Curved
	Twisted
	Undetermined
Last removal orientation	None
	Right
	Left
	Undetermined
Striking platform/ Flaking surface angle	Acute (<90°)
	Perpendicular (90°)
	Obtuse (>90°)
	Undetermined
Striking platform preparation	Plain
	Facetted
	Reshaped
	Dihedral flat
	Dihedral convex
	Punctiform
	Linear
	Undetermined
External platform ridge preparation	None
	Abrasion
	Flaking
	Bladelet
	Undetermined
Flaking surface maintenance	Flake
	Blade
	Bladelet
	Overshot laminar
	Crest
	Partial crest
	Undetermined
Maintenance removal location	Distal
	Proximal
	Perpendicular (90°)

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	Distal perpendicular
	Distal oblique
	Undetermined
Lateral maintenance type	Flake
	Blade
	Bladelet
	Overshot laminar
	Undetermined
Lateral maintenance orientation	Right perpendicular
	Left perpendicular
	Right striking platform
	Left striking platform
	Right distal
	Left distal
	Combinations
	Undetermined
Reduction pattern	Convergent
	Parallel
	Combinations
	Undetermined
Mode	A1-A12, B1-B7
Type and additional attributes	

Figure 15: Core attribute list

flaking surfaces along narrow edges of the core blank. B7 indicate that the core has flaking surfaces on both narrow and broad faces.

- Type and additional attributes.

2.7 REDUCTION SEQUENCE

In this study, the reduction sequence reconstruction is based on data obtained through the attribute analysis. Basic concepts of reduction sequence (RS) are used, such as a chronological description of the different steps (in continuity or not) of the production of laminar elements (*e.g.* Geneste, 1989). Detailed techno-economic reconstructions and cognitive aspects are not directly addressed here.

For analytical purposes, the lifetime of an artifact can be divided in four main stages, ranging from raw material procurement to discard:

- Raw material procurement: raw material can be collected from a primary outcrop (site of formation of the material) or secondary outcrop (site where the material has been transported from the primary outcrop).

- Technology: this step includes the preparation of the nodule/core, the production of the blank, retouch and resharpening, and all the byproducts of these operations.

- Use: artifact is used either directly where it was produced or on another location. It can be included with other elements in the production of a composite tool. Among others, cores, blanks, byproducts or retouched elements can be used, and then retransformed before being reused.

- Discard: eventually the artifact is discarded, either on the site where it was produced or at another location. After the discard, the artifact can subject to various post-depositional processes.

As shown in Figure 16, these stages are sometimes interconnected and should not be considered as clear-cut chronological steps. This study aims to identify complex dynamics between stages especially when they repeat through time and space.

2.8 REDUCTION SEQUENCE RECONSTRUCTION

The following section summarizes the methodology used to reconstruct the RS. The four levels of analysis presented below run from the detailed description toward to more synthetic reconstructions.

The first level of analysis is devoted to the identification of short sequences through the description of

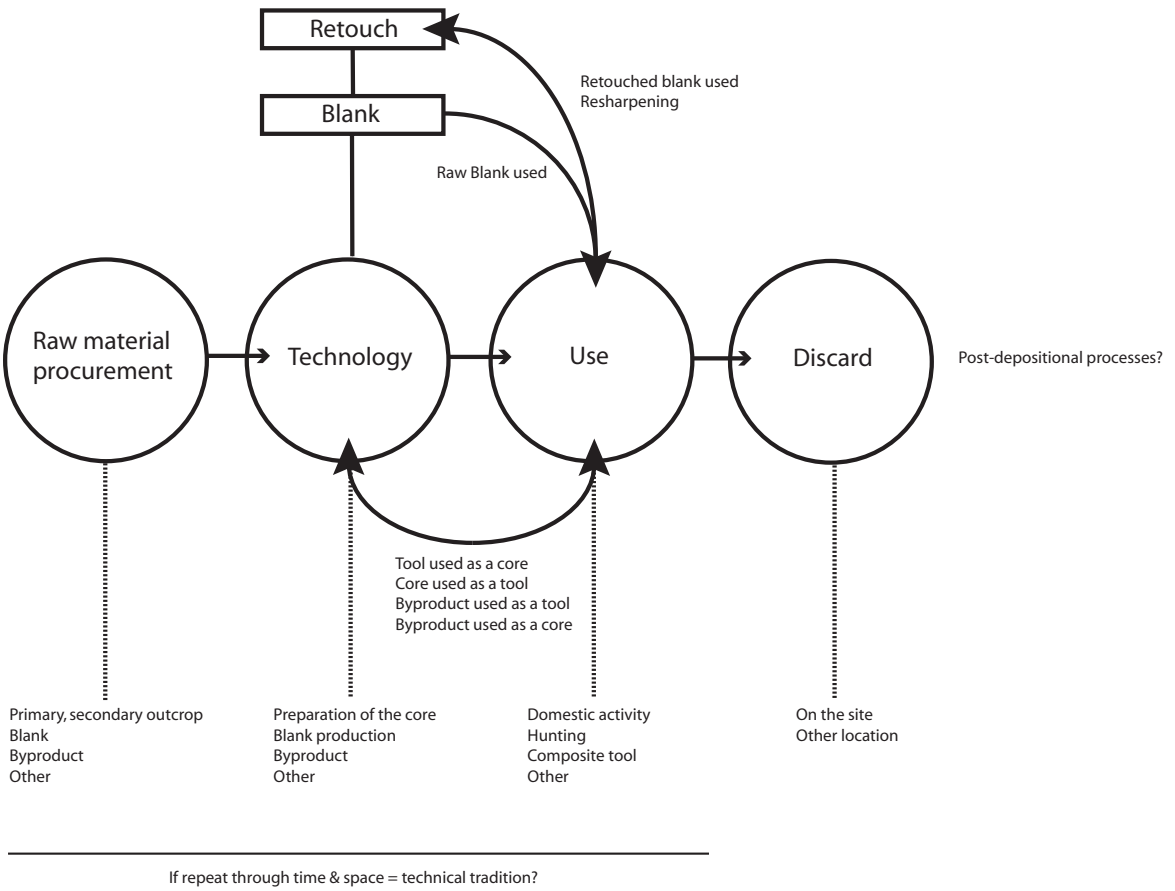


Figure 16: Example of a theoretical reduction sequence (adapted from Grace, 1996)

arifacts technological attributes and through chronological reconstructions of the removals. Cores are described individually to reconstruct the last steps of the reduction prior to discard. Laminar retouched tools and informative blanks are described in order to formulate hypotheses regarding the morphology of the desired endproducts and the goals of the production. Preliminary observations are tested on the material using the body of data obtained through the attribute analysis. The latter supports the reconstruction of the RS and illustrates the technological variability observed within the sample.

The second level of analysis focuses on the frequency of the described RS in the given sample. Based on the data set, patterns, trends and recurring elements that can lead to the recognition of a systematic approach are described. The goal is to reconstruct a RS that can be considered as representative of the sample.

The third level deals with connections between the RS by trying to establish the nature of the links (if there any) between sequences. Analyzis of core blanks and preforms are combined with quantitative data in order to detect reduction effects. Ultimately, laminar reduction systems from different archeological levels and sites are compared with each other in order to identify evidence supporting the existence of one/several technical traditions (Pelegrin *et al.*, 1988).

2.9 REDUCTION SEQUENCE AND TECHNICAL TRADITION

During the reduction sequence, the knapper faces a series of constraints (*e.g.* availability and physical properties of the raw material) in trying to achieve a pre-conceptualized goal. Reaching this goal means making technological choices among a set of technical options within the limits imposed by environmental and economical constraints. It is postulated that the repetition of similar decisions relatively synchronous but separated in space may illustrate an additional social constraint (Lemonnier, 1992). This assumption implies the existence of technical traditions from which a regional and chronological patterning in the archeological record may emerge, as opposed to a situation where, even considering the ecological backgound, totally random decisions would lead to a high level of variaility. The null-hypothesis of this approach assumes that assemblage variability is driven by behavioral ecology (see Isaac, 1986) principles. To reject this assumption, roughly contemporaneous assemblages should show a repetition of major typological and technological similarities in different ecological contexts. Assessing connections between reduction sequences appears usseful in order to keep the production of laminar elements in the context of the overall assemblage. Moreover, repetitions of systems showing similar interconnected sequences in different sites appear meaningful in order to detect technical traditions. A new location is likely to provide more options in terms of raw material, but also new constraints and new needs. It is assumed that the more a complex set of identical knapping sequences repeat through chronologically and geographicaly related assemblages, the less the similarities (and not the variability) can be explained exclusively as a response to ecological setting. The more a complex procedure repeats, the more likely it indicates a shared techno-complex. Following Byrne's approach (2007), the concepts of *intricate complexity* and *near unibiquity* indicates cultural transmission. Intricate complexity corresponds to a level of complexity that is unlikely to be re-invented multiple times. When combined with ubiquity within a population, it likely indicates a cultural transmission process. This approach was adopted by Stout *et al.* (2010) in their reassessment of Oldowan technological variability. If the degree of complexity is considered in the context of Early Upper Paleolithic assemblages, Byrne's theoretical framework can be helpful in order to trace the abstract boundaries between technocomplexes.

Within the same site, complex chains of RS repeating through different archeological levels and covering a relatively long time span could also indicate a technical tradition. It becomes, however, more difficult to reject the null-hypothesis of ecological explanation, as the topographic or environmental location of the site may results in a convergence in the structure of lithic assemblages.

3 – The Kara-Bom Upper Paleolithic variant

3.1 KARA-BOM: SITE DESCRIPTION AND TECHNOLOGICAL ANALYSIS

3.1.1 GEOGRAPHICAL SETTING

Kara-Bom (N 50° 43'; E 85° 42') is located in the Yelo Basin in the intermountain depression system of Central Altai (Siberia, Russia). The elevation of this area reaches 1100 m asl between mountains composed mainly of Middle Devonian metamorphic rocks and ranging to around 2300 m asl. Lying on the foothills of a schist cliff, Kara-Bom is located adjacent to a fresh water spring. At about 700 m from the site is a natural amphitheatre and a low pass to the neighboring valley. These topographic features could have been attractive for hunters as they provide a natural trap (Figure 17).

3.1.2 BACKGROUND

The excavation started in 1980 under the supervision of Okladnikov (Figure 20, Area 1). As it was first thought that the deposits were heavily disturbed by water circulation, the initial phase of excavation was executed by digging arbitrary spits of 25-30 cm thickness over a surface of 16 m² (Figure 19). Following the discovery of an artifact bearing horizon starting from the second spit (Okladnikov, 1983: 6)

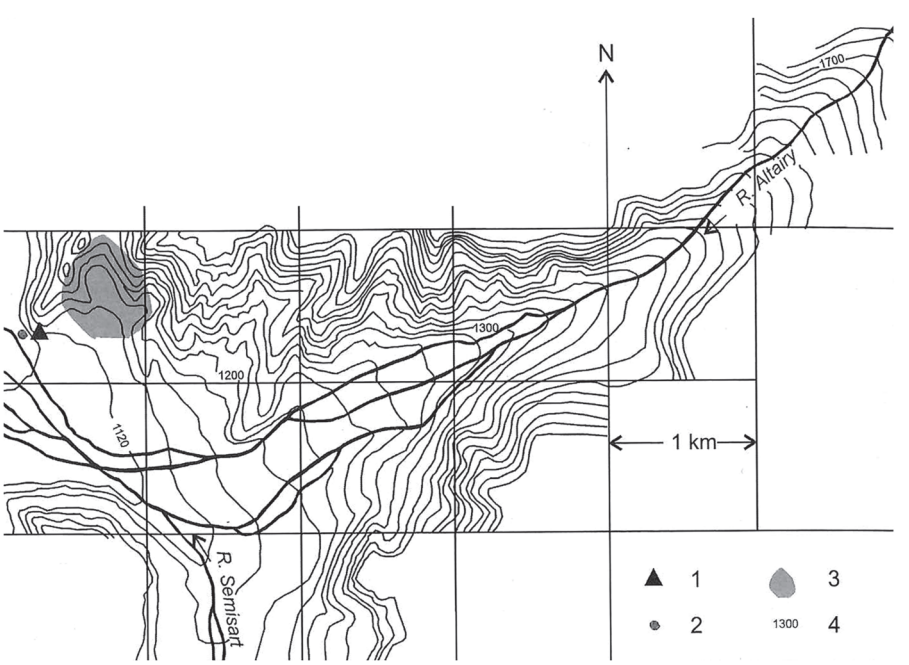


Figure 17: Topographic map. 1: Kara-Bom site; 2: spring; 3: amphitheatre; 4: absolute elevation asl. (after Derevianko and Rybin, 2003)



Figure 18: Kara-Bom, A.P. Okladnikov (center) at Kara-Bom during the 1980s excavations (courtesy of E.P. Rybin)

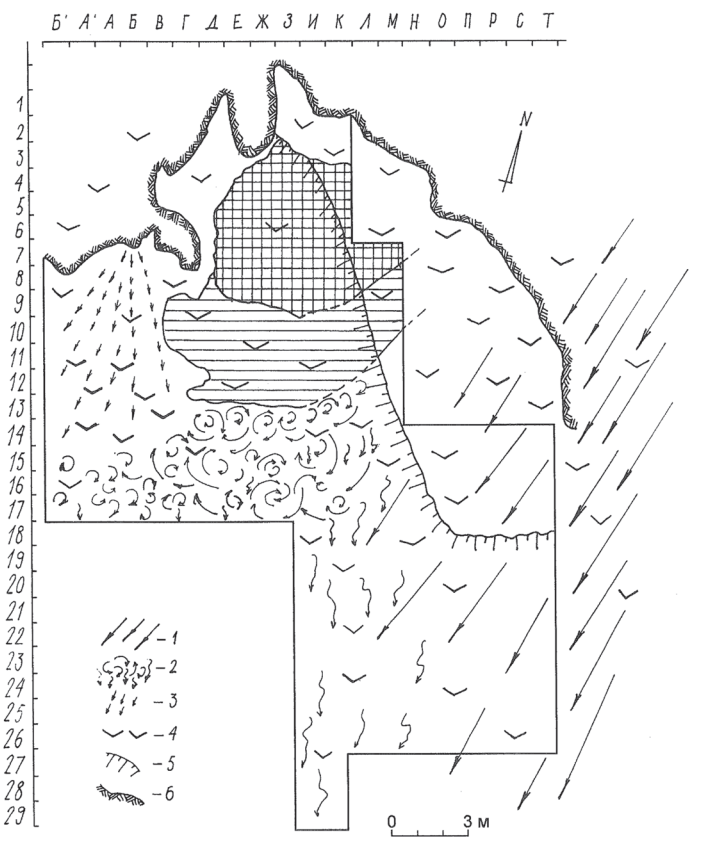


Figure 19: Kara-Bom, analytical reconstruction of post-depositional processes affecting the Kara-Bom site. 1: direction of the melting snow; 2: spring activity; 3: rain water flow; 4: gravitational disturbances (rockfall); 5: underground limit of the cliff; 6: visible limit of the cliff (after Derevianko *et al.*, 1998)

excavators proceeded following stratigraphic layers. The so-called workshop is located in the third spit (Level 3 of Okladnikov's scheme) in a yellowish-brown sandy loam that contains large plates of schist. In 1980, although other parts of Area 1 were excavated deeper, the workshop was not completely excavated (Okladnikov, 1983). According to Okladnikov's report, the western part of the workshop was excavated to a maximum absolute depth of -411 cm, which corresponds to the top of the MPH1.

In 1987, the Altai team of the North Complex Archaeological Expedition (Institute of Archaeology and Ethnography) started the second phase of excavations under the direction of Derevianko and Petrin. Between 1987 and 1993, no fewer than 300 m² were excavated following an extended Cyrillic grid system based on the one used by Okladnikov (Figure 20: area 1-4). Similar datum points and square divisions were used, allowing comparisons based on absolute altitudes (Okladnikov, 1983: 6). In 1991, excavation in Area 1 was completed. A fire-place was found in quadrants I-K/8-9 and a new excavation was made in squares L, M/7-9 corresponding to the stratigraphic position of Okladnikov's workshop. There after, excavation in Area 4 established a new lithological and archeological stratigraphic scheme. Six artifact bearing horizons were recognized, two of which were attributed to the Middle Paleolithic (Derevianko, Petrin, *et al.*, 1998). More recently, Areas 1 and 4 were correlated on the basis of stratigraphic and archeological elements. The workshop (1980 and 1987 excavations, squares Z-L/7-9 from Area 1, including the I-K/8-9 fireplace) is associated with Occupation Horizons (OH) 5 and 6 from the newly excavated Area 4 (Derevianko and Rybin, 2003).

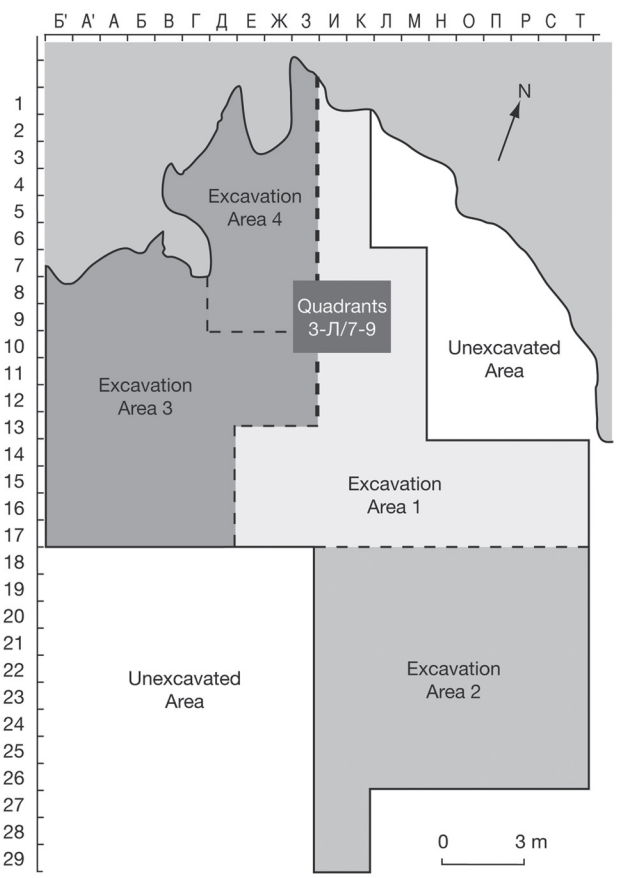


Figure 20: Kara-Bom, map showing excavated and unexcavated areas (modified after Derevianko *et al.*, 1998)

3.1.3 STRATIGRAPHY

The lithological and cultural divisions are briefly described following the section I-1/11. The 3.5 m thick sequence was subdivided into three major units (Figure 21). Unit 1 includes lithological strata 1-8, unit 2 corresponds to stratum 9 and unit 3 to strata 10 and 11. Slope deposits from the lithological uppermost unit 1 contain fine aeolian sediments and grayish yellow sandy loam and debris. Strata 4 to 2 were identified close to the cliff, as they were washed out by erosion starting approximately 3 m from the wall. The uppermost portion of stratum 4 has yielded the Occupation Horizon 1 (OH1). Stratum 5 is composed of brownish-gray loam and is subdivided into 5a and 5b, the later yielding more *debris*. Occupation Horizons 2 (OH2) and 3 (OH3) are respectively associated with strata 5a and 5b. Stratum 6 consists of gray coarse rock fragments, schist elements and gravels cemented by sandy-loam. The uppermost portion of stratum 6 shows the admixture of humic sediment and includes (OH4). This could correspond to a buried soil in secondary position. Starting from the central part of the stratum, schist slabs occur in horizontal position and they increase in density as one moves deeper. OH5 was identified in the central part of the stratum and OH6 is located close to the lowermost portion. OH4, 5 and 6 are attributed the to Upper Paleolithic. Stratum 9 is composed of a homogenous deposit and is subdivided in three substrata. Separated from the OH6 by three sterile strata (7, 8 and 9a), the first Middle Paleolithic Horizon (MPH1) is associated with sub-stratum 9b and MPH2 with sub-stratum 9B. Humic sediments occur in sub-stratum 9B. The bottom of the sequence is composed of cryoturbated slumping deposits overlying the bedrock (strata 10-11) and is archeologically sterile (Derevianko, Nikolayev, and Petrin, 1993; Derevianko, Petrin, *et al.*, 1998; Derevianko, Petrin, and Rybin, 2000; Derevianko and Rybin, 2003). According to Okladnikov's report, the western part of the workshop was originally excavated to a maxi-

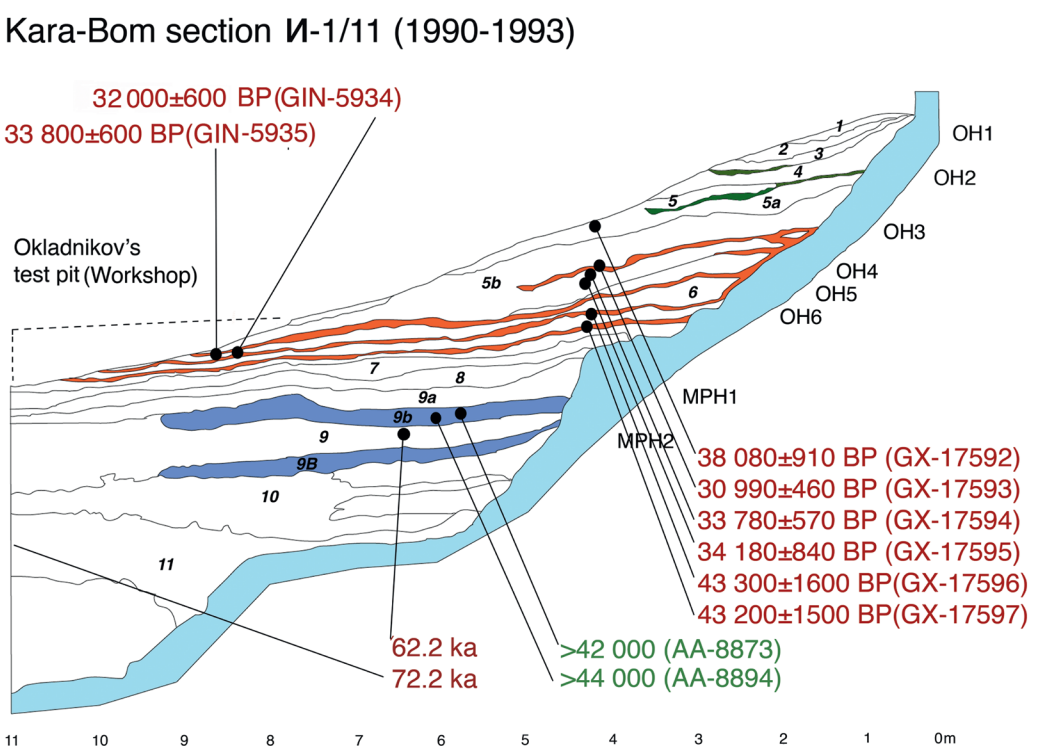


Figure 21: Kara-Bom, I-1/11 section with dated sample locations, numbers are lithological strata (modified after Derevianko and Rybin, 2003)

mum absolute depth of -411 cm in square Z12, which corresponds to the top of the MPH1 (Okladnikov, 1983: 6). It seems, therefore, unlikely that the Okladnikov test pit reached the Middle Paleolithic occupation layers in this area. Between squares B-N/14-17, the test pit was excavated deeper. This area was described, however, by Nikolaiev as disturbed due to spring water circulation (Derevianko, Petrin, *et al.*, 1998).

3.1.4 CHRONOLOGY

The first attempt to date the sequence yielded two conventional radiocarbon results. The first is 32,000 ± 600 ^{14}C BP (GIN-5934) on a bone collagen sample coming from stratum 4, but for which the cultural association with OH4 remains unclear. The second, 33,800 ± 600 ^{14}C BP (GIN-5935), comes from a wood charcoal sample associated with a fireplace located in quadrants I-K/8-9, between OH4 and OH5. In 1991, Goebel excavated a small column within the section exposed by Petrin. The sequence has been dated by AMS, conventional ^{14}C, and by Electro Paramagnetic Reasonance (EPR) (calendar age, uptake unspecified)(Derevianko, Nikolayev, and Petrin, 1993; Goebel *et al.*, 1993). Two infinite dates were obtained for the MPH 1; > 44 ka ^{14}C BP (AA-8894) and > 42 ka ^{14}C BP (AA-8873), both coming from bone collagen as no charcoal was found associated with this level. In addition, lithological stratum 8 (below the MPH1) and 11 (below MPH2) yielded EPR results of 62.2 ka and 72.2 ka respectively. These results mainly bracket MPH2, however, the upper sample was taken within a sandy loam sediment matrix from stratum 9, just underneath the interface with the MPH1 that the geologist Nikolayev recognizes as 'rather hypothetical' (Derevianko, Nikolayev, and Petrin, 1993). The small profile exposed does not include OH5 and OH6, as the section starts from stratum 7. The MPH1 occurs at mid-section, separated from OH6 by more than 50 cm of sterile sediment, in which Nikolayev recognizes two clear interfaces (7/8, and 8/9). Although he was excavating by 50 cm thick spits, Okladnikov previously mentioned this hiatus (Okladnikov, 1983; Derevianko, Nikolayev, and Petrin, 1993). The OH6 and OH5 have AMS ages of 43,200 ± 1,500 ^{14}C BP (GX-17597) and 43,300 ± 1,600 ^{14}C BP (GX-17596) respectively, both on wood charcoal, with the latter being directly associated with a fireplace from quadrant I4/5 within OH5 (Goebel *et al.*, 1993). Two ^{14}C dates were obtained on charcoal coming from above OH4 and yielding 34,180 ± 640 ^{14}C BP (GX-17595) and 33,780 ± 570 ^{14}C BP (GX-17594). OH3 has yielded a date of 30,990 ± 460 ^{14}C BP (GX-17593). In this series, only the following result does not fit with the stratigraphic succession. A 38,080 ± 910 ^{14}C BP (GX-17592) date was obtained on a charcoal sample collected close to the surface and in the vicinity of a frost crack. It was the only sample of the 1991's series not associated with archeological material. Among the results obtained during the first dating campaign, the result coming from OH5 is clearly younger then Goebel's results. In this case, the latter are considered reliable as they are directly linked with the I4/5 fireplace. Coming from above a step in the bedrock, these results are very unlikely contaminated by material from MPH1. The two results obtained on OH5 and OH6 samples indicate an age between 46 and 40 ka BP at a two-sigma range. It is noteworthy that they are very close to the limits of the ^{14}C method, and Goebel notes that they could also indicate a minimum age. The stratigraphic position of the I-K7/9 fireplace (downslope) and its conventional ^{14}C date do not rule out an association of this feature with the OH4. The occurrence of *Coelodonta antiquitatis* (woolly rhinoceros) coming from the fire structure from quadrants I-K7/9 (Derevianko and Rybin, 2003) seems to indicate an occupation during a rather cold phase. In OH6 and OH5, fauna is generally badly preserved. In OH6, the presence of *Equus hidruntinus* (wild ass), *Equus sp.* (horse/ass), *Capra sibirica* (ibex) and *Crocuta spelaea* (hyena) are reported. *Bison sp.* (bison) occurs in OH5 but also in OH4 together with *Equus sp*.(Vasiliev, 2003).

3.1.5 TAPHONOMIC APPROACH

This study focuses on the material associated with OH5 and OH6 and starts by trying to assess the integrity of the assemblage within the stratified part of the site excavated according to stratigraphic layers. For this, breakage refits on broken laminar elements and short sequence refits are used. Artifacts are plot-

Squares	OH4	OH4/OH5	OH5	OH5/OH6	OH6	Type	ID
Z7/Z8	1					Break	h
Z7		1				Break-X/Y?	n
Z5/Z6			1			Sequence	p
Z7			1			Break	m
J8			1			Break	g
I9/Z8			1			Break	e
Z8			1			Break-X/Y?	f
I9/Z9			1			Break	b
I9			1			Break	a
Z6			1			Break	o
I9/E8				1		Sequence	c
Z9				1		Break	d
Z7/Z9				1		Sequence	i
I8					1	Break	j
Z7/E7					1	Sequence	l
Z8					1	Break	k
	1	1	8	3	3		N=32

Table 1: Kara Bom, distribution of inter-(shaded rows) and intra-OH refits.

ted on I-1/11 section according to their positions following the coordinate system used during the excavation (*e.g.* Hofman, 1986; Cziesla, 1990; Bordes, 2000). The purpose of this work was not to refit long technological sequences to tackle behavioral issues, but rather to test movement between layers.

The refitted group of artifacts can be divided into three main categories. The first group includes broken elements for which it was possible to rule out breakage due to excavation methods (Figure 22). On some of the snapped sections, mineral concretions testify to the ancient character of the breakage.The second category deals with the technological refits, testifying to knapping activities (Figure 23). The third one can be either on breakage or technological, but for these spatial information within the square was missing. For these, an arbitrary position was chosen, generally in the middle of the square.

The majority of the refits are attributed to OH5 (Table 1). Among the two refits involving OH4, one connects it with OH5 from lateral a distance of 2 m. Among six refits involving OH6, three connect it with OH5. These connections between the levels do not show substantial vertical movement (Figure 24). They seem to suggest a rather good integrity of the OH5, showing inter-level contacts downslope with OH6 (quadrant 7/9), where OH5 and 6 are very close to each other. However, the good preservation of the I5/4 fireplace seems to indicate a low-energy sedi-

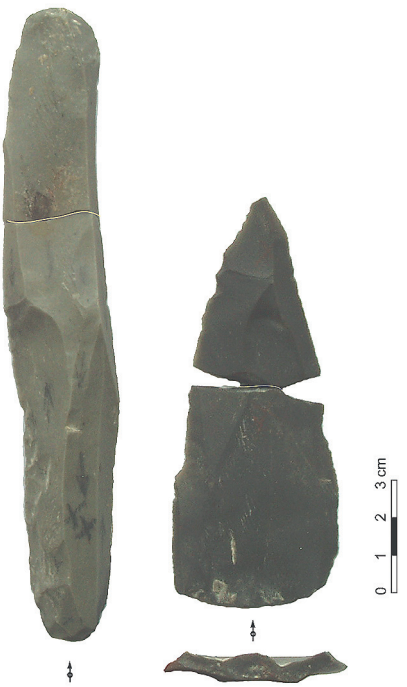


Figure 22: Refits on breakage. Left: O; Right: K



Figure 23: Technological refit (I): side blade refitted on a retouched blade

mentation rate where both OH5 and 6 are separated by maximum 25 cm thickness.

All in all, it seems that the material from OH4, OH5 and OH6 should be treated as independent stratigraphic units at least for the E-K/1-11 excavation units. However, four refits show some occasional problems downslope, along lines 7-9. In all cases, artifacts were found at the same depth showing no vertical movements. According to previous studies on the 1980-1991s collection, it is also worth noting that no refits were found between artifacts from MPH1 and OH6. Although further efforts could be devoted on this specific issue, the occurrence of intervening sterile levels reinforces the idea that those cultural horizons were distinct. However, one technological refit of a laminar core, including nine artifacts, indicates some mixing between OH at the bottom of the slope. Among nine artifacts, four were attributed to OH4, three to 'the periphery of OH5', downslope, and two to the Okladnikov's workshop (Slavinsky and Rybin, 2007). Given that the archeological layers are stretched in this part of the site, and given the good preservation of the hearth feature at the bottom of OH6, this situation does not reflect a large scale high energy process. No connections have been found between OH6 and OH4 and the idea that the fire structure is an intrusion from OH4 to OH6 seems unlikely. The available data rather suggest localized slope processes combined with minor mixing during the excavation or during the labeling. Refits between OH4, OH5 and OH6 have been tested but given the nature of the raw material and the time devoted to this type of analysis, it is unlikely that all possibilities of refits have been tested.

3.1.6 SAMPLE COMPOSITION

During the second phase of excavation, 20 m² were excavated in MPH1. A total of 104 artifacts, including 9 potential preforms, 3 cores, 41 tools and 46 flakes. This material was described as a Mousterian

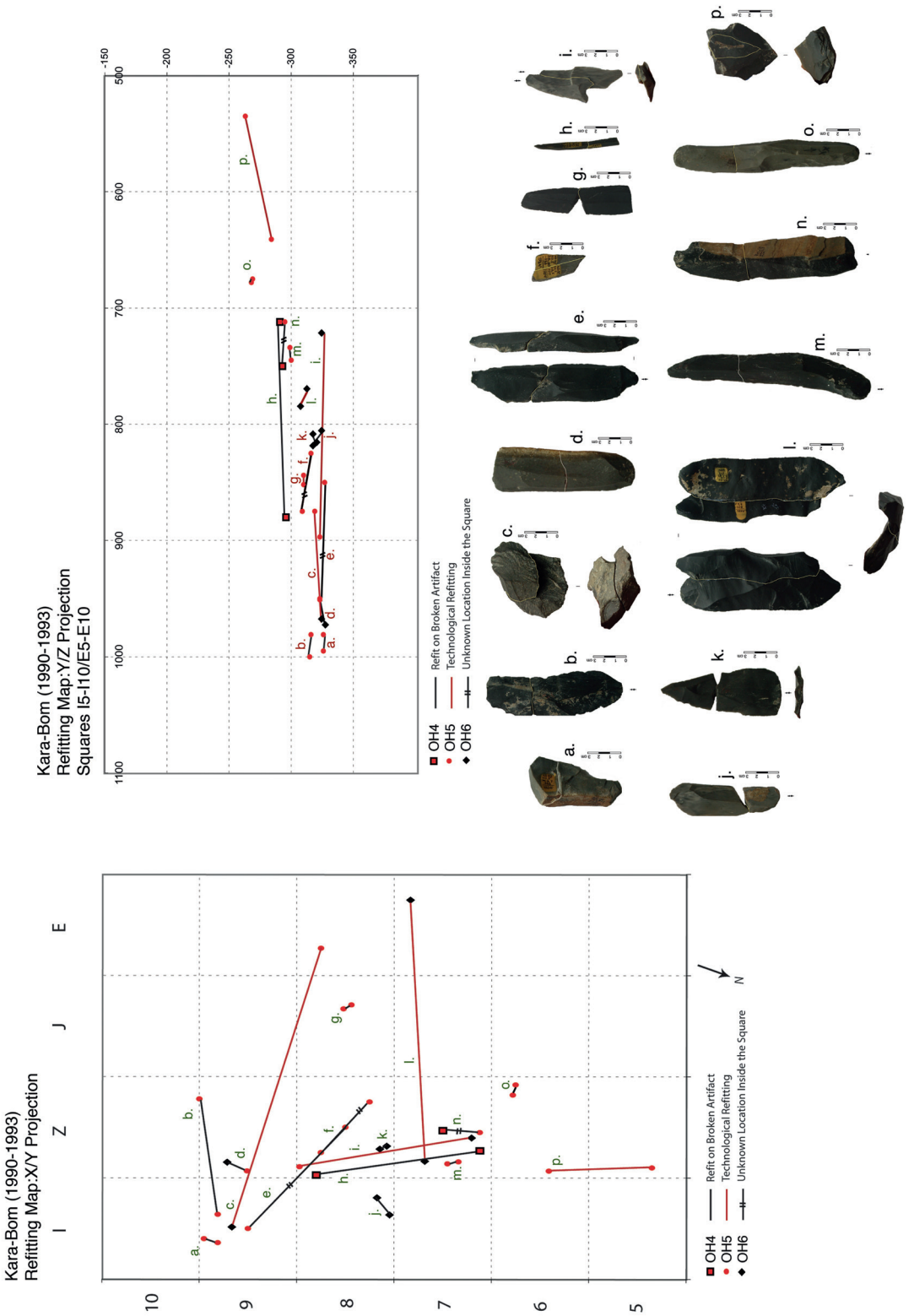


Figure 24: Kara-Bom: refitted artifact plot in section (right) and in plan (left)

	MPH1		OH6		OH5		OH4		1980–1991	
	N	*f*	N	*f*	N	*f*	N	*f*	N	*f*
Blade	15	44%	126	61%	123	65%	34	62%	0	0%
Bladelet	0	0%	36	17%	22	12%	5	9%	0	0%
Microblade	0	0%	0	0%	3	2%	0	0%	0	0%
Flake	5	15%	4	2%	4	2%	0	0%	0	0%
Core	2	6%	14	7%	10	5%	0	0%	21	100%
Tool	12	35%	28	13%	26	14%	16	29%	0	0%
	34	100%	208	100%	188	100%	55	100%	21	100%

Table 2: Kara-Bom, general structure of the sample

assemblage. OH6 yielded 878 artifacts from a 12 m² surface including 351 blades, 339 flakes, and 143 tools (Derevianko, Petrin, *et al.*, 1998). For OH5, 14 m² were excavated yielding a total of 594 lithic artifacts, with a concentration in squares Z-I/5-9. 282 blades (mainly fragments), 215 flakes, and 81 tools are reported in the original publication. OH4 was excavated over a surface of 11 m², yielding 214 lithic artifacts, among which 4 are preform/cores, 73 are blades and 39 are listed as tools (Derevianko, Markin, *et al.*, 2001). Although it was sometimes described as chert (*e.g.* Goebel, 1993; Brantingham *et al.*, 2000; Derevianko *et al.*, 2001) or as cryptocristaline silicate (Goebel, 2004), the raw material in use mostly consist in metamorphic rock . The primary outcrops are located in the surrounding mountains (*e.g.* Mt Aptyrga) along tectonic cracks and are carried by the Altairy River on a relatively short distance (1-2 km away). Tabular blocks offer the necessary volume for the production of massive blades. The homogeneity, the fine-grained texture and the hardness (6.5 on the Mohs scale) make this highly suitable material convenient (Derevianko *et al.*, 2000; Derevianko and Shunkov, 2005). It represents 98% of the raw material used in both Middle and Upper Paleolithic levels in Kara-Bom (Brantingham *et al.*, 2000). The material from OH6-OH4 was previously described as a transitional technology showing a shift between a Levallois parallel blade reduction towards prismatic and narrow-face cores. This change is linked with the predominance of blade production over flake production and with the first appearance of 'microblades' (Petrin and Chevalkov, 1992). These small laminar elements are said to be produced from the narrow face of exhausted blade cores (Petrin and Chevalkov, 1992) or on massive *débordant* flakes (Derevianko, Petrin, *et al.*, 1998, 1999; Derevianko and Rybin, 2003; Derevianko and Volkov, 2004).

The general structure of the sample studied here is described in Table 2. Mainly laminar elements from the stratified part of the site and bearing an unambiguous level label were selected. Some of the artifacts showing inconsistency between their altitude and their stratigraphic attributions have been either removed or described separately. For example, three blades (including two naturally backed blades) were labeled as MPH1 but have an altitude corresponding to OH5 in the relevant squares. These artifacts were, therefore, removed from consideration. Another core (KB-92.YO5.Z6.1) was published as belonging to OH5 (Derevianko *et al.*, 1998, Fig.41, num. 4) but with an altitude of -398. Given that the lowest artifact in that square has an altitude of -343, the core is described in the 'Additional artifacts' section.

The numeric differences between the sample considered here and the material reported in the original publication can be explained in various ways. Although all material that was available at the time of the study have been sampled, large differences in terms of tools can be observed. First, this is due

to the fact that only laminar artifacts bearing clear intentional retouch are considered here, so that numerous tools on flake blanks, *'notches'* or '*naturally backed knife'*, although belonging to the Bordes's type list (Bordes, 1961), have been left out of the tool category. These categories of tool represent a significant part of the original artifact list. For example, the sum of denticulates, notches, knives and blanks bearing irregular or sporadic retouch represent 83 artifacts in OH6 and 42 artifacts in OH5. Second, for some of the assemblages, almost all burins have been described as cores (Mode B) in various stages of reduction.

3.2 LAMINAR TECHNOLOGY: MPH1

3.2.1 BLANK ATTRIBUTES

Breakage

Leaving out the complete elements, mesioproximals and mesial fragments are the most common among the blade set (Table 3). For analytical purposes, a minimum number of individual blanks (MNI) is calculated. It includes all artifacts which have a platform (complete, proximal and mesioproximal fragments). The MNI reduces the risk that artifact breakage introduces a bias in the dataset. For MPH1, an MNI of 15 artifacts is calculated on a total sample of 20 artifacts.

Platform: size and preparation

Taken as a whole, blade platforms have a mean thickness of 3.7 ± 1 mm and a mean width of 9.4 ± 5.2 mm. Flakes have a mean thickness of 9.4 ± 2.3 mm. Flake platform widths have a mean of 30.8 ± 10.2 mm. In spite of the small sample size, blade platform thickness (Mann-Whitney, T=Ub=0, p=<.05) and width (Mann-Whitney, T=Ub=1, p=<.05) are significantly lower than for flakes. This trend can also be observed when disentangling morphological categories; however, the sample sizes become too small to be statistically tested. Blades with facetted platforms (N=3) have a mean thickness of 3.8 ± 2.8 mm and mean width of 9.3 ± 2.3 mm, and the only one flake has a facetted platform of 6.4 mm thick and 15 mm wide. Plain platforms tend to be less thick and less wide.

Blank size attributes

Length

As only four artifacts are complete, it is not possible to observe any trend in MPH1. The two blades are 36.4 and 87.9 mm long and the two laminar flakes are 77.8 and 42.4 mm long.

	Total		Blade		Flake	
	N	*f*	N	*f*	N	*f*
Distal	0	0%	0	0%	0	0%
Mesiodistal	1	5%	1	7%	0	0%
Mesial	4	20%	4	27%	0	0%
Mesioproximal	8	40%	6	40%	2	40%
Proximal	3	15%	2	13%	1	20%
Complete	4	20%	2	13%	2	40%
	20	100%	15	100%	5	100%

Table 3: Kara-Bom, MPH1, breakage

	Total		Blade		Flake	
	N	*f*	N	*f*	N	*f*
Plain	6	40%	4	40%	2	40%
Facetted	4	27%	3	30%	1	20%
Dihedral	3	20%	1	10%	2	40%
Undetermined	2	13%	2	20%	0	0%
	15	100%	10	100%	5	100%

Table 4: Kara-Bom, MPH1, platform preparation

Plain platform	Total		Blade		Flake	
	Thickness	Width	Thickness	Width	Thickness	Width
Sample size	6		4		2	
Mean (mm)	5.2	15.8	3.2	6.6	9.1	34
Standard deviation (mm)	3.3	15	0.8	2.8	2.4	10
Range (mm)	2.2 to 10.8	2.6 to 41.1	2.2 to 3.9	2.6 to 8.8	7.5 to 10.8	27 to 41.1

Table 5: Kara-Bom, MPH1, plain platform size

	Total sample			MNI		
	Total	Blade	Flake	Total	Blade	Flake
Sample size	20	15	5	13	8	5
Mean (mm)	26.7	22.2	40.2	28.6	21.3	40.2
Standard deviation (mm)	10.7	8.1	1.4	10.7	5.7	1.4
Range (mm)	12.8 to 42.5	12.8 to 41.4	35.4 to 42.5	15.2 to 42.5	15.2 to 33.1	35.4 to 42.5

Table 6: Kara-Bom, MPH1, blank width

Width

The mean width of blade and flake categories are different (Table 6), in both total sample and MNI, reflecting the fact that the categories are defined on the basis of shape attributes.

Thickness

In spite of the effect of the small sample size, flakes tend to be significantly thicker than the total blade sample (Mann-Whitney, T=Ub=10, p=<.05) and the blade MNI (Mann-Whitney, T=Ub=1, p=<.05) (Table 7).

	Total sample			MNI		
	Total	Blade	Flake	Total	Blade	Flake
Sample size	20	15	5	13	8	5
Mean (mm)	7.7	6.7	10.4	7.7	6	10.4
Standard deviation (mm)	2.7	2	1.3	2.9	0.9	1.3
Range (mm)	3.9 to 14.5	3.9 to 11.3	7.4 to 14.5	4.6 to 14.5	4.6 to 7.8	7.4 to 14.5

Table 7: Kara-Bom, MPH1, blank thickness

Dorsal scar pattern

Laminar blanks are mainly unidirectional although when considering the only two complete artifacts, one is bidirectional and the other one unidirectional. Two of the flakes show the same picture, one being unidirectional and the other bidirectional. Two of the flakes show a radial dorsal patterning and are not included in the Table 8 as they do not fit in any of the defined categories. Among the laminar blanks, one is a neo-crest blade fragment.

Cross-section

Cross-sections are mainly trapezoidal, indicating that the removals were detached following several ridges (Table 9). Two of the flakes showing a radial dorsal patterning have a polyhedral section. When considering the MNI, the main trends are unchanged. Trapezoidal sections dominate (N=10), followed by triangular (N=3).

	Total		Blade		Flake	
	N	*f*	N	*f*	N	*f*
Unidirectional	8	44%	7	47%	1	33%
Unidirectional and cortex	1	6%	1	7%	0	0%
Bidirectional	4	22%	3	20%	1	33%
Bidirectional and cortex	0	0%	0	0%	0	0%
Crest	0	0%	0	0%	0	0%
Second Crest	0	0%	0	0%	0	0%
Neo-crest	1	6%	1	7%	0	0%
Undetermined	4	22%	3	20%	1	33%
	18	100%	15	100%	3	100%

Table 8: Kara-Bom, MPH1, dorsal scar pattern

	Total		Blade		Flake	
	N	*f*	N	*f*	N	*f*
Flat	0	0%	0	0%	0	0%
Rectangular	1	5%	1	7%	0	0%
Triangular	5	25%	5	33%	0	0%
Trapezoidal	12	60%	9	60%	3	75%
Polyhedral	2	10%	0	0%	2	25%
	20	100%	15	100%	5	100%

Table 9: Kara-Bom, MPH1, blank cross-section

Profile

In the total sample and in the MNI, profiles are mainly straight in both flake and blade categories (Table 10). Slightly curved profiles are also quite frequent.

Orientation

Blanks are mainly axial although given the small sample size and the number of undetermined values; this trend is not significant (Table 11). In fact, when considering the blade MNI, values are equal (N=3) except for the undetermined category (N=1).

	Total		Blade		Flake	
	N	*f*	N	*f*	N	*f*
Straight	11	61%	8	57%	3	75%
Slightly Curved	4	22%	3	21%	1	25%
Curved	0	0%	0	0%	0	0%
Twisted	2	11%	2	14%	0	0%
Undetermined	1	6%	1	7%	0	0%
	18	100%	14	100%	4	100%

Table 10: Kara-Bom, MPH1, blank profile

	Total		Blade		Flake	
	N	*f*	N	*f*	N	*f*
Right	3	15%	3	20%	0	0%
Left	4	20%	3	20%	1	20%

… continue page 66

None	7	35%	4	27%	3	60%
Undetermined	6	30%	5	33%	1	20%
	20	100%	15	100%	5	100%

Table 11: Kara-Bom, MPH1, blank orientation

3.2.2 CORES: REDUCTION PATTERNS AND SIZE ATTRIBUTES

Two cores and two core-like tools are described in this section. The core-like tools are also included in the retouched tools list. Flake cores do not fit in our Mode classification system as it was designed for laminar reduction systems.

Core description

Flake cores (N=2)

∗ KB-92.M1.J11.3.2348
This core is produced on a block/slab blank (Figure 25). The back is mainly cortical and is prepared by a series of radial removals around the periphery, giving the flaking surface a sub-triangular shape. Some of the removals appear deeper and more invasive when they correspond to striking platform preparations associated with the last dorsal removal negatives. The dorsal face illustrates the alternate use of two platforms perpendicular to each other. Assuming that one of these platforms is mainly used to shape the flaking surface, this core can be classified as unidirectional recurrent Levallois.

∗ KB-92.M1.Z11.1.2347
This core is produced on a block/slab blank and displays a combination of cortex and natural surfaces on its back (Figure 26). The contour of the ventral face shows a series of radial removals, some of which are striking platform preparations. The dorsal face displays a series of radial removals, the last phase of reduction being a three-step sequence (left, right and middle) which give to the last removal a triangular shape. The general morphology of the core suggests Levallois affinities.

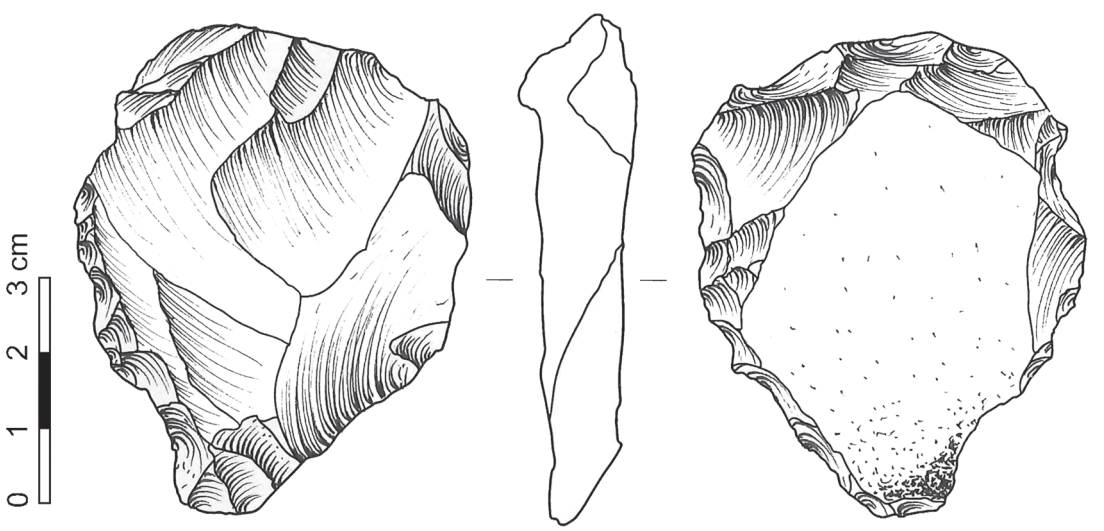


Figure 25: Kara-Bom, MPH1, KB-92.M1.J11.3.2348

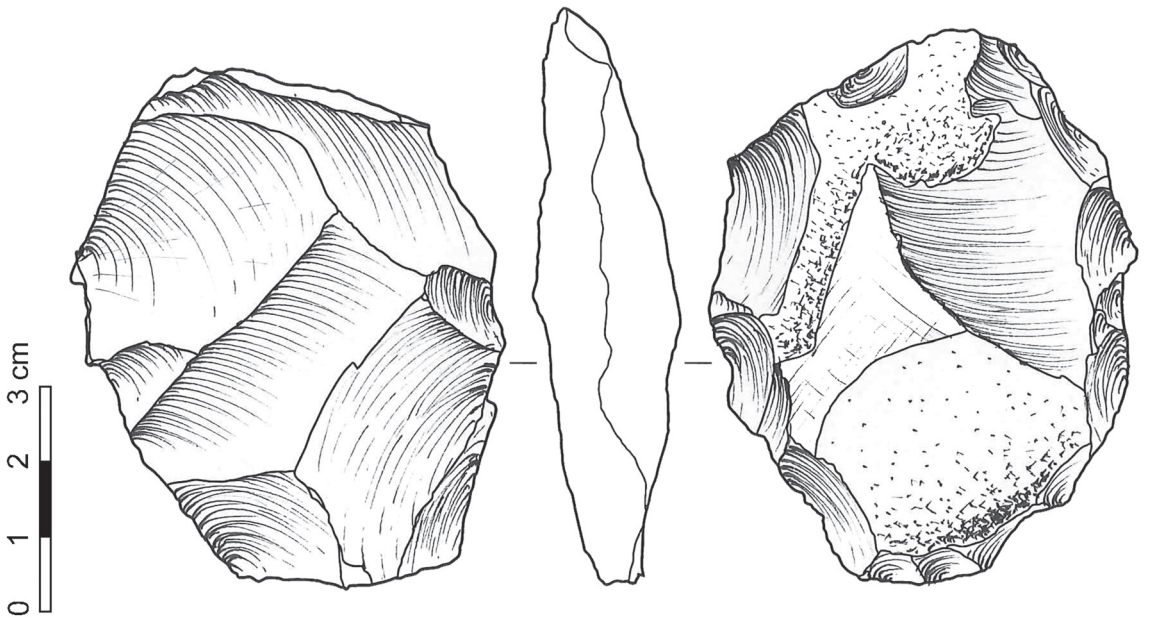


Figure 26: Kara-Bom, MPH1, KB-92.M1.Z11.1.2347

Core-like tools (N=2)

* KB-92.M1.D11.7.2327
This artifact is on a unidirectional blade blank with an inverse truncation on the proximal part (Figure 27). Two possible removals are located along the left edge of the blank. For one of the surfaces, it was not possible to determine the direction of the removal. It is not clear if the removals are posterior or anterior to the detachment of the core blank as no bulb negative is preserved. Therefore, this artifact is typed as a truncated blade and included in the retouched blade category.

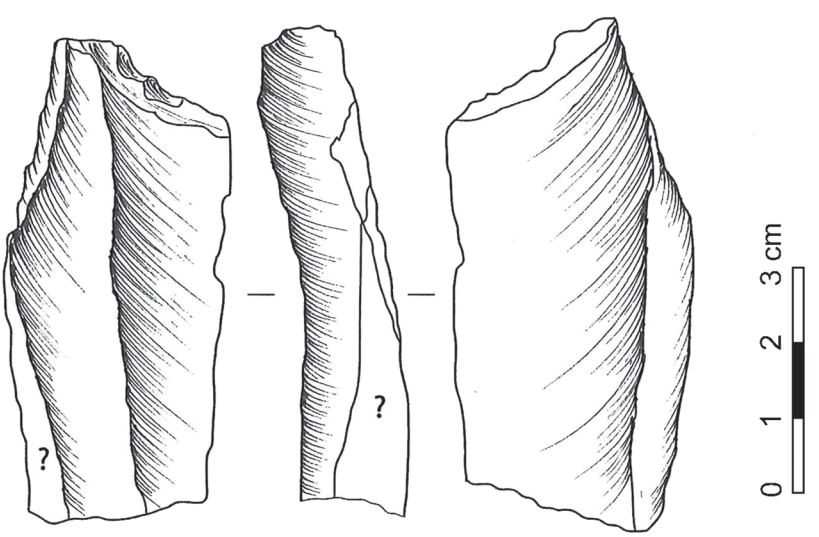


Figure 27: Kara-Bom, MPH1, KB-92.M1.D11.7.2327

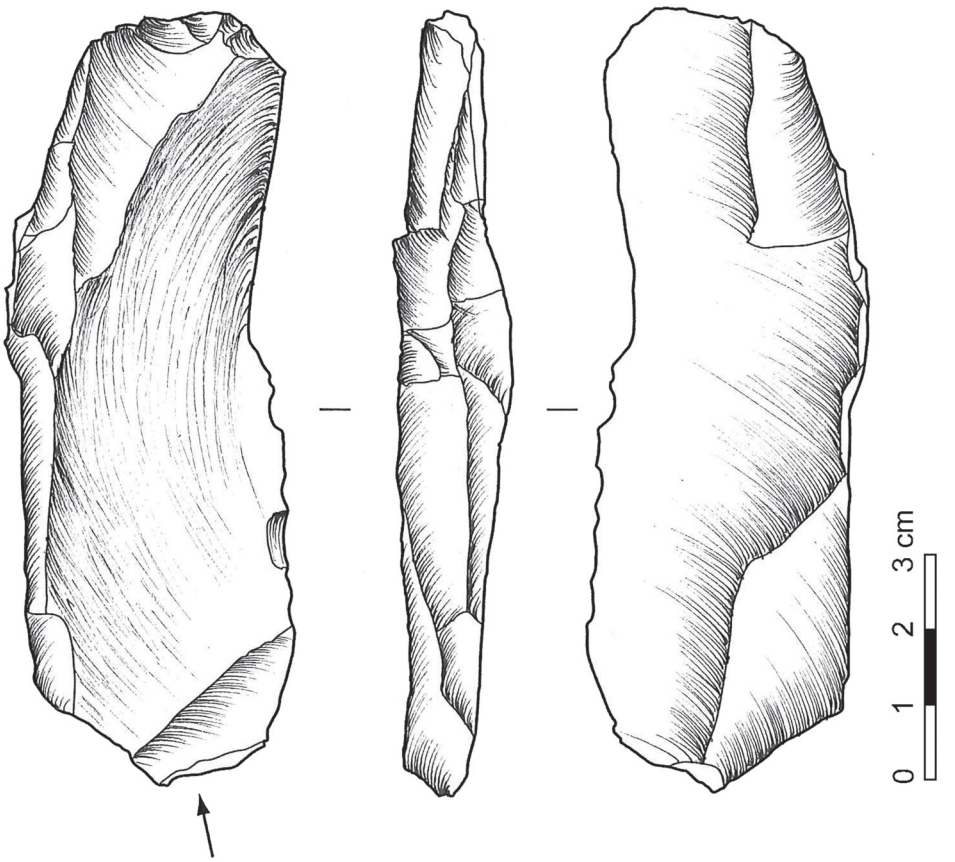


Figure 28: Kara-Bom, MPH1, KB-92.M1.Z11.13.2344

∗ KB-92.M1.Z11.13.2344

This artifact is produced on a laminar blank detached from the corner of the flaking surface of a large blade core (Figure 28). It shows a series of laminar negatives along the left edge, the right edge being sharp and thin. Two flake removals were detached from opposed platforms and extend mainly on the ventral face of the blank. They make it impossible to determine if the laminar removals from the edge are posterior to the detachment of the blank or not. In this context, this artifact cannot be considered as a Mode B core, and is instead typed as a burin and classified in the broader category of retouched blades.

3.2.3 REDUCTION SEQUENCE RECONSTRUCTION

Giving the small sample size, the reduction sequence cannot be reconstructed on a robust, quantified basis. However, some general observations can be proposed. The blanks can be classified into three main morphological categories: blades with parallel edges, and flakes with convergent edges, and flakes.

Laminar blanks with parallel edges

Blades show a combination of unidirectional and bidirectional reduction sequences but also facetted and plain striking platforms. Some of the largest laminar artifacts illustrate a bidirectional reduction system

with two opposed platforms (Figure 29, num. 5 and 6). The morphology of large/ medium size cores is unknown as they are absent in the sample. The occurrence of a neo-crested blade (Figure 29, num. 3), however, indicates that, at least occasionally, the management of the flaking surface by the removal of a thicker blank at the intersection between two surfaces. A production of small size blades/bladelets is also possible as one of the blanks displays two natural backs and is, therefore, detached from a core with a narrow flaking surface. However, the two core-like tools described above are rather atypical and cannot be directly associated with this type of production.

Convergent blanks

The convergent blanks are mainly flakes, but their shape attributes indicate an intermediate position between the flake and blade category. From a qualitative point of view, some of them can be designated as laminar flakes. They show both unidirectional

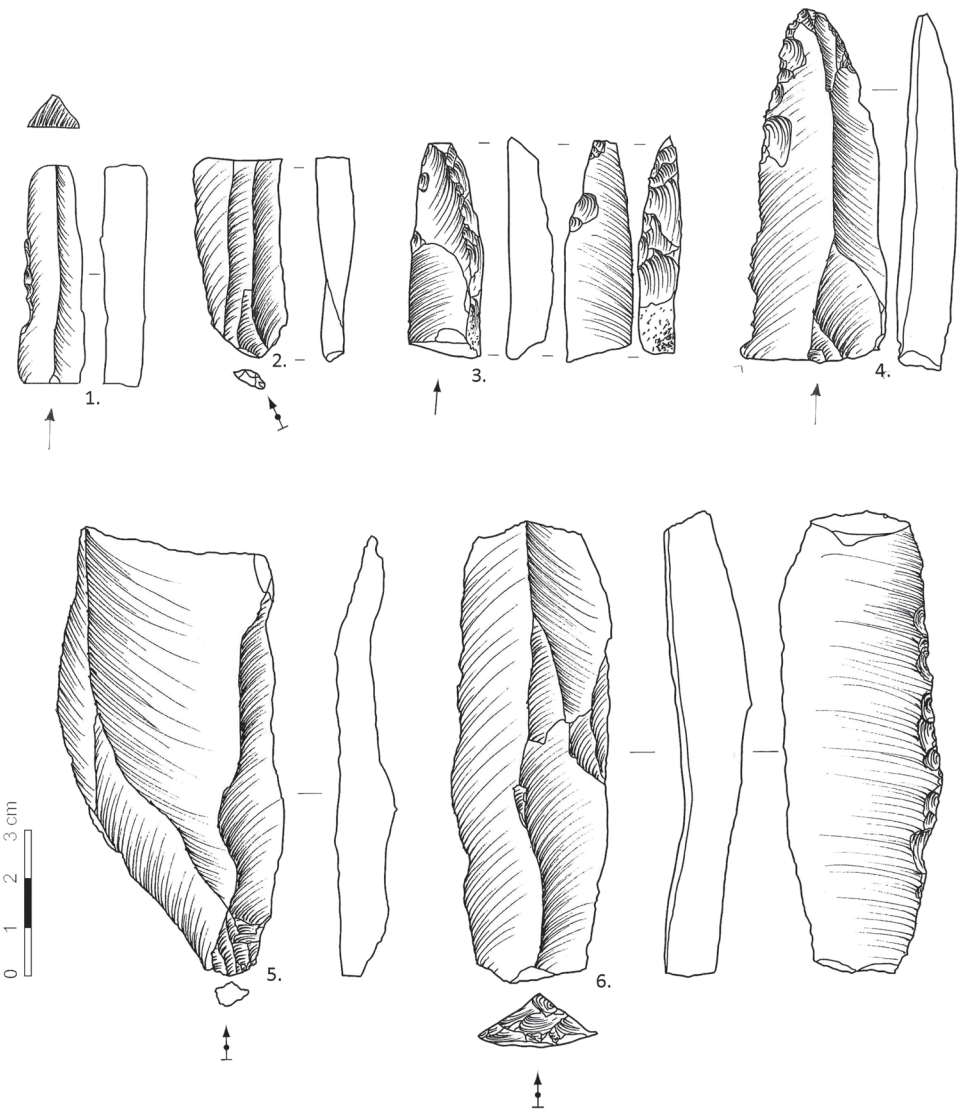


Figure 29: Kara-Bom, MPH1, Laminar blanks and retouched tools

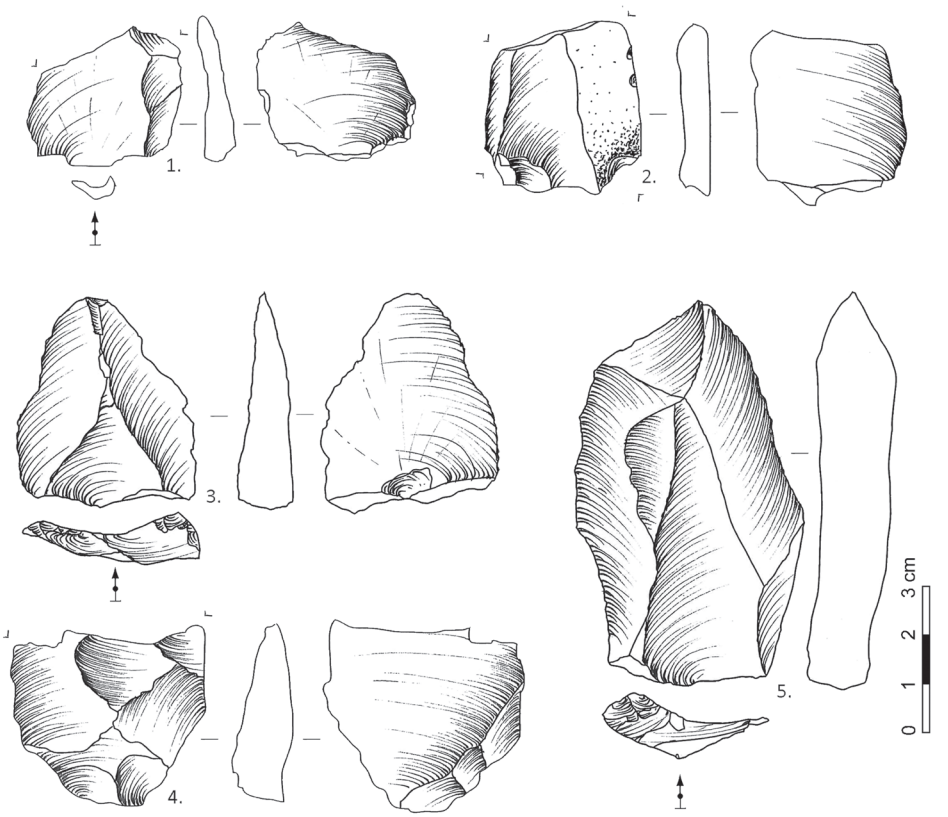


Figure 30: Kara-Bom, MPH1, convergent and flake blanks

and bidirectional scar patterning. Some are similar to Levallois points, but the central removals visible on their dorsal face can sometimes precede the lateral ones. Given the sample size, this may indicate a certain degree of variability in the method of production. Generally, these blanks are rather short and have a thick platform. One artifact shows some flaking on the side of a dihedral platform (Figure 30: 3). Another artifact has a plain platform slightly modified due to an aborted removal (Figure 30: 5). The convergent blanks could be associated with flake cores such as KB-92.M1.Z11.1.2347 (Figure 26).

Flake blanks

Some flakes in the assemblage may be linked with the Levallois flake cores. They have a roughly circular shape and a dorsal scar pattern showing radial removals (Figure 30: 4).

Platform preparation and percussion technique

The percussion technique is difficult to assess given the size and the nature of the sample. The mean platform thickness of the total sample is more than 4 mm, but this is partly due to the presence of flakes that have significantly thicker platforms than the blades. Moreover, no sign of abrasion has been observed on the blanks. So, in this case, it is assumed that the flakes are detached with a hard hammer. For the blades, the question is still open although no features usually associated with the use of a soft hammer have been observed.

	N	*f (among tools)*	*f (from total, N=55)*
Retouched blade	10	91%	29%
Retouched bladelet	0	0%	0%
Retouched Point	0	0%	0%
Endscraper	0	0%	0%
Other	1	9%	3%
	11	100%	32%

Table 12: Kara-Bom, MPH1, main types of retouch tool

Retouched tools

The retouched toolkit is mainly composed of retouched blades and of a single retouched flake (Table 12). As a general observation, differences in patina and the occurrence of edge damage on several blanks (N=2) and tools (N=3) suggest that some of the irregular retouch, notches and denticulations perhaps related to post-depositional processes. Following a conservative approach, 11 artifacts are selected. Only three have a platform preserved, one is plain, one is unidentified and the third is facetted. The platform thickness varies from 2.1 to 9.8 mm and the width between 4.2 and 18.9mm.

	N	*f*
Distal	0	0%
Mesiodistal	1	9%
Mesial	6	55%
Mesioproximal	1	9%
Proximal	0	0%
Complete	3	27%
	11	100%

Table 13: Kara-Bom, MPH1, retouched tool breakage

One blade fragment shows bilateral retouch on the distal end and displays a small burin-spall like removal starting from the tip (Figure 29: 4). This feature also occurs on a non-retouched convergent blank (Figure 30: 3). In a Middle Stone Age context, burin-like removals are listed by Villa and Soressi (2009) as diagnostic for impact fractures. In MPH1, the size of the spalls is reduced and the length of the step-scar is too short to be convincing. One notch is produced on a Levallois flake displaying bidirectional dorsal scar patterns (Figure 31).

The notch bears at least two generations of retouch and some and an inverse truncation is visible on the proximal end of the ventral face.

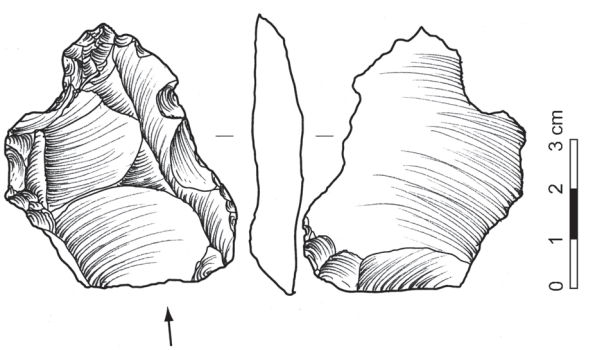


Figure 31: Kara-Bom, MPH1, retouched tool on Levallois flake

The retouch is mainly direct (Table 14), and is located on the mesial (N=4), on the proximal (N=3) and on the distal part (N=2) of the dorsal face, and

on the mesial (N=2) and proximal part (N=1) of the ventral face.

	N	*f*
Direct	7	64%
Inverse	2	18%
Alternate	2	18%
	11	100%

Table 14: Kara-Bom, MPH1, retouch location (face)

One artifact has a curved profile and one has a twisted one. The rest of the tools have a straight profile. Except for three artifacts, oriented on the right, none of the tool orientations could be determined.

3.3 LAMINAR TECHNOLOGY: OH6

3.3.1 BLANK ATTRIBUTES

Breakage

The distribution of both blades and bladelets indicates a majority of mesial and mesioproximal fragments, with a clear lack of distal elements. Based on these observations, an MNI of 82 blades and 18 bladelets is calculated on a total sample of 162 laminar artifacts recorded (Table 15).

Platform: size and preparation

Based on observations from the MNI sample, OH6 blades show similar frequencies of plain and facetted platforms and a minor occurrence of flat dihedral platforms (Table 16). As for the bladelets, facetted platforms dominate but the sample is reduced by the presence of numerous undetermined platform types. Considering all categories together, the mean platform thickness is 5.7 ± 3.7 mm and the mean width is 12.9 ± 6.6 mm. When separating blade and bladelet categories, the results show a different picture. Blade mean platform thickness is 6.2 ± 3.7 mm and bladelets have a mean of 2.8 ± 1.5 mm. In the following tables, measurements are grouped per morphological types. Two plain and one facetted platform are discarded due to damage.

It appears that facetted platforms have a higher platform thickness than the mean of the overall assemblage. There is a clear overlap between blade and bladelet platform thickness (Table 17).

For the plain platforms, mean thickness differences between the blades and the bladelets can be related

	Total		Blade		Bladelet	
	N	*f*	N	*f*	N	*f*
Distal	4	2%	3	2%	1	3%
Mesiodistal	21	13%	15	12%	6	17%
Mesial	36	22%	25	20%	11	31%
Mesioproximal	31	19%	23	18%	8	22%
Proximal	6	4%	6	5%	0	0%
Complete	64	40%	54	43%	10	28%
	162	100%	126	100%	36	100%

Table 15: Kara-Bom, OH6, blank preservation

	Total		Blade		Bladelet	
	N	*f*	N	*f*	N	*f*
Plain	39	39%	35	43%	4	22%
Facetted	41	41%	33	40%	8	44%
Dihedral Flat	7	7%	6	7%	1	6%
Undetermined	13	13%	8	10%	5	28%
	100	100%	82	100%	18	100%

Table 16: Kara-Bom, OH6, platform preparation

Facetted platform	Total		Blade		Bladelet	
	Thickness	Width	Thickness	Width	Thickness	Width
Sample size	40		32		8	
Mean (mm)	6.5	13	7.3	14.6	3.4	6.6
Standard deviation (mm)	4	7.3	4.1	7.2	1.2	2.6
Range (mm)	1.5 to 23.1	2.3 to 30.8	1.8 to 23.1	4.9 to 30.8	1.5 to 4.7	2.3 to 9.6

Table 17: Kara-Bom, OH6, facetted platform size

Plain platform	Total		Blade		Bladelet	
	Thickness	Width	Thickness	Width	Thickness	Width
Sample size	37		33		4	
Mean (mm)	4.9	10.1	5.3	10.8	1.3	3.8
Standard deviation (mm)	3.5	5.6	3.4	5.4	0.7	0.6
Range (mm)	0.7 to 17.4	2.3 to 25.4	1.1 to 17.4	2.3 to 25.4	0.7 to 2.3	3.2 to 4.6

Table 18: Kara-Bom, OH6, plain platform size

to the small sample size of the latter (Table 18). Nevertheless, blade plain platforms are statistically less thick than facetted platforms (Mann-Whitney, T=Ub=357.5, p=<.05), a trend that is also observed when considering blades and bladelets as a whole (Mann-Whitney, T=Ub=544.5, p=<.05). Dihedral platforms are not numerous (blade N=6, bladelet N=1) and show a flat morphology. They have a mean thickness of 4.7 ± 2.8 mm (ranging from 0.8 to 9.4 mm) and a mean width of 13.7 ± 7.6 mm (ranging from 4.7 to 27.5 mm). It appears that dihedral platforms are closer in size to the plain than to the facetted ones. No traces of abrasion occur on the external ridge of the platforms except in a few cases (N=6), where an intensive abrasion totally smoothed the external platform angle.

	Total	Blade	Bladelet
Sample size	64	54	10
Mean (mm)	71.7	78.2	36.6
Standard deviation (mm)	30.2	28.1	10.2
Range (mm)	17.1 to 152.9	27.9 to152.9	17.1 to 51.6

Table 19: Kara-Bom, OH6, blank length

Blank size attributes

Length

As length is measured only on complete elements, the results presented are based on a smaller sample. Blade and bladelet length ranges clearly overlap but the two categories have different means and standard deviations (Table 19). When considered as a whole, the distribution of length measurement appears to be normally distributed around a mean of 71.7 mm (Shapiro-Wilk, W=0.96, p= .06) (Figure 32).

Width

Means and standard deviations for the total sample are generally lower than for the MNI, with the exception of the bladelets which display a slightly lower means and standard deviations (Table 20). However, none of the observed differences are statistically significant. It suggests that there is no direct relationship between the width of the blank and the rate of breakage. In this case, repeating measurements on fragments coming from a same artifact would not affect the general trends visible in the overall popu-

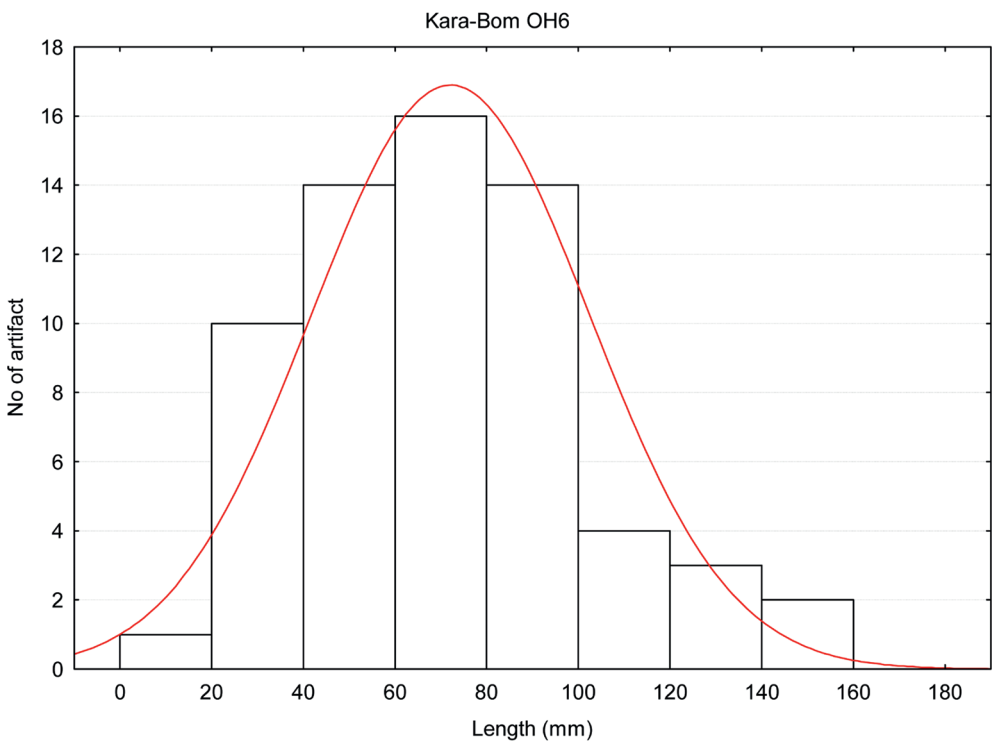


Figure 32: Kara-Bom, OH6, blank length distribution

	Total sample			MNI		
	Total	Blade	Bladelet	Total	Blade	Bladelet
Sample size	162	126	36	100	82	18
Mean (mm)	22	25.6	9.4	23.3	26.1	10.2
Standard deviation (mm)	11.2	10.1	1.7	11.2	10.4	1.5
Range (mm)	6.9 to 66.9	10.8 to 66.9	6.9 to 12.5	7.7 to 66.9	10.8 to 66.9	7.7 to 12.5

Table 20: Kara-Bom, OH6, blank width

lation. The width means of blade and bladelet categories appear different in both MNI and total sample, reflecting the arbitrary character of the classification of these two types.

However, the histogram of width measurements from the total sample and the MNI shows a bimodal distribution (Figure 33). The first mode is between 10-15 mm width and the second between 25-20 mm width. With respect to the smaller sample size, the two modes are also visible in the MNI distribution although in a less clear fashion. The positive skewness of the histograms (respectively 0.89 and 0.99 for the whole population and for the MNI) can be partly explained by an apparent size cut-off of 5 mm. After looking at the shatter from OH6 assemblage, it appears that it is not due to a selection or artificial cut-off post-excavation, but rather to the lack of systematic screening. As described in the following sections, it seems anyway unlikely that a large part of

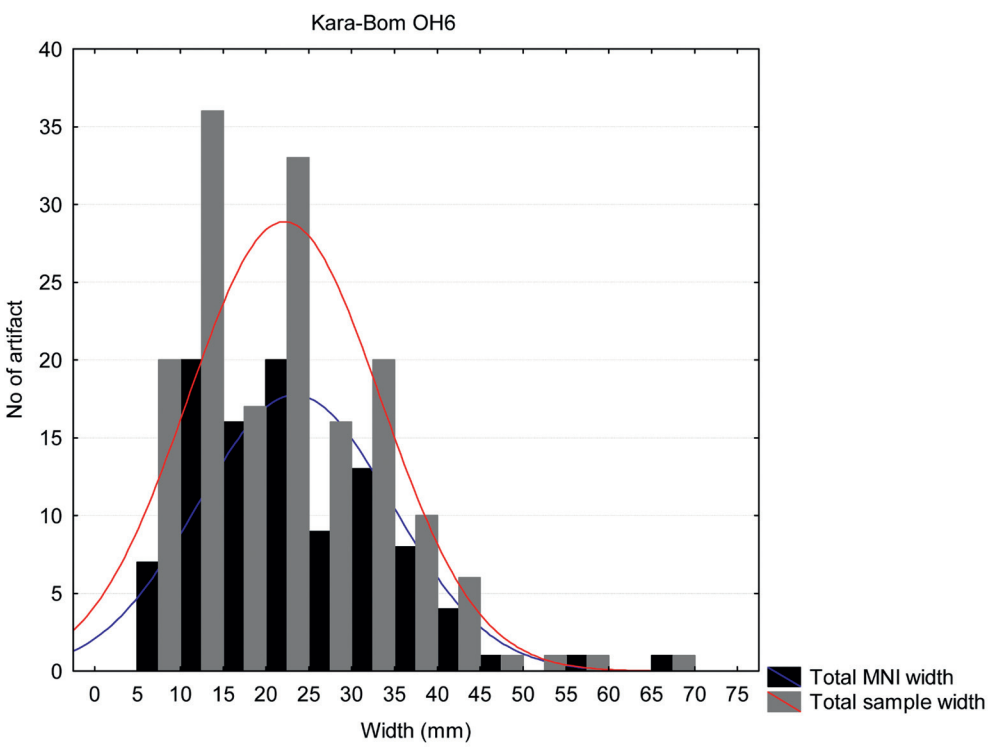


Figure 33: Kara-Bom, OH6, blank width distribution

	Total sample			MNI		
	Total	Blade	Bladelet	Total	Blade	Bladelet
Sample size	162	126	36	100	82	18
Mean (mm)	7.9	9.1	4	8.3	9.1	4.5
Standard deviation (mm)	4.4	4.3	1.6	2.1	3.9	1.7
Range (mm)	2.1 to 29.4	2.5 to 29.4	2.1 to 7.7	2.1 to 21.8	2.5 to 21.8	2.1 to 7.7

Table 21: Kara-Bom, OH6, blank thickness

the assemblage is missing, as cores that could testify of a systematic production of microblades are absent.

Thickness

Compared with the total population, MNI blank thickness shows equal or slightly higher mean values and also sometimes a smaller standard deviation (Table 21), although not significantly. As for the width, it seems that breakage does not influence significantly the main trends observed in terms of thickness in the sample considered. Blade and bladelet thickness clearly differ. The thickness histogram is unimodal and shows a positive skewness (respectively 1.45 and 0.85 for the whole population and for the MNI). The MNI, although based on less numerous measurements, shows a similar distribution to that of the total sample population (Figure 34).

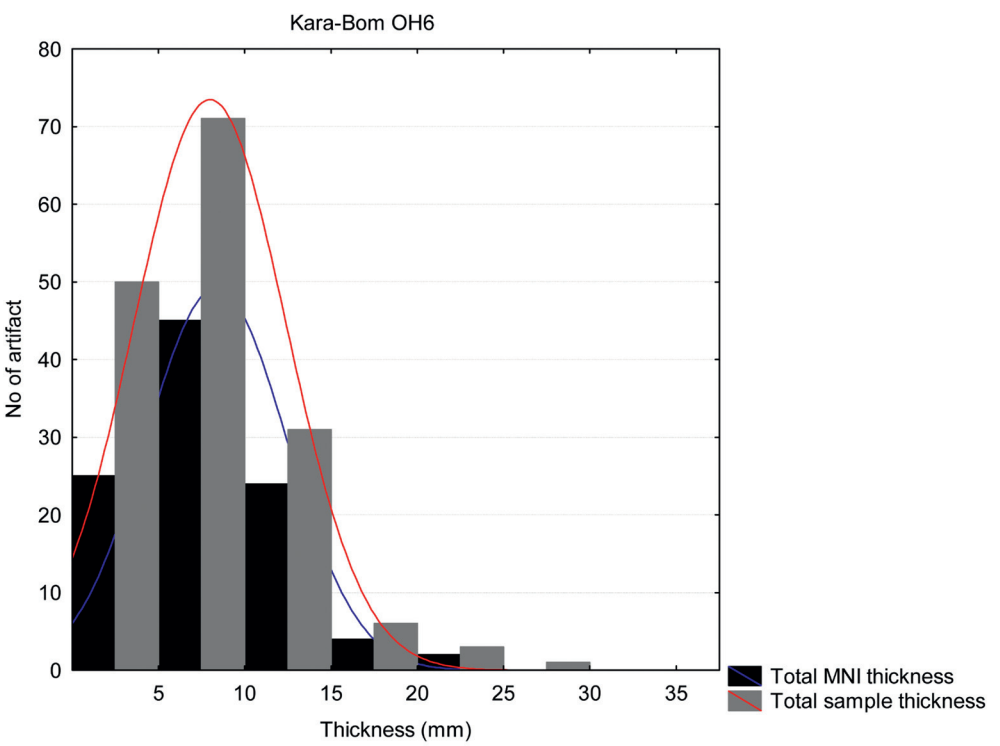


Figure 34: Kara-Bom, OH6, blank thickness distribution

Dorsal scar pattern

In spite of the quasi absence of cortex on the blanks, the occurrence of technical elements of various sizes, such as crested blanks, second crest *(sous-crete)* and neo-crest, shows that maintenance operations occur at different stages of the reduction sequence (Table 22). Unidirectional and bidirectional scar patterns have similar frequencies in the total sample (χ^2 (6)= 8.46, p=.21), and differences observed between unidirectional and bidirectional within blade and bladelets categories are not statistically significant. This coexistence of both bidirectional and unidirectional elements suggests that the main reduction sequences are not strictly unidirectional or alternate bidirectional.

However, the frequency of breakage of the blanks may bias this observation. In other words, blade fragments are more likely to be described as unidirectional (Bar-Yosef and Van Peer, 2009). When only complete elements are considered, the sample is reduced to 64 blanks.

Statistically, there are no significant changes when one compares the total sample with only the complete blanks. However, it appears that the unidirectional patterns are slightly overestimated in the total sample. Among the complete blanks, a shift of approximately 10% from unidirectional to bidirectional is observed, the sharpest change occurring in the bladelet category (Table 23). Within the latter, bidirectional patterning becomes significantly dominant

	Total		Blade		Bladelet	
	N	*f*	N	*f*	N	*f*
Unidirectional	78	48%	65	52%	13	36%
Unidirectional and cortex	1	1%	1	1%	0	0%
Bidirectional	67	41%	47	37%	20	56%
Crest	2	1%	2	2%	0	0%
Second Crest	5	3%	4	3%	1	3%
Neo-crest	8	5%	7	6%	1	3%
Undetermined	1	1%	0	0%	1	3%
	162	100%	126	100%	36	100%

Table 22: Kara-Bom, OH6, dorsal scar pattern

	Complete blank		Complete blade		Complete bladelet	
	N	*f*	N	*f*	N	*f*
Unidirectional	24	38%	22	41%	2	20%
Bidirectional	33	52%	25	46%	8	80%
Crested	7	11%	7	13%	0	0%
	64	100%	54	100%	10	100%

Table 23: Kara-Bom, OH6, dorsal scar patter frequencies among complete blanks

(χ^2 (1)= 7.2, p= <.05) although this observation is balanced by a reduction of the sample size.

Cross-section

A majority of triangular and trapezoidal cross-sections is observed in both blade and bladelet categories, which are equally represented when considering the total sample from OH6 and show minor differences within the blade category (Table 24).

However, in the bladelet category, triangular elements are significantly dominant, indicating the frequent use of a single ridge during the production of small laminar blanks.

Profile

Straight profiles clearly dominate the sample, directly followed by slightly curved and curved blanks. This trend is expressed in both categories. Twisted profiles are almost totally absent (Table 25).

As for the dorsal scar pattern, profile frequencies can be biased by breakage. The trends observed on the total sample are present in the MNI sample (Table 26) and show that breakage does not affect the profile determination.

	Total		Blade		Bladelet	
	N	*f*	N	*f*	N	*f*
Flat	3	2%	2	2%	1	3%
Rectangular	1	1%	0	0%	1	3%
Triangular	80	49%	58	46%	22	61%
Trapezoidal	77	48%	65	52%	12	33%
Polyhedral	1	1%	1	1%	0	0%
	162	100%	126	100%	36	100%

Table 24: Kara-Bom, OH6, type of cross-section

	Total		Blade		Bladelet	
	N	*f*	N	*f*	N	*f*
Straight	117	72%	94	75%	23	64%
Slightly Curved	33	20%	25	20%	8	22%
Curved	7	4%	4	3%	3	8%
Twisted	4	2%	2	2%	2	6%
Undetermined	1	1%	1	1%	0	0%
	162	100%	126	100%	36	100%

Table 25: Kara-Bom, OH6, type of profile

	Total		Blade		Bladelet	
	N	*f*	N	*f*	N	*f*
Straight	71	71%	60	73%	11	61%
Slightly Curved	19	19%	16	20%	3	17%
Curved	5	5%	3	4%	2	11%
Twisted	4	4%	2	2%	2	11%
Undetermined	1	1%	1	1%	0	0%
	100	100%	82	100%	18	100%

Table 26: Kara-Bom, OH6, type of profile based on MNI

Orientation

It appears that axial blanks are the most common within the blade sample, with only 19% of the blanks being off-axis. Bladelets seems to show a similar pattern although for a large part of the fragments, the orientation could not be determined (Table 27).

When looking at the MNI, the frequencies of undetermined orientation sharply decrease as the orientation can be determined more easlily when the platform is preserved. It appears that the trends observed on the total sample are confirmed by the observations on the MNI, showing that in this case, the fragmentation of blanks does not significantly affect

	Total		Blade		Bladelet	
	N	*f*	N	*f*	N	*f*
Right	11	7%	8	6%	3	8%
Left	20	12%	17	13%	3	8%
None	95	59%	80	63%	15	42%
Undetermined	36	22%	21	17%	15	42%
	162	100%	126	100%	36	100%

Table 27: Kara-Bom, OH6, blank orientation

	Total		Blade		Bladelet	
	N	*f*	N	*f*	N	*f*
Right	10	10%	8	10%	2	11%
Left	17	17%	14	17%	3	17%
None	70	70%	58	71%	12	67%
Undetermined	3	3%	2	2%	1	6%
	100	100%	82	100%	18	100%

Table 28: Kara-Bom, OH6, blank orientation based on MNI

the determination of orientation. Moreover, differences become larger in spite of the reduction of the sample size (Table 28).

3.3.2 CORES: REDUCTION PATTERNS AND SIZE ATTRIBUTES

From a general point of view, cores are not numerous within the OH6 sample. Among 14 cores identified, four are produced on small blocks or slabs (Mode A): two being flat-faced bidirectional cores with two independent flaking surfaces and two being semi-turning bidirectional cores. The majority of the cores are produced on blade blanks (Mode B), with six of them being unidirectional, and four of them being bidirectional (Figure 35).

	n	%
A1		
A2		
A3		
A4		
A5		
A6	2	14%
A7		
A8		
A9		
A10	2	14%
A11		
A12		
B1	3	21%
B2		
B3		
B4		
B5	6	43%
B6		
B7	1	7%
	14	100%

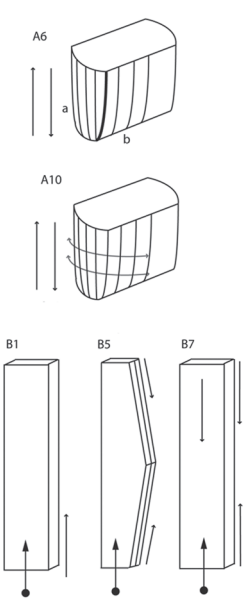


Figure 35: Kara-Bom, OH6, frequencies of cores per Mode

Size attributes

All measurements are recorded according to the system described in Chapter 2 which does not change based on the type of blank on which the core is produced. As a result, measurements are comparable, but in the case of Mode B cores, the thickness corresponds to the length of the blade blank, and the length of the core represents the thickness of the blade. No differences observed are statistically significant, except core length (Mann-Whitney, T=Ub=0, p=<.05) and the flaking surface width (Mann-Whitney, T=Ub=3, p=<.05) both of which are smaller in Mode B cores. With small sample sizes, Mann-Whitney U test has little power and tends to produce Type II errors. In this case, the results are not biased by the sample size. Differences in core length and flaking surface width reflect the fact that Mode B cores have their flaking surface located on the narrow edge of a blade blank, the latter, although relatively thick, remains generally thinner than a Mode A core on block. It is, however, clear that the rest of the values have a quite similar mean. When leaving out KB-92. YO6.J8.3.1761 (Figure 49) (although being a core on blade blank, it is technologically similar to Mode A6 cores), the size differences between the two Modes are more clearly expressed, reflecting different constraints in flaking surface size depending on the type of core blank.

Striking platform preparation

Striking platforms are mainly facetted with a frequency equal to the sum of the other categories (Table 30). The situation is similar when looking at the Mode B cores but is more balanced than in the Mode A cores. Based on such a small sample size, it is not possible to draw any definite conclusions; however, facetted platforms seem more represented in the bladelet category although there is no clear relationship between blank size and type of preparation. Profiles of the Mode A last removals are curved (N=1), slightly curved (N=1), straight (N=1) and undetermined (N=1). In Mode B, they are straight (N=4), twisted (N=1), slightly curved (N=1) and undetermined (N=4). From a general point of view, core management consists in occasional rejuvena-

	Mode A			Mode B		
	Mean	σ	N	Mean	σ	N
Core length	65.2	19.3	4	14.2	4	10
Core width	39.4	19.3	4	28.7	9.6	10
Core thickness	37.1	19.6	4	60.4	11.9	8
Flaking surface length	61	18	4	55.1	9.3	7
Flaking surface width	37	22.3	4	17.3	2.6	7
Last removal length	60	12.5	3	39.3	8.3	7
Last removal width	14.3	4.4	3	14.2	2.8	7

Table 29: Kara-Bom, OH6, general size values (mm) per core Mode

	Total		Mode A		Mode B	
	N	*f*	N	*f*	N	*f*
Plain	1	7%	1	25%	0	0%
Facetted	7	50%	1	25%	6	60%
Reshaped	4	29%	2	50%	2	20%
Undet	2	14%	0	0%	2	20%
	14	100%	4	100%	10	100%

Table 30: Kara-Bom, OH6, type of striking platform preparation

tions of the striking platform by faceting, or by removing a complete or a partial tablet. As described in the following section, the use of neo-crests or *débordant* blades is rather often observed on the cores at the intersection of two surfaces, with the occasional occurrence of a posterior crest. The latter can be to prepare a new flaking surface but is also known in various UP contexts as a procedure to prepare lateral convexities of a volumetric blade core (*e.g.* Pigeot, 1987). Distal shaping of flaking surfaces is almost absent and the general reduction pattern is rather parallel. In fact, all cores show parallel reduction patterns except two of the Mode B type, one shows convergent removals (KB-92.YO6. Z8.58) and one remains undetermined.

Core descriptions

Mode A6 (N=2)

∗ KB-92.Y06.J8.31.1698

This core is produced on a block showing two independent flaking surfaces and two opposed platforms. The right side and the back of the block are still fully cortical. The first flaking surface shows a succession of two laminar removals (1 and 2) struck from the lower platform followed by a switch to the upper platform. A first blade is detached from the junction between the two flaking surfaces (3), followed by a series of three hinged removals (4-6). The second flaking surface shows a single clear blade removal (1) followed by three hinged removals struck from

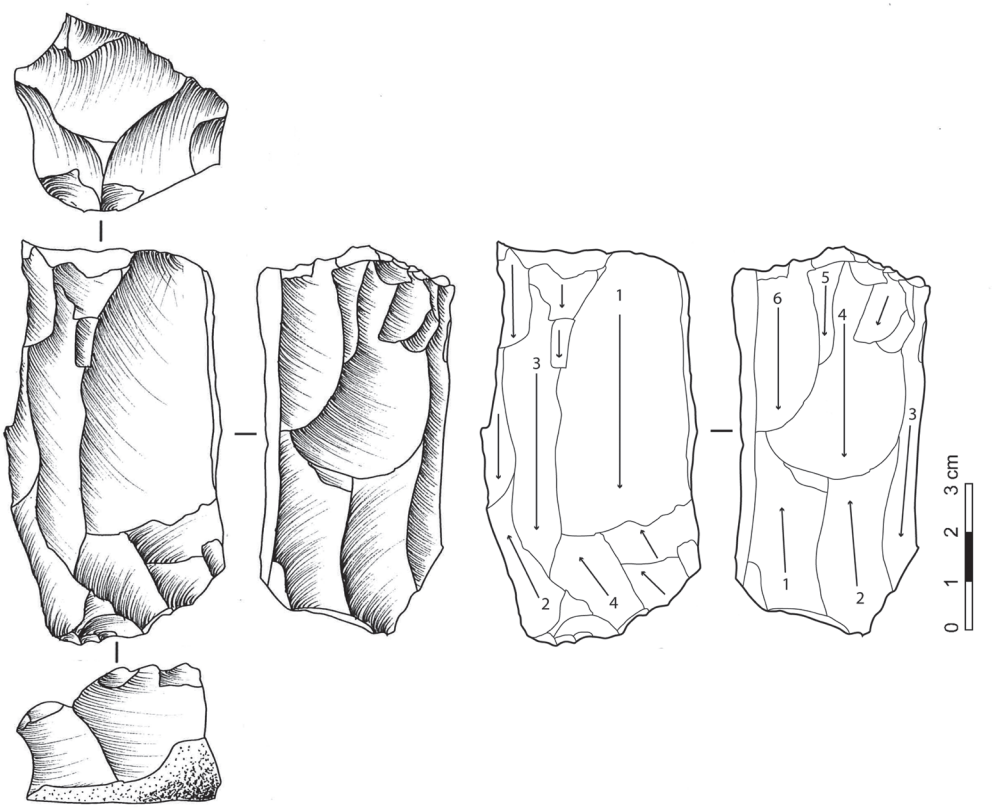


Figure 36: Kara-Bom, OH6, KB-92.Y06.J8.31.1698

the lower platform, one of which (4) is interpreted as an attempt to remove a side blade from the junction of the two flaking surfaces. Two additional small removals indicate another attempt to remove a blade from the same ridge but from the upper platform.

The upper striking platform is shaped by radial flaking removing several partial tablets. The lower platform shows less intense preparation, the surface being shaped by two sub-cortical hinged removals.

∗ KB-92.YO6.Z7.12.513

This core presents two flaking surfaces opposed to a cortical back prepared by radial flaking (Figure 37). The larger surface displays negatives of a bidirectional blade production following a short series of 3-4 relatively wide removals detached from two opposed platforms. The second flaking surface is located on the left narrow side, as shown by a series of laminar removals detached from two opposed platforms.

The striking platforms are shaped by flake removals opening a plain surface and creating an acute angle at the junction between the flaking surface and the back of the core. As far as it can be observe, early stages of the reduction indicate (1) the use of two opposed platforms at the junction between the right lateral and the broad flaking surface and on its left ends. The second phase takes place in the middle of the broad flaking surface (2) and is followed by a removal in the middle (3), both struck from the lower platform. It is followed by a switch to the upper platform with a small flake and a more elongated removal (4) and by a hinged central blade removal (5). Then, following a hinged removal (6), two removals (7) are likely attempts to remove the negatives left by the previous knapping accident. The last stages of reduction take place on the narrow flaking surface on the left side of

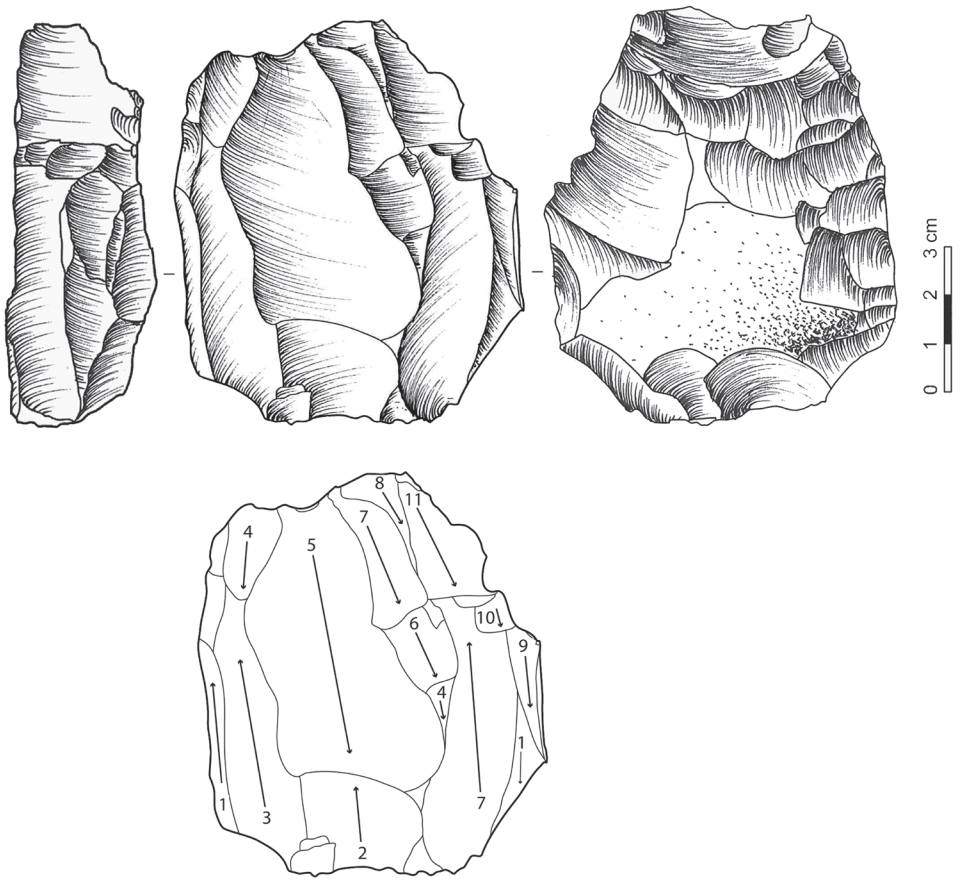


Figure 37: Kara-Bom, OH6, KB-92.YO6.Z7.12.513

the core. A lateral removal scar (9) is followed by severe hinged fractures (10 and 11) struck from the upper platform. At first glance, the core seems to show two independent flaking surfaces (cfr. Mode A6). The radial preparation of the back suggests a surface approach similar to the Levallois method (Boëda, 1994). However, the last removals are located at the junction between the two surfaces. Hinge fractures illustrate a significant number of attempts to remove a side blade, reshaping the lateral convexity of the wider flaking surface. Thus, considering the possible interaction between the two surfaces, the reduction is not only based on the treatment of a surface (like in a Levallois blade core) but rather illustrates a sub-volumetric approach. The general orientation of removals indicates a parallel pattern of reduction.

Mode A10 (N=2)

* KB-92.YO6.Z9.9.67

This core is produced on a slab preserving both cortical lateral surfaces (Figure 38). The back of the core is crested by alternate removals. It displays a single flaking surface located on the narrow edge of the slab. Removals are detached from two opposed platforms, the earliest being located at the intersection between the right lateral face and the main flaking surface. The reduction sequence reconstruction shows frequent platform switches with the two first removals (1 and 2) showing a change from the upper to the lower platform. Although it is not possible to establish a precise chronology of the platform switches, it seems likely that the reduction progressed by short sequences of several removals

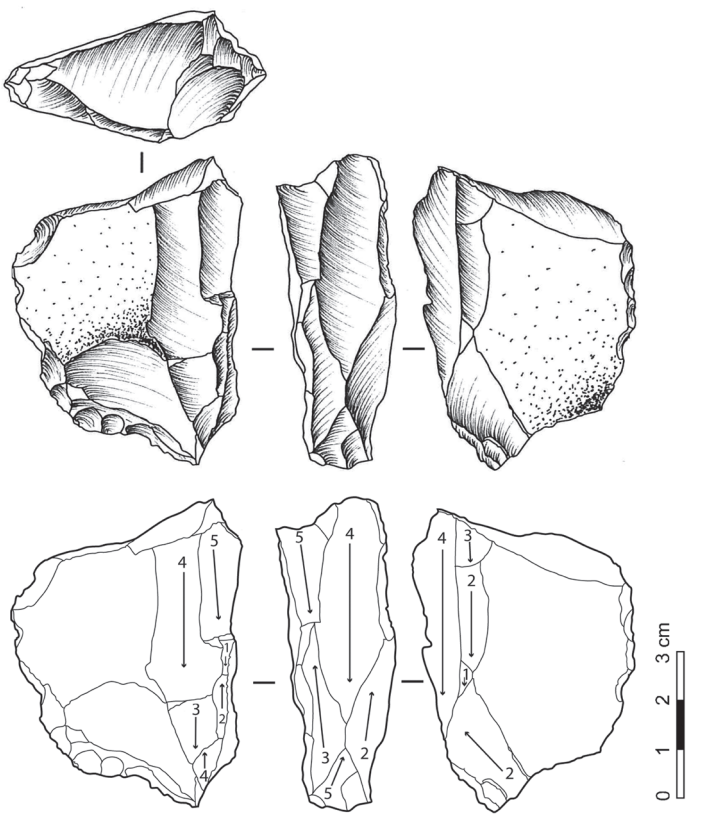


Figure 38: Kara-Bom, OH6, KB-92.YO6.Z9.9.67

rather than by a strict alternate bidirectionality. The lower platform is missing due the last series of removals, the upper platform shows several removal scars which most likely indicates several phases of rejuvenation, as well the remaining part of a preparation by faceting. A clear negative correspond to a small blade removal of 46 mm length for a minimum of 13 mm width. The latter follows the ridge produced by the two opposed removals detached from the lower platform. The cross-section of the core indicates a semi-turning reduction pattern as described by Pigeot (1987). Orientation of the removals seems to indicate a sub-parallel reduction, which ends on the upper platform by a hinge fracture.

∗ KB-92.YO6.Z7.50.948

This core of a rather small size is produced on an unknown blank type (Figure 39). The sides have been shaped by lateral and longitudinal flaking that may have been linked with a first flaking surface. It shows two platform switches. A first removal is detached from the upper platform followed by two removals from the lower platform and a last one struck from the upper platform. All removals are detached along the longitudinal axis, but the flaking surface tends to extend from a broad toward a narrow flaking surface.

Mode B1 (N=3)

∗ KB-92.YO6. Z8.58.58

This core is produced on cortical laminar blank bearing negatives of anterior removals on its back (Figure 40). A single flaking surface shows a series of three removals struck from a single platform and following the longitudinal axis of the blank. Two last hinged negatives follow a perpendicular flake removal and likely represent the final stage of the reduction at the right corner of the flaking surface. A

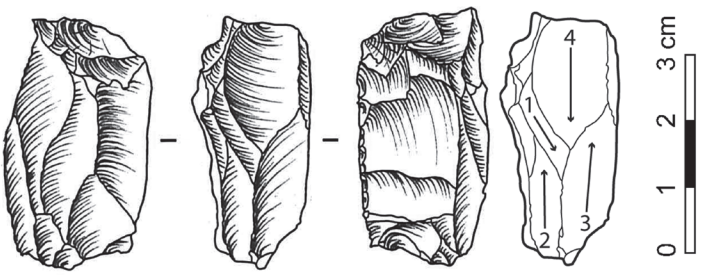


Figure 39: Kara-Bom, OH6, KB-92.YO6.Z7.50.948

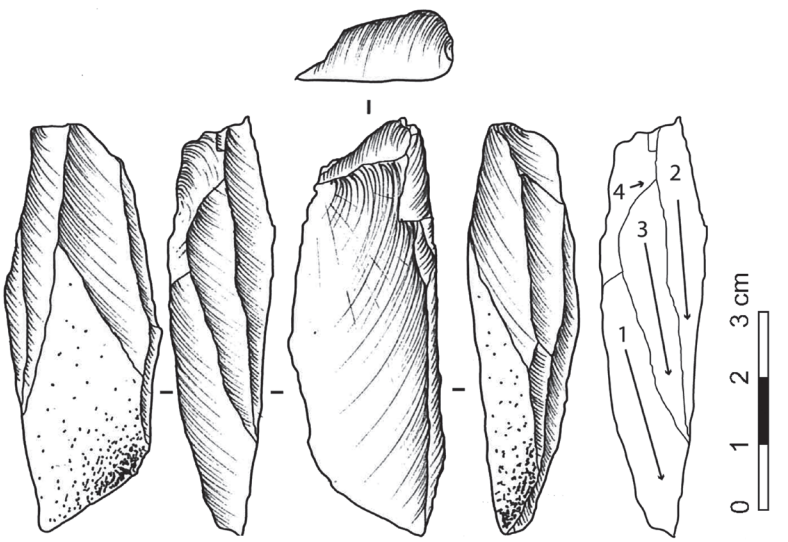


Figure 40: Kara-Bom, OH6, KB-92.YO6. Z8.58

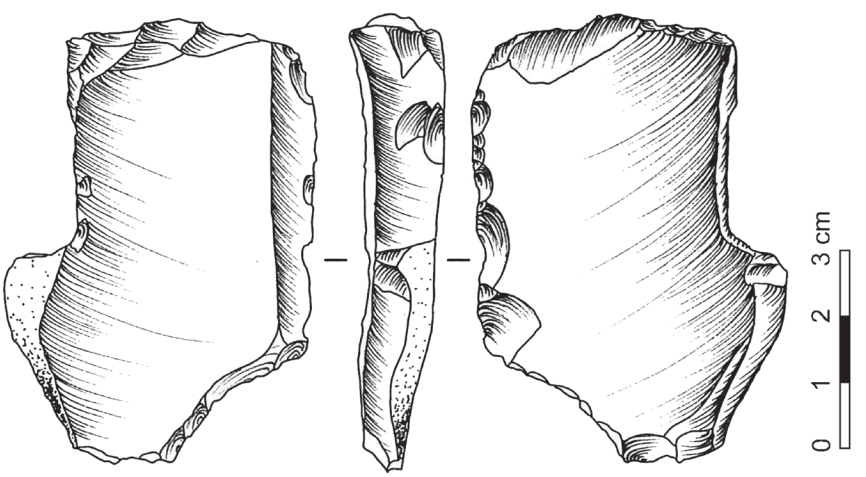


Figure 41: Kara-Bom, OH6, KB-92.YO6.I9.5.1280

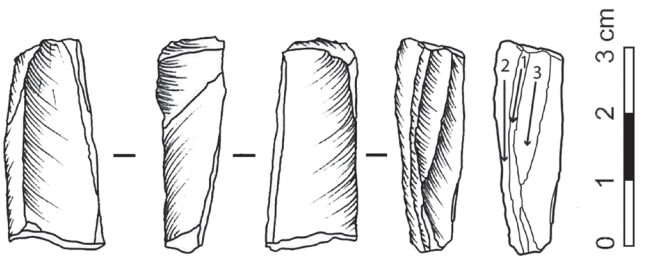


Figure 42: Kara-Bom, OH6, KB-92.YO6.I8.12.48

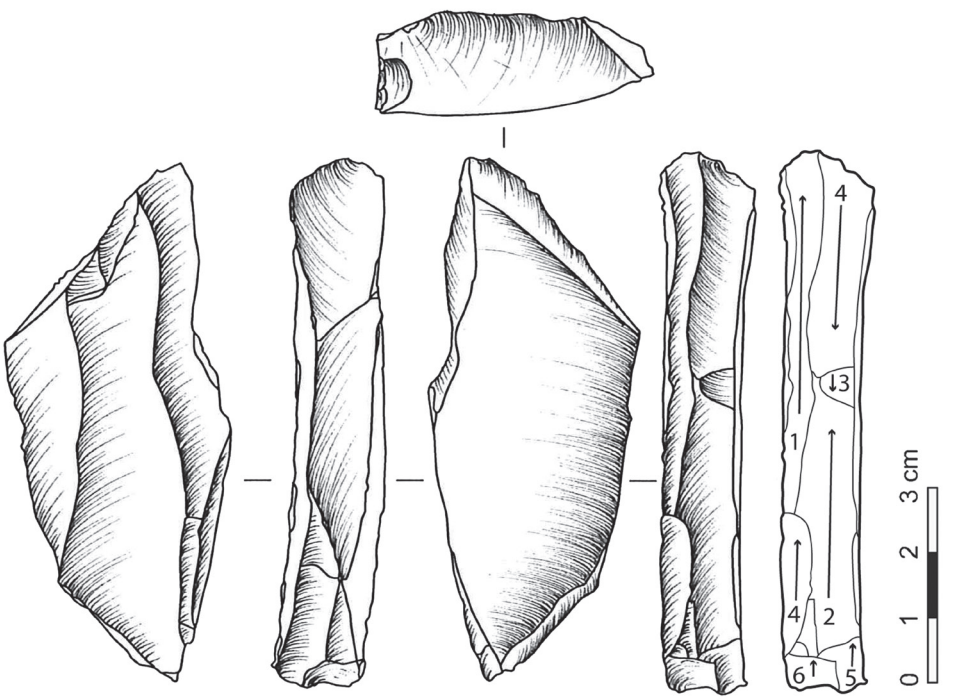


Figure 43: Kara-Bom, OH6, KB-92.YO6.J6.6. 1987

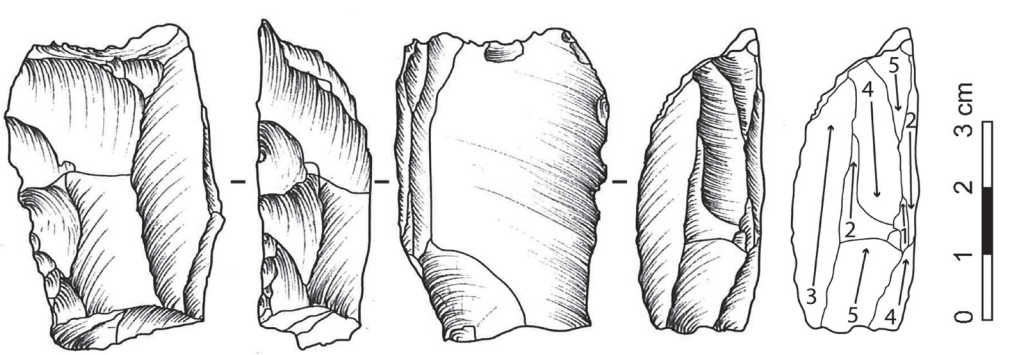


Figure 44: Kara-Bom, OH6, KB-92.YO6. Z7.38.168

single removal negative represents the only visible management of the striking platform.

∗ KB-92.YO6.I9.5.1280

This artifact is a wide laminar cortical blank bearing unidirectional negatives on the dorsal face (Figure 41). It bears a distal truncation and inverse irregular retouch. Two removals were detached from the upper platform along the cortical right edge, followed by two hinged removals ending the reduction process. Judging by the dorsal scar pattern, the blank was likely a larger blade and typologically could be described as a burin on a truncation (Demars and Laurent, 1992).

∗ KB-92.YO6.I8.12.48

This artifact is described as a fragment of a core produced on a laminar blank (Figure 42). Three removals detached from the proximal end of the blank can be observed. They follow the longitudinal axis of the blank. This core shows some of the smallest last removals observed within the OH6 sample.

Mode B5 (N=6)

∗ KB-92.YO6.J6.6. 1987

This artifact is produced on a unidirectional blade blank showing removal scars along the right edge (Figure 43). A relatively narrow flaking surface displays negatives of a bidirectional reduction system operated from two opposed platforms. The upper platform displays clear waves caused by a snapping event above which small negatives from the preparation of the platform by faceting are still visible. The lower platform shows a minimum of three removals associated with the detachment of a partial tablet. Chronological reconstruction seems to suggest that at least sometimes; removals are covering the whole length of the flaking surface (1). A short sequence of two removals starts from the lower platform (1 and 2) before switching to the upper platform (3). The next phase is characterized by the occurrence of two hinged negatives (4) from both platforms, ending the reduction process. Typologically, this piece is close to the polyhedral burin *(burin polyedrique)* described in Late Gravettian context (*e.g.* Hahn, 1969; Klaric *et al.*, 2009).

∗ KB-92.YO6. Z7.38.168

This artifact is produced on a blade blank and is remarkable for its reduced size (Figure 44). The back shows a crested morphology anterior to the last rejuvenation of the lower platform. It is not clear if it has to be considered as a morphological feature occurring on the blank prior to when the reduction started or if it corresponds to a later preparation. A single flaking surface is located along the right edge of the blank. Removal are detached from two opposed striking platforms and following a longitudinal axis.

The earliest visible removals are detached from the lower platforms from right to left in two sequences (1-3 and 3-5) before a switch to the upper platform. A single removal (2) seems to have successfully covered the whole length of the flaking surface and is followed by a hinged fracture (4) and a very small removal (5). The second platform switch starts by an attempt to detach a blade from the left corner of the flaking surface followed by another hinged fracture (5) that marks the end of the reduction process. Both striking surfaces have been reshaped by a single (upper) or several removals (lower).

∗ KB-93.YO6. E8.1.4321

This is another example of small sized cores produced on thick laminar blanks showing two opposed striking platforms (Figure 45). Small laminar blanks are detached along the longitudinal axis, by alternate bidirectional reduction. The ventral side of the core blank displays perpendicular flake scars. By following a single ridge, one of the removals is naturally pointed and likely has a triangular cross-section. Both striking platforms have been reshaped by radial removals.

∗ KB-92.YO6.Z6.14.758

The core is produced on a segment of neo-crested blade removed from a large blade core (Figure 46). It displays two opposed plain platforms. Platforms bear clear traces of snapping events, especially on

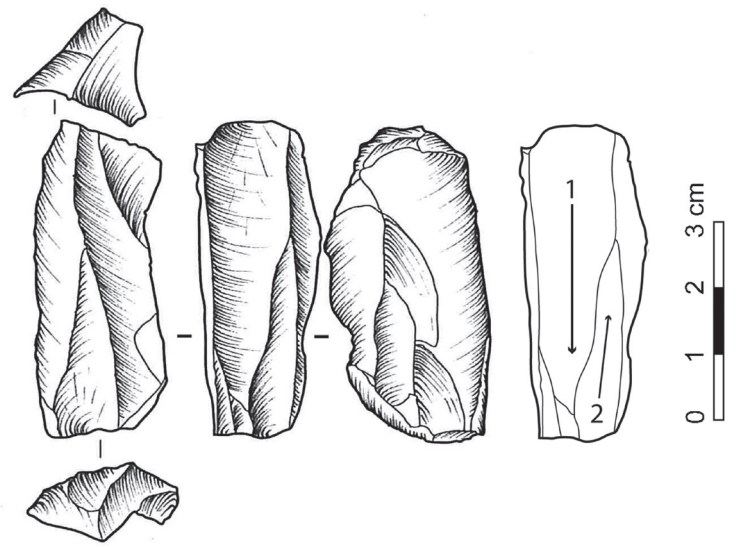


Figure 45: Kara-Bom, OH6, KB-93.YO6. E8.1.4321

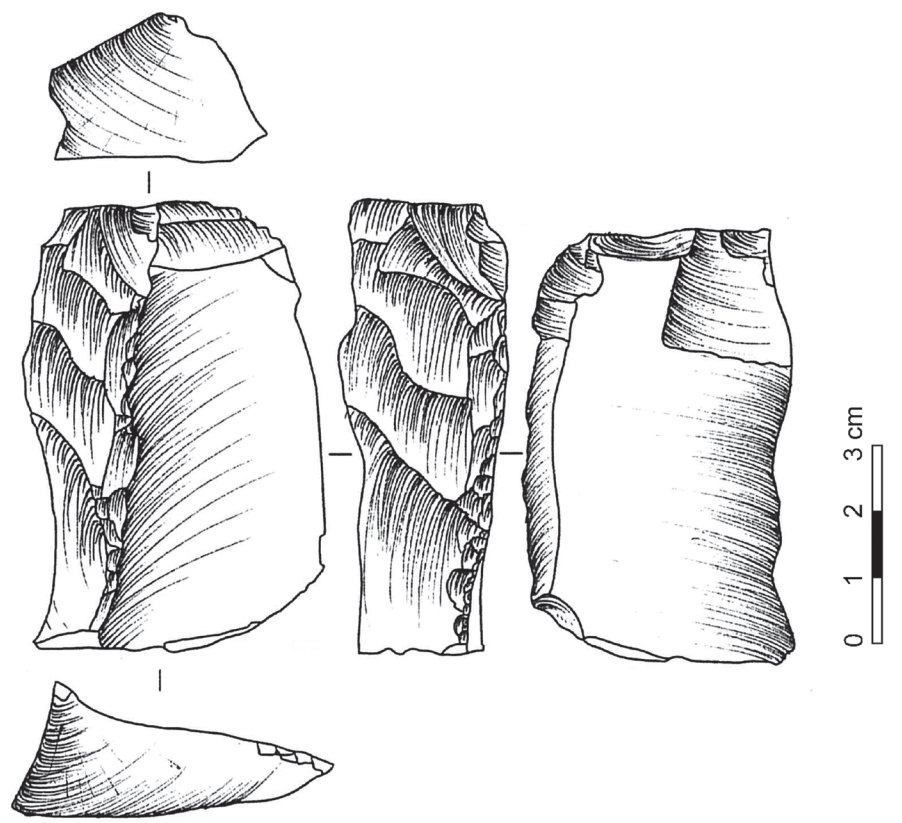


Figure 46: Kara-Bom, OH6, KB-92.YO6.Z6.14.758

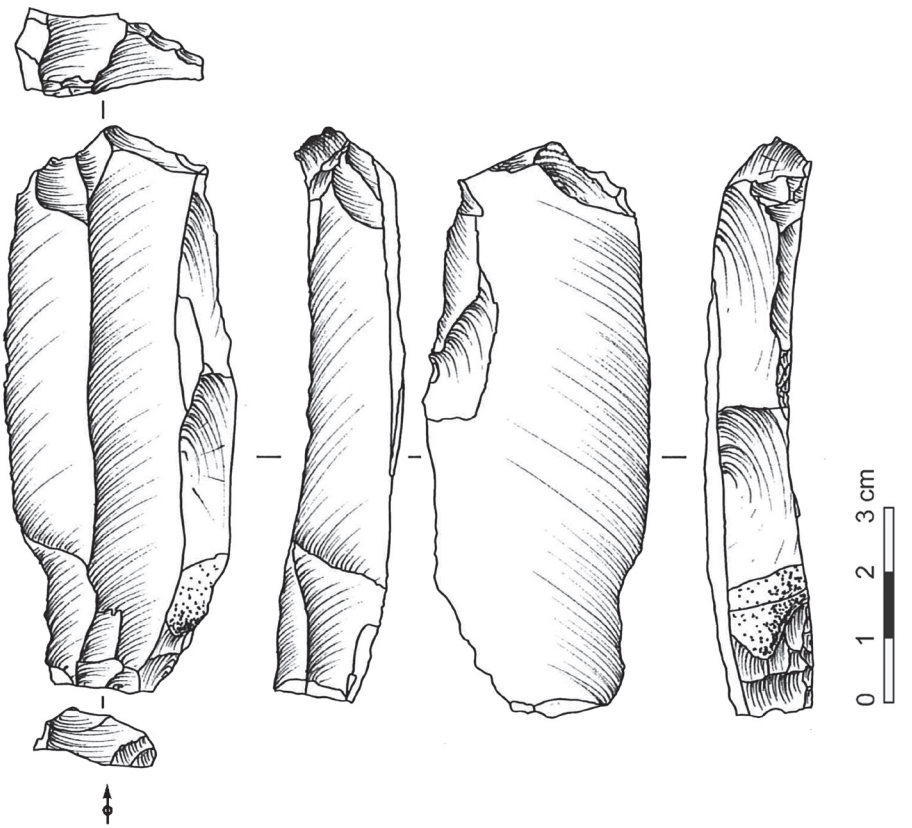


Figure 47: Kara-Bom, OH6, KB-92.YO6. I9.5.1280

the lower platform on which an impact is still visible. One laminar removal is detached from the lower platform and follows the longitudinal axes along the left edge of the blank. At least two more attempts failed as shown by the succession of hinged removals detached from the upper platform. Another hinged flake is visible on the ventral face of the blank.

∗ KB-92.YO6. I9.5.1280

This core is produced on a second crest blade bearing unidirectional dorsal scar patterns (Figure 47). Although little evidence of reduction can be observed, the preparation of a striking platform struck from the ventral side, at the distal end of the blank, and the perpendicular flake removed from the ventral face prior to the detachment of thin spall illustrate the initial stages of reduction. The lower striking platform is set up by the removal of the core blank platform from which two hinged flakes are struck. This artifact is typologically a *burin dièdre d'angle* (Demars and Laurent, 1992).

∗ KB-92.YO6.I8.12.48

This artifact is likely a fragment of a larger core produced on a blade blank. It displays a preparation of the striking platform as shown by the dihedral morphology of the distal end (Figure 48). The right edge shows several removal negatives, showing that the longitudinal edge is used as a flaking surface.

In this case, it is however not possible to push further the description and many questions remain regarding the original size and the stage of reduction of the core prior to the breakage event.

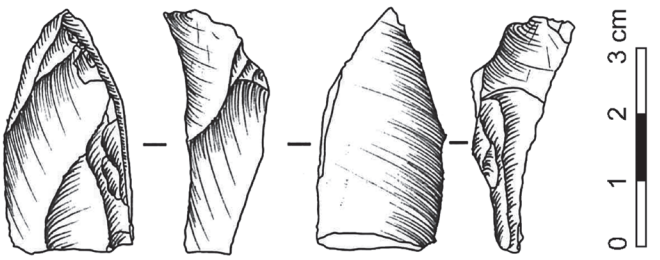


Figure 48: Kara-Bom, OH6, KB-92.YO6.I8.12.48

Mode B7 (N=1)

∗ KB-92.YO6.J8.3.1761

Produced on a blade blank, this core shows two flaking surfaces, one on the dorsal face and one located on the right lateral edge (Figure 49). The broader surface shows bidirectional removals of laminar flakes struck from two opposed platforms prepared by faceting (truncation). The narrow one shows the remains of a crest on the upper platform, independent of the platform on the broader flaking surface. This crest is posterior to a removal detached from the upper platform and is likely guiding a laminar removal struck from the lower platform. The ventral face bears removals detached prior to the last preparation of the lower platform.

The general pattern of reduction is parallel. The relationship between the two flaking surfaces, however, is not as clear as for larger blade cores. It cannot be excluded that the side removals play a role in the management of the lateral convexities. Such management operation may occur as a laminar reduction of a broad flaking surface necessarily lead to a flattening of the core. This artifact shows numerous similarities with blade cores or with the general reduction pattern of bladelet core of 'Kostenki technique' (*e.g.* Slimak and Lucas, 2005). Similar objects are classified by Dibble and McPherron (2007) and as flake cores, but typologically, they fit in the truncated-facetted category (Schroeder, 1969, 2007), Nar-Ibrahim truncation (Solecki and Solecki, 1970) or Kostenki knives (Efimenko, 1958; Turq and Marcillaud, 1976; Escutenaire, 1997).

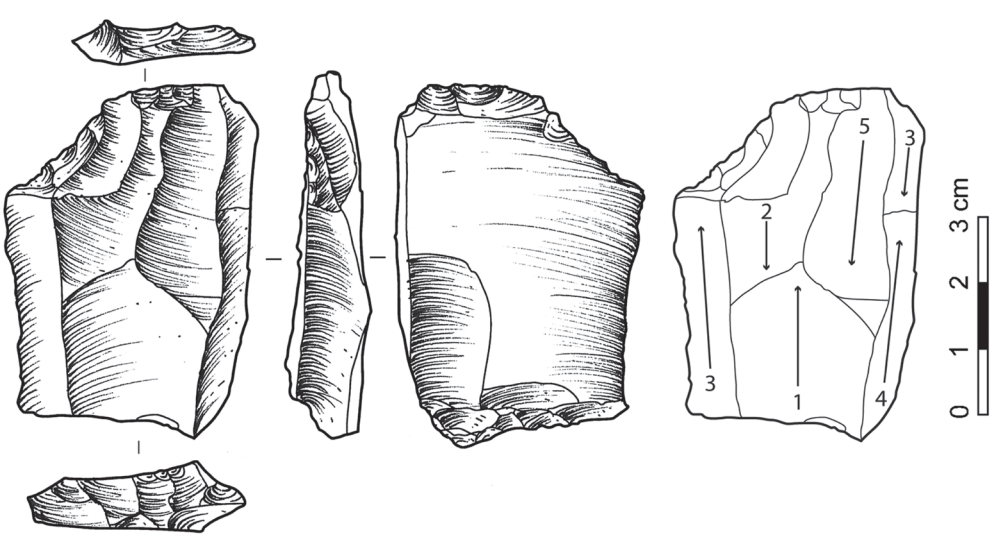


Figure 49: Kara-Bom, OH6, KB-92.YO6.J8.3.1761

3.3.3 REDUCTION SEQUENCE RECONSTRUCTION

Following the results of the blank attribute analysis and the core descriptions, an analytical reconstruction of the individual reduction sequences is proposed in the following section.

Laminar blanks with parallel edges

From a morphological point of view, two main types of blade are observed. The first category corresponds to artifacts displaying parallel edges starting from the mesial part. This type of blank covers the whole range of length and width observed in the OH6 sample. Dorsal scar patterns show a coexistence of uni- and bidirectional reduction process. The largest complete examples show that the maximum length of such blades sometimes exceeds 160 mm. Starting from the earliest stage of reduction, crested blades are used to enhance or create the first guiding ridge but also to maintain a certain degree of lateral convexities of the flaking surfaces. These management operations occur all along the reduction process, as shown by the various sizes of neo-crested blanks (Figure 50).

Although not numerous and heavily reduced, large/medium size blade cores are mainly produced on blocks or nodules (Mode A). The reduction sequence reconstruction illustrates a succession of short unidirectional sequences followed by a change to the opposed platform. This situation is reflected by the roughly equivalent frequency of uni- and bidirectional dorsal scar patterns. Strict alternate bidirectionality (showing a platform switch after each removal) seems unusual on Mode A cores. Blank cross-sections are mostly triangular or trapezoidal showing a frequent use of multiple ridges guiding the detachment of laminar blanks. The short unidirectional sequences do not follow a clear systematic path, although the largest blade core presents a series of 2-3

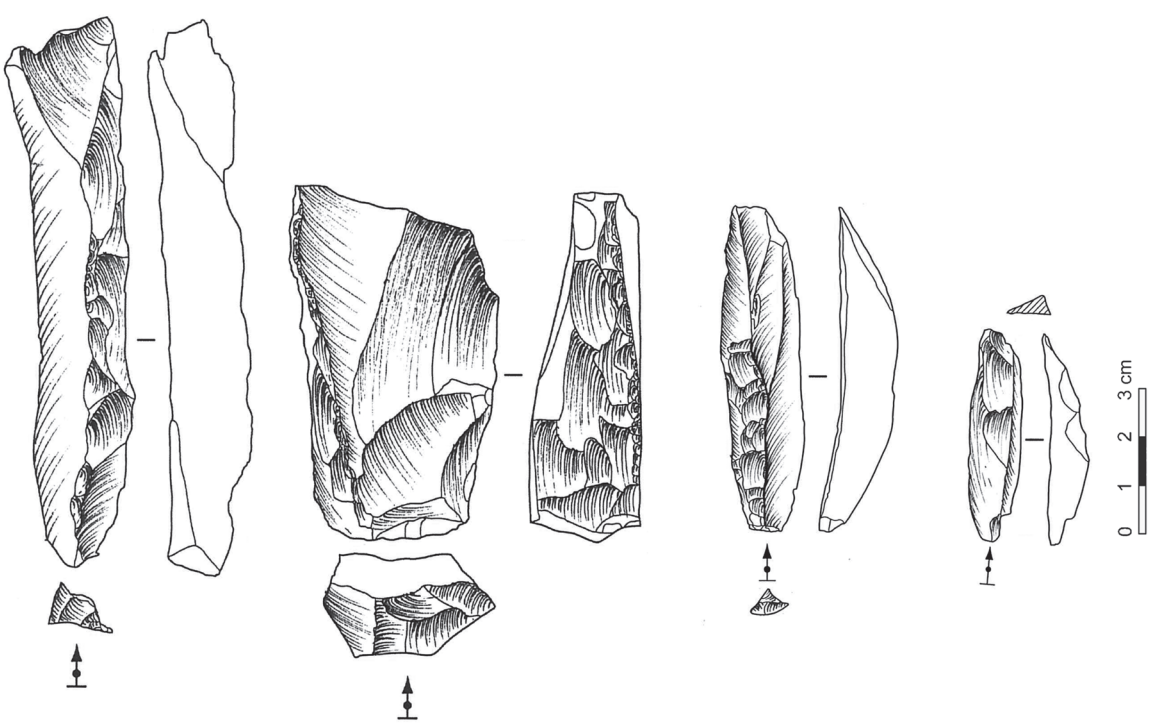


Figure 50: Kara-Bom, OH6, crested blanks

removals from left to right, using the previous scar as a ridge (see Figure 36). All Mode A cores show a use of two flaking surfaces, either independently (Mode A6) or in continuity (Mode A10). These two variants are, however, very similar and may reflect different stages of reduction. From time to time, a thick blade (crested or not) is detached from the intersection of two surfaces in order to reshape the lateral convexity of the core. Although blanks can be produced from both surfaces, diacritic reconstructions show that the reduction takes place mainly on the broader surface and extends to the narrow face during the final phase (see Figure 36 and Figure 37). This could indicate a secondary role of the narrow face, mainly used to remove the crested elements necessary to reshape the convexity of the broader surface. In this case, the two flaking surfaces are not strictly independent nor in continuity (semi-turning reduction), but rather inter-dependent. In addition, the presence of *débordant*, facetted platforms on thin blades indicates that the reduction can also takes place at the junction of the two surfaces.

The situation is slightly different for the small size blade/bladelet production. This type of blank is mainly detached from cores on blades (Mode B). Core blanks are selected among the thickest laminar blanks. As illustrated on Figure 51, the distribution of core blank thickness for Mode B overlaps with the thickest 25% of the total sample of blades and with the blade MNI. Statistically, the medians of core blank thickness differ from overall blade thickness (Mann-Whitney, T=Ub=186.5, p=<.05) and MNI blade thickness (Mann-Whitney, T=Ub=133.5, p=<.05) showing that they belong to a different population. In other words, the thickest byproducts from the large blade production are selected and transformed into cores for the production of smaller blanks. The thickest blades are mainly crested blanks, or *débordant* blades, removed from the intersection of the flaking surface and the lateral side of the blade core.

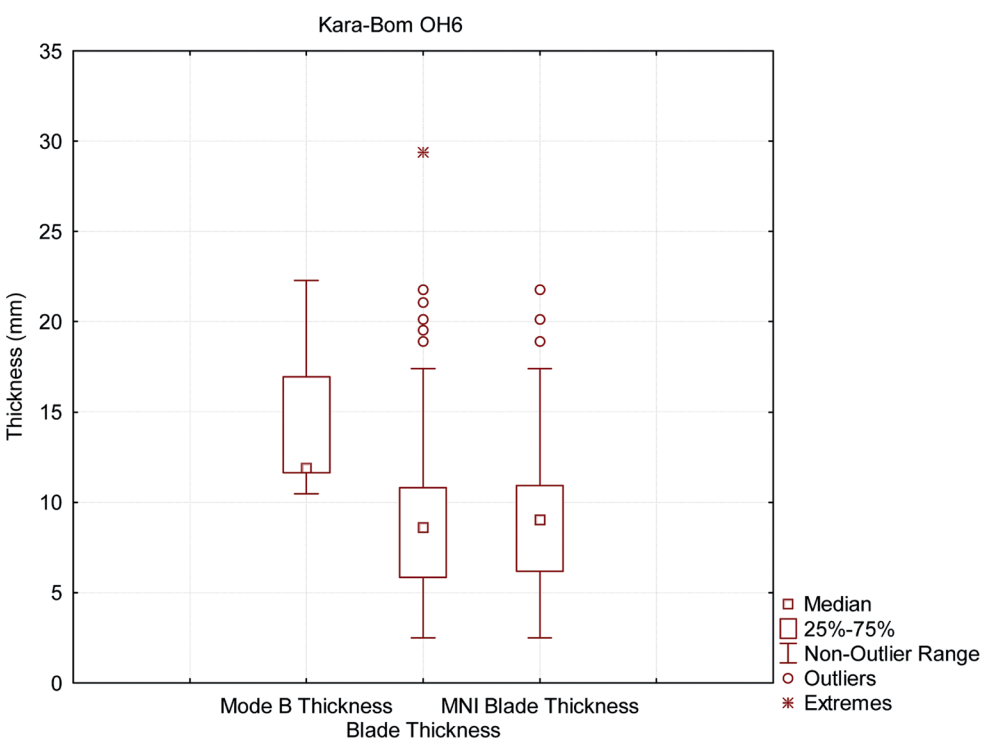


Figure 51: Kara-Bom, OH6, thickness of Mode B blanks compared with the overall blade thickness (total sample and MNI)

If necessary, the blade is snapped prior starting the Mode B reduction. This allows a certain control on the length of the removals, but also offers the possibility to select the thickest part of the blank to obtain a minimum 10 mm wide flaking surface. Within the OH6 sample, some of the features observed on the internal surface of broken pieces seem to indicate a snapping by percussion (see Figure 9 and 12). However, this behavior is likely opportunistic as it cannot be regarded as a systematic process unless it occurs in higher frequency. Reduction is systematically taking place along one edge of the blank, following its longitudinal axis. As for the Mode A cores, it tends to follow short sequences of 2-3 removals (Mode B1) before a platform switch occurs. A few small size cores show alternate bidirectional removals at the last stage of the reduction process. Unless a knapping accident (such as hinged fractures) happens, removals seem to cover the whole length of the flaking surface. Thus, although a use of two relatively independent platforms is attested too, the flaking surface is considered as a whole and not as the sum of two distinct surfaces.

The reduction is mainly frontal, but in some cases, an expansion on the lateral side of the core approaches a semi-turning progression. This latter fact may be accentuated by the method itself as the narrow morphology of the core blank makes it difficult to obtain a long lasting reduction. As shown by the occurrence of small-sized crested blades, core management is also taking place on Mode B cores.

The morphology of the blanks obtained varies according to their initial position on the flaking surface. On very narrow flaking surfaces, blanks are generally removed from the corner of the flaking surface, resulting in either a natural back and/or a triangular section. When the flaking surface is wide enough, blanks may be detached from the middle part of the flaking surface, and therefore, show a thinner triangular section. A few removals display a rectangular section. As most of the time they bear negatives of hinged fractures on their dorsal face, they could be interpreted as flaking surface management operations. As observed on some of the complete blanks, a distinction can be made between pointed elements and the rest. The pointed small blades show both triangular but also trapezoidal cross-sections. This latter fact is clearly linked with the bidirectionality of the reduction. As the general orientation of the removal is parallel, laminar blanks with a trapezoidal section can only be pointed by using two opposed platforms. All in all, the common denominator between these blanks is that they are relatively narrow, elongated, axial and have a straight profile.

By comparing the width of the flaking surfaces, differences between Mode A and Mode B core distributions can be observed (Figure 53). Mode A, although poorly represented, covers the whole range of widths observed within the blank population. However, Mode B shows a skewed distribution with the mean corresponding to one of the peaks of the blank bimodal distribution. This situation reflects the coexistence of two technological schemes. One of these focuses on the use of a narrow edge of thick blades as a flaking surface in order to produce small-size laminar blanks. Only one Mode B core of truncated-facetted morphology has one of its flaking surfaces wider than 20 mm. The overlap between flaking surface width of Mode A and Mode B could explain why the bimodality of the distribution is not fully visible. In spite of the small number of observable last removals on the cores (N=10), a difference between the modes is visible with Mode A tending to produce wider blanks than Mode B (see Table 29).

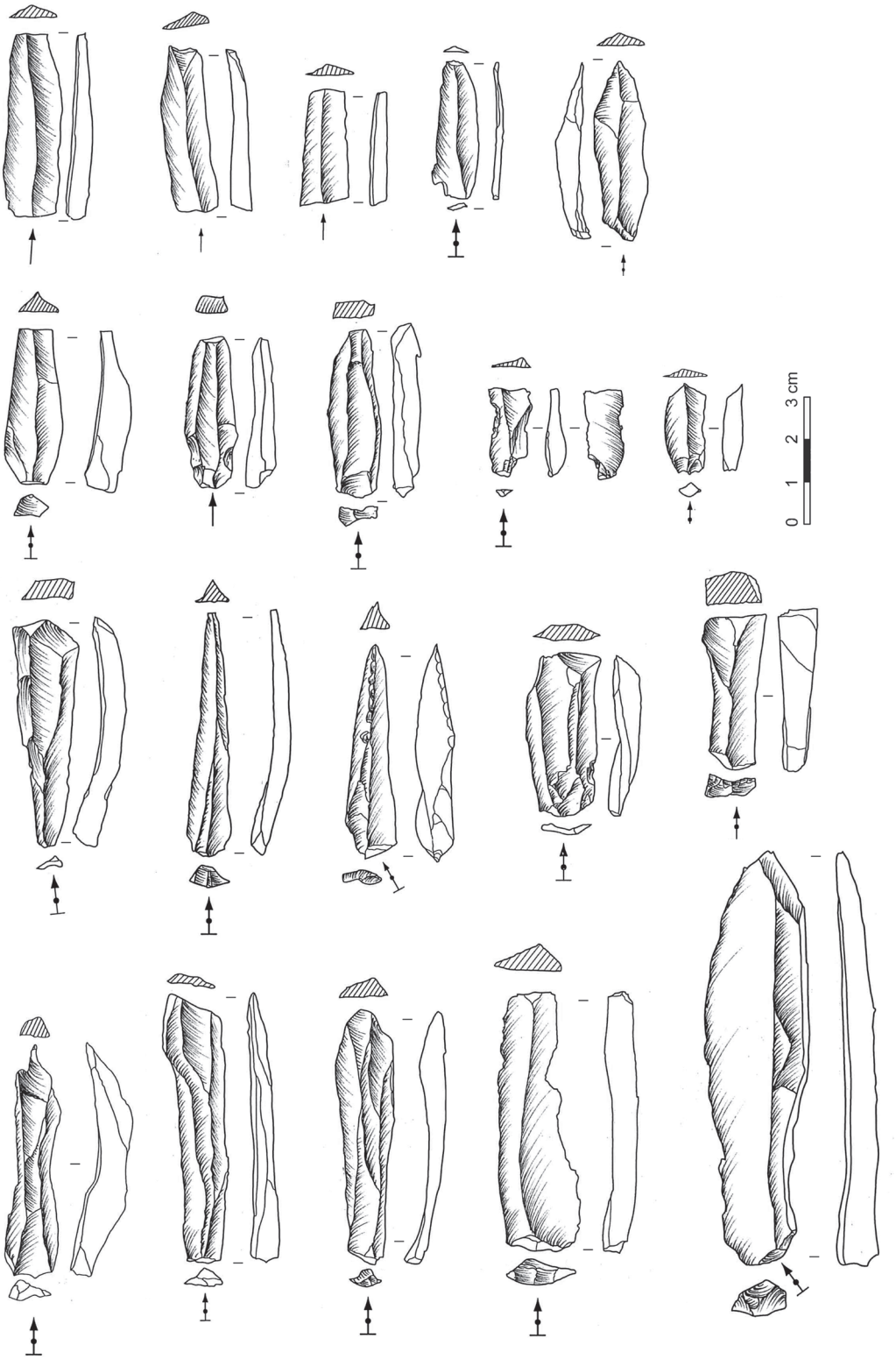


Figure 52: Kara-Bom, OH6, laminar blanks

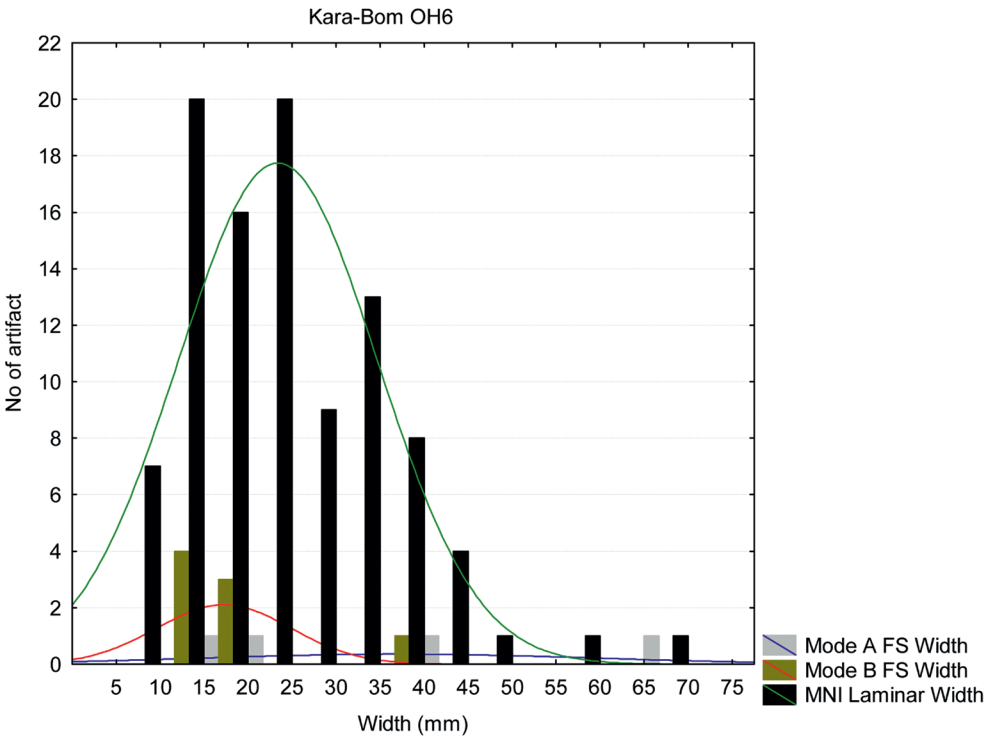


Figure 53: Kara-Bom, OH6, Mode A and Mode B flaking surface width and MNI width

Convergent blanks

A second type of laminar blank showing convergent mesio-distal edges is present (N=10). Five blanks are complete, three are mesioproximal and two are distal and mesiodistal fragments. Except for one, they all have bi-directional removal scars on the dorsal face and all show trapezoidal sections. Their profiles are straight or slightly curved. The majority (N=8) have a width between 25 and 40 mm for a length between 60 and 110 mm, and a maximum thickness around 1cm. Two artifacts are of a smaller size with a width of 9.5 and 12.9 mm. The size of their platform does not differ from the variability observed on the overall blade sample regardless of whether their morphology is plain (N=5) or facetted (N=3). Two of these blanks show clear traces of an extreme abrasion of the external platform edge. The bladelet category also includes this kind of blank although they are less numerous (N=2). The convergent blades are all axial.

The reduction sequence leading to the production of such blanks implies a minimum of 3 laminar removals given the number of scars visible on their dorsal face. The largest convergent blade displays a width that indicates a rather large core or a core reduced on its wider face. The straight profile and the relatively flat dorsal face seem to indicate that they are detached from cores such as Modes A3 to A6, presenting at least one broad flaking surface. In the OH6 sample, only one core (see Figure 37) seems to correspond to this description. The chronological reconstruction shows at least one sequence of three unidirectional removals, which given the previous scars associated with the opposed platform, could easily yield a bidirectional dorsal scar patterning. The trapezoidal section of these elements suggests that in the case of a unidirectional reduction, a clear convergent orientation of removals is required to obtain pointed blanks. As most of these unretouched artifacts show bidirectional scar patterns, the largest convergent blanks are likely produced on wide-faced cores. However, without long refitted sequences,

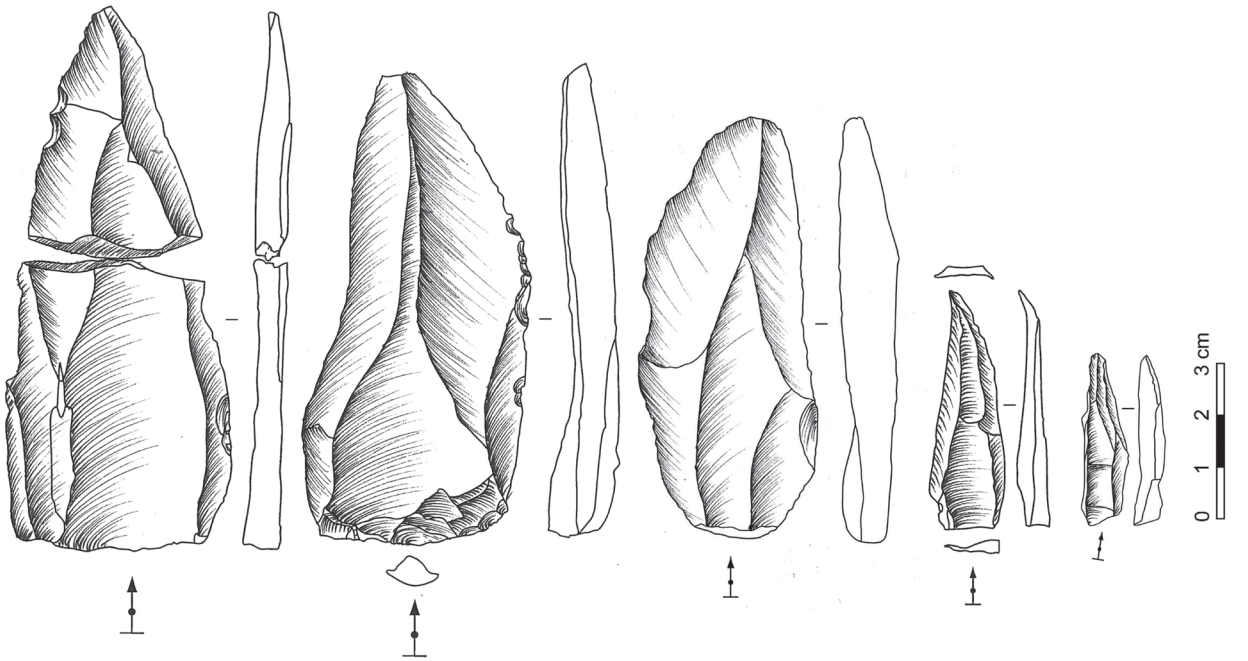


Figure 54: Kara-Bom, OH6, convergent laminar blanks

other possibilities cannot be ruled out. In fact, these artifacts could also be occasionally produced during a bidirectional blade production from larger cores. The smallest convergent blanks are less demanding in terms of flaking surface width. It is assumed that some of them could be produced on truncated-facetted cores (Figure 54, second from the right), as they appear to be technologically similar to the wide-faced core described above. However, one of the smallest convergent blanks is rather narrow and displays multiple laminar scars detached from an opposed platform in its mesiodistal part. In addition, a clear natural back is visible. In this case, the blank was likely detached from a Mode B core (Figure 54: first from the right).

Platform preparation and percussion technique

As previously mentioned, no traces of thin abrasion have been recognized on cores or on blanks. In a few cases, the external platform angle of the blank is heavily smoothed by a strong abrasion. Plain and facetted platforms coexist, the latter showing morphological variability. Beside the classical faceting, two main variants could be observed. The first shows an extension of the faceting on the lateral side of the blank, indicating that the blank was removed close to the junction of two surfaces. The second variant shows a partial faceting of the platform, as a perpendicular preparation flaking to change the external platform angle, but the point of percussion is located on an unprepared plain surface. This preparation is sometimes combined with flaking surface trimming from the platform (Figure 55, left). When considering the blade category, the mean platform thickness is clearly above the 4 mm limit defined by Pelegrin (1995) and characterized as thick platforms *(talon épais)*. More generally speaking, flaking on the bulb (circa 18% of the blade MNI) and lip (circa 13% of the blade MNI) occur sporadically on the blanks.

Considering these elements together, it is assumed that the technique of percussion in use is mainly a stone hammer *sensu lato*. If numerous features are analogous to those described in practical experiments using hard hammer stone on flint, the lack of experiments on the Kara-Bom specific raw material leave the question partly open. However, some features such as extreme abrasion of the EPA, or the flaking

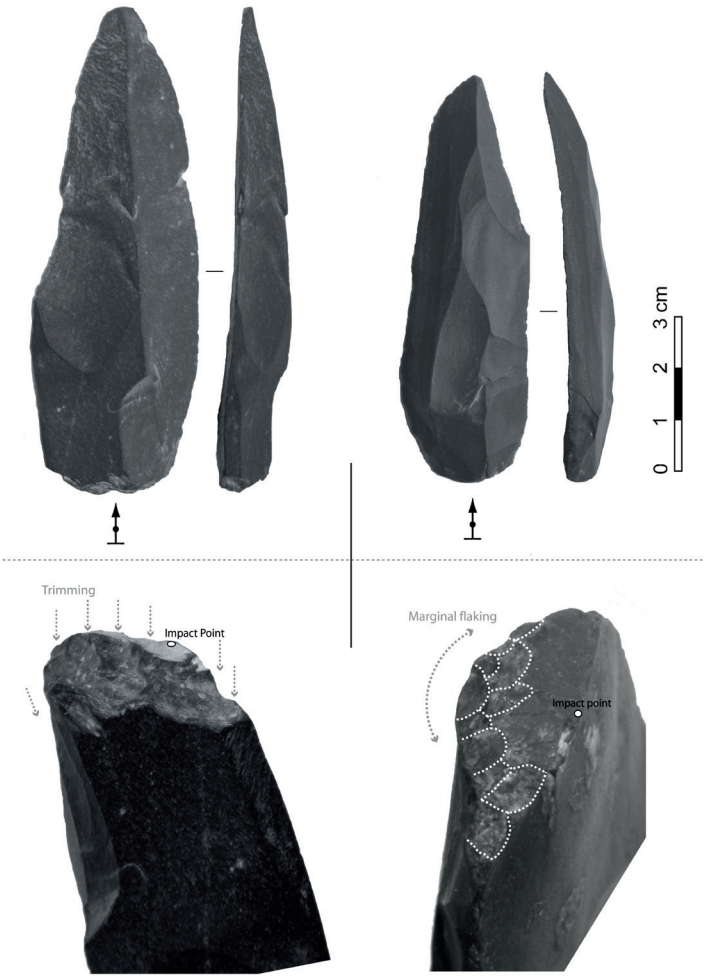


Figure 55: Kara-Bom, OH6. On the right, partial faceting (KB-92.YO6.Z8.22.924). On the left, trimming (KB-92.YO6.Z6.26.1383)

of the bulb, could indicate the occasional use of soft hammer stone (*e.g.* limestone). The quasi-total absence of features typically associated with the use of organic hammer is noteworthy and suggest that the use of stone hammer remains the most parsimonious hypotheses. Similar hammers, displaying traces of percussion, have been reported as associated with OH6 (Derevianko, Petrin, *et al.*, 1998).

Retouched tools

27 retouched tools were recorded in the sample: 21 on blades, 5 on bladelets, and 1 on a laminar flake. Except the later, the sample does not include tools on flakes. A conservative approach is applied here to recognize intentional retouch and to leave out ambiguous artifacts when they fail to exhibit clear evidence for secondary treatments.

	N	*f* (among tools)	*f* (from total, n=189)
Retouched blade	12	43%	6%
Retouched bladelet	6	21%	3%
Retouched point	8	29%	4%
Endscraper	2	7%	1%
Other	0	0%	0%
	28	100%	15%

Table 31: Kara-Bom, OH6, frequency of major retouched tool types

The preservation of the tools shows a different picture than for the blank sample. Complete artifacts dominate the sample, but mesial fragments are less than others, as distal fragment are totally absent. As discussed below, this is related to the position of the retouch, which tends to occur less frequently on the mesial part of the tool.

	N	*f*
Distal	0	0%
Mesiodistal	4	14%
Mesial	1	4%
Mesioproximal	6	21%
Proximal	3	11%
Complete	14	50%
	28	100%

Table 32: Kara-Bom, OH6, retouched tools, breakage

In terms of platform preparation, facetted and dihedral platforms are the most common, with only a few occurrences of plain platforms. When comparing these frequencies with the whole laminar sample, it appears that facetted platforms are not more significantly numerous among the toolkit than in the laminar blanks (χ^2 (1)= 0.104, p=.92). Dihedral platforms are more frequent but not enough to be statistically meaningful. So, the most striking difference is the lack of plain platforms (χ^2 (1)= 9.706, p=<.05). Given that a third of the tools do not show identifiable platforms, these observations might also be biased by the reduced sample size. The mean platform thickness is similar to what is observed on the non-retouched blanks (Mean=5.98 ± 3.36 mm).

	N	*f*
Plain	2	7%
Facetted	12	43%
Dihedral Flat	5	18%
Undet	9	32%
	28	100%

Table 33: Kara-Bom, OH6, retouched tools, platform preparation

In terms of length, or thickness, no clear pattern emerges when comparing the toolkit with the laminar elements. However, it seems that the width of retouched tools shows a bimodal distribution similar to what it is observed in the laminar blanks. Considering that retouch is likely to reduce the width of blanks, such a correspondence is noteworthy (Figure 56).

It seems clear that the OH6 assemblage does not show examples of extreme tool reduction, artifacts being only slightly modified by the secondary treatment. Dorsal scar patterns are highly similar to the non-retouched blanks, with 55% of bidirectional and 44% unidirectional scar patterns, and are mainly axial. The infrequent occurrence of unidirectional convergent dorsal scars is noticed, although this type of patterning is absent from the non-retouched elements.

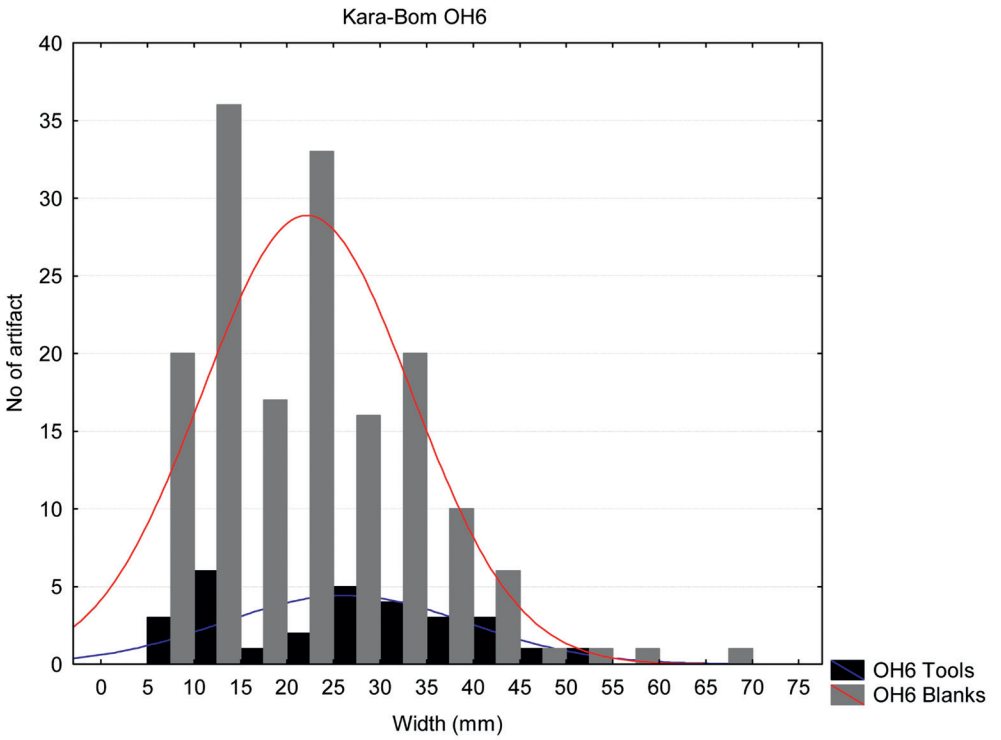


Figure 56: Kara-Bom, OH6, width histogram comparing retouched tools and blanks

	N	*f*
Right	4	14%
Left	2	7%
None	17	61%
Undet	5	18%
	28	100%

Table 34: Kara-Bom, OH6, retouched tools, Orientation

Blades with parallel edges are retouched on the proximal (Figure 26: 9) and distal parts, sometimes into pointed blades (Figure 26: 12), sometimes into endscrapers (Figure 26: 10), with the latter transformed by a direct marginal retouch on the distal end. Convergent or pointed blanks are modified mainly by direct retouch (Table 35) affecting the proximal part of the blanks (Table 36; Figure 26: 2, 3, 11), but also sometimes the distal part (Figure 26: 4, 13), somewhat accentuating the pointed shape of the tip. Tools showing a combination of retouch on the dorsal face (N=2) also show an association of distal and proximal retouch.

	N	*f*
Direct	23	82%
Inverse	5	18%
Alternate	0	0%
	28	100%

Table 35: Kara-Bom, OH6, retouch location (face)

The presence of a single atypical Mousterian point is of note. It is produced on a *débordant* Levallois point blank, for which the right *débordant* edge is accentuated by a short series of inverse steep retouch. The left edge shows continuous thin retouch. No core

	Dorsal		Ventral	
	N	*f*	N	*f*
Distal	5	18%	1	4%
Mesial	2	7%	2	7%
Proximal	10	36%	0	0%
Combination	2	7%	0	0%
Continuous	3	11%	1	4%
Undetermined	6	21%	0	0%
	28	100%	4	15%

Table 36: Kara-Bom, OH6, retouch location (edge)

corresponding to such technology has been found in the OH6 sample.

Most of the retouch is located around the proximal and distal ends of blanks. This is also reflected by the lack of retouched mesial blade fragments although the latter are clearly the most numerous among the unretouched blanks. Among the five blanks showing inverse retouch, two bear thin retouch along the right edge of bladelets showing an unidirectional dorsal scar patterning. They are typologically Dufour bladelets of Dufour sub-type (Demars and Laurent, 1992). One of these likely comes from a Mode B core as the blank displays a part of the core's ventral face (Figure 57: 6). A small blade displaying mesiodistal semi-steep retouch along the right edge also occurs. The blank is a thick, bidirectional, naturally-backed blade detached from a Mode B core (Figure 57: 8). One backed bladelet on an atypical narrow cortical blank occurs in the sample and displays a small truncation at the proximal end.

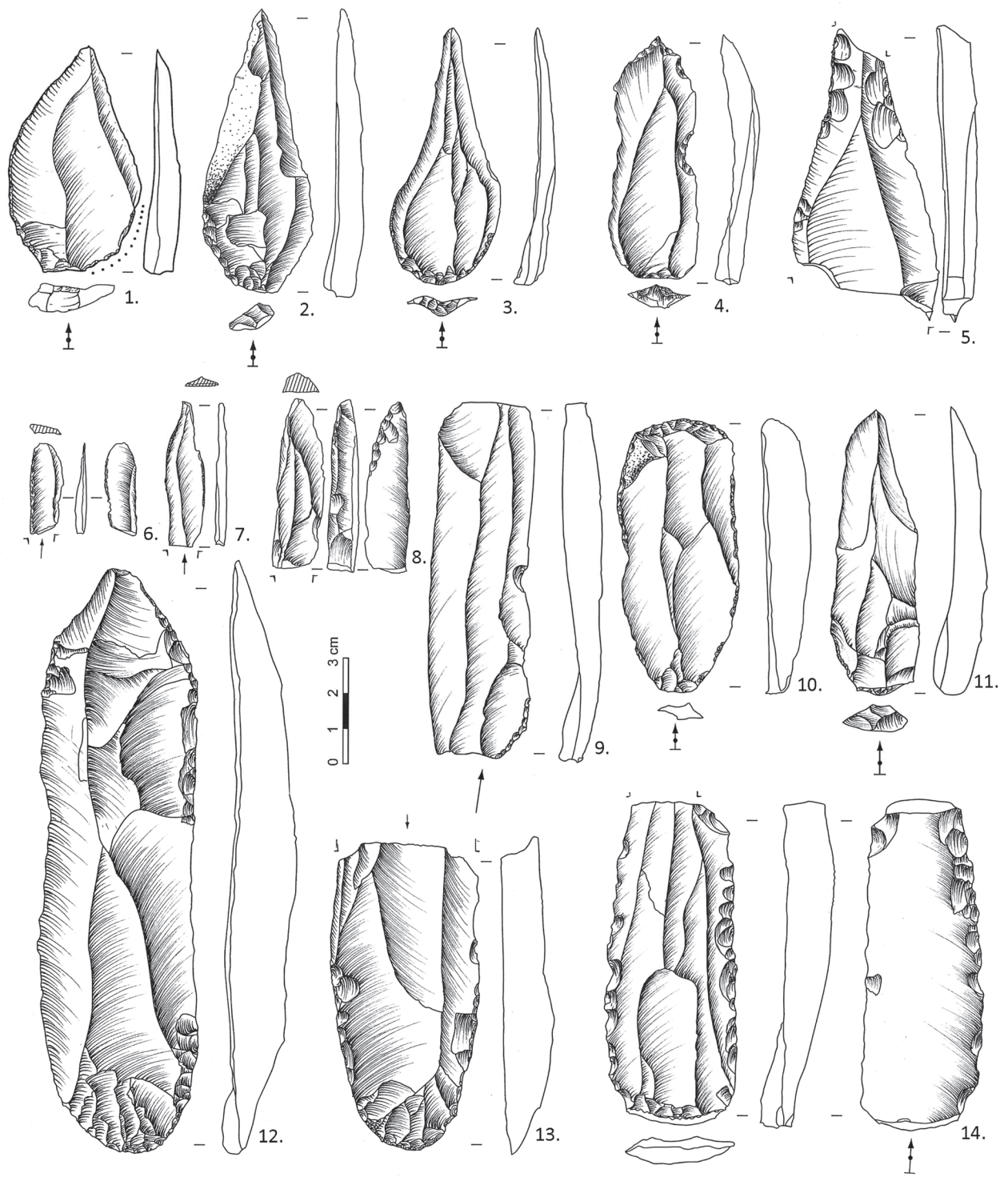


Figure 57: Kara-Bom, OH6, retouched tools

3.4 LAMINAR TECHNOLOGY: OH5

3.4.1 BLANK ATTRIBUTES

Breakage

Complete artifacts, mesial and mesioproximal fragments are the most represented (Table 37). Based on these observations, an MNI of 69 blades and 11 bladelets is calculated on a total of 148 laminar artifacts recorded.

Platform: size and preparation

Considered as a whole, laminar blanks show similar frequencies of facetted and plain platforms (Table 38). This trend is clearly expressed in the blade category, as the majority of bladelet platforms are facetted. The latter observation is balanced by a fairly reduced sample size. The mean platform thickness is 5.3 ± 4.1 mm and mean platform width is 12.4 ± 8 mm. For the blade category, mean platform thickness is 5.7 ± 4.1 mm and mean width is 13.3 ± 7.7 mm. Bladelet mean platform thickness is 2.6 ± 3.2 mm and mean width is 6.4 mm ± 7.5 mm. The small sample of bladelets shows a lot of variability. Here measurements are listed per morphological type.

	Total		Blade		Bladelet	
	N	*f*	N	*f*	N	*f*
Distal	10	7%	6	5%	4	16%
Mesiodistal	17	11%	12	10%	5	20%
Mesial	41	28%	36	29%	5	20%
Mesioproximal	27	18%	25	20%	2	8%
Proximal	14	9%	12	10%	2	8%
Complete	39	26%	32	26%	7	28%
	148	100%	123	100%	25	100%

Table 37: Kara-Bom, OH5, breakage

	Total		Blade		Bladelet	
	N	*f*	N	*f*	N	*f*
Plain	26	18%	24	20%	2	8%
Facetted	32	22%	26	21%	6	24%
Dihedral Flat	8	5%	7	6%	1	4%
Undet	82	55%	66	54%	16	64%
	148	100%	123	100%	25	100%

Table 38: Kara Bom, OH5, platform preparation

Facetted platform	Total		Blade		Bladelet	
	Thickness	Width	Thickness	Width	Thickness	Width
Sample size	32		26		6	
Mean (mm)	5.4	13.7	5.9	15.1	3.3	7.4
Standard deviation (mm)	3.4	8.7	3.2	8.2	3.8	9
Range (mm)	13.5 to 0.5	35.3 to 1.5	13.5 to 1.8	35.3 to 2.6	10.5 to 0.5	25.4 to 1.5

Table 39: Kara-Bom, OH5, facetted platform size

Plain platform	Total		Blade		Bladelet	
	Thickness	Width	Thickness	Width	Thickness	Width
Sample size	26		24		2	
Mean (mm)	4.2	10.4	4.5	11	0.9	2.7
Standard deviation (mm)	2.9	6.9	2.9	6.8	<0.1	1.2
Range (mm)	11.6 to 0.8	28.4 to 1.9	11.6 to 0.8	28.4 to 2.4	0.9 to 0.8	3.6 to 1.9

Table 40: Kara-Bom, OH5, plain platform size

Blade facetted platform are significantly thicker than plain ones (Mann-Whitney, T=Ub=267, p=<.05)(Table 39). This is also visible in the bladelet category, but the small sample size does not allow any further observations. Variance differs between the two morphological categories, as facetted platforms appear slightly more variable in size than plain platforms. These differences are, however, not statistically significant.

A few flat dihedral platforms occur in the sample (blade N=7, bladelet, N=1) (Table 40). The mean thickness is 8 ± 7.8 mm, and mean width is 13.8 ± 7.3 mm. This type of platform is clearly thicker than the whole population but shows a similar mean width as the facetted platforms. From a general point of view, we observe a quasi-total absence of thin abrasion on the blanks external platform edge. The only exceptions are observed on blades (N=5) which show a strong abrasion smoothing of the EPA.

Blank size attributes

Length

As length is measured only on complete elements, the results presented are based on a smaller sample. It appears that blades and bladelets overlap in terms of range and standard deviation. The length is not normaly distributed (Shapiro-Wilk, W=0.90 p=<.05) and the fragmentary nature of the sample show a positive skewness (1.5)(Figure 58).

	Total	Blade	Bladelet
Sample size	39	32	7
Mean (mm)	67.3	73.17	40.7
Standard deviation (mm)	28.9	27.4	19.8
Range (mm)	180 to 25.5	180 to 29.6	83.7 to 25.5

Table 41: Kara-Bom, OH5, blank length

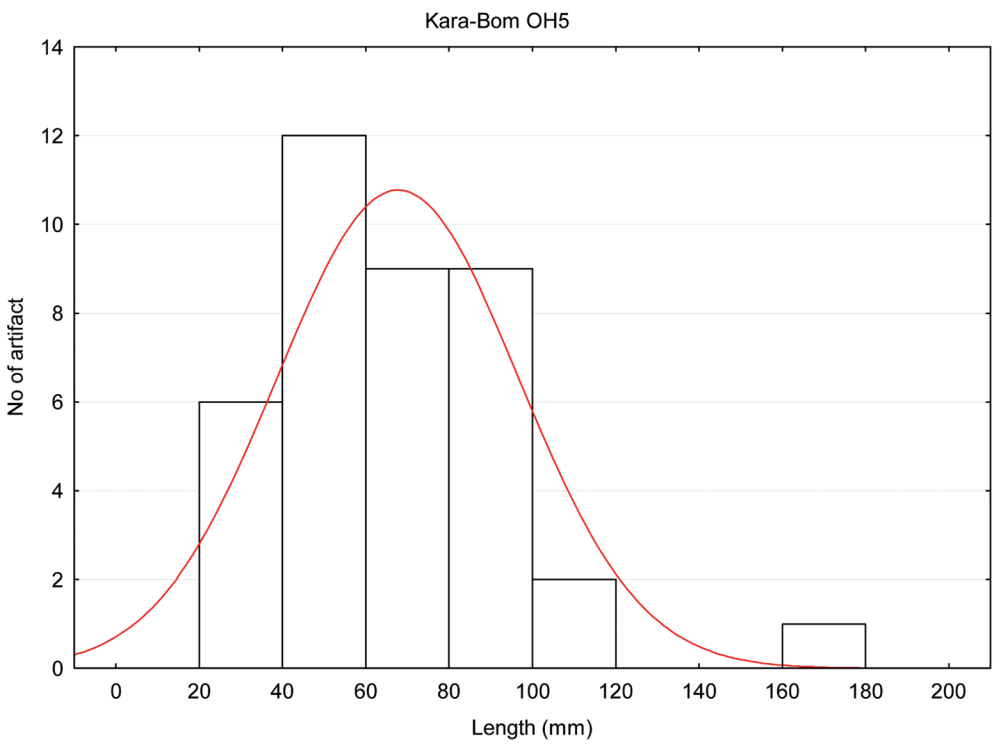


Figure 58: OH5, blank length distribution

Width

In terms of width, when comparing mean and standard deviations from the complete sample and from the MNI, it appears that MNI values are either equal or higher than in the total sample (Table 42).

The distribution of width measurement from the total sample may be bimodal distribution (Figure 59). The first mode would peak between 10-15 mm width and the second corresponds to the mean. However, the two modes are less visible in the MNI distribution, although both MNI (Shapiro-Wilk, W=0.96 p=<.05) and total sample (Shapiro-Wilk, W=0.97 p=<.05) are not normally distributed. The positive skewness of the histograms (respectively 0.61 and 0.88 for the whole population and for the MNI) can be partly explained by an apparent cut-off of 5 mm. The occurrence of two microblades (width < 6mm) is noted but due to their poor representation, they are grouped with the bladelets.

	Total sample			MNI		
	Total	Blade	Bladelet	Total	Blade	Bladelet
Sample size	148	123	25	80	69	11
Mean (mm)	23.1	25.9	9.5	24	26.1	10.8
Standard deviation (mm)	10.5	9	5.3	11.3	10.4	7.5
Range (mm)	64.2 to 4.1	64.2 to 9.8	32.8 to 4.1	64.2 to 4.9	64.2 to 9.8	32.8 to 4.9

Table 42: Kara-Bom, OH5, blank width

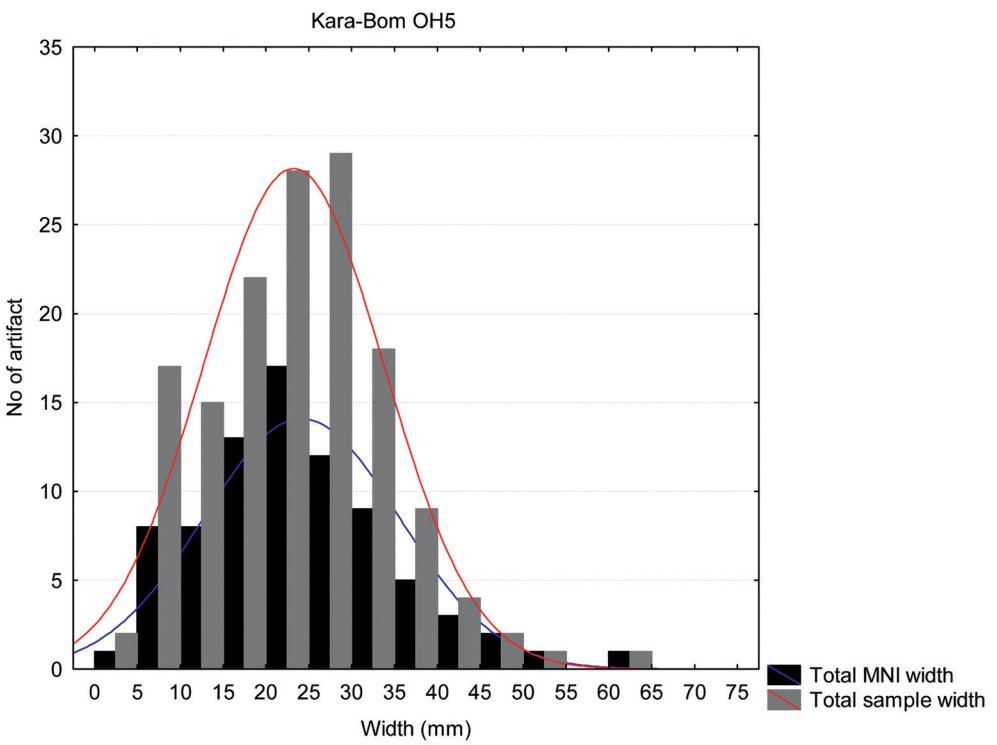


Figure 59: Kara-Bom, OH5, blank width distribution

Thickness

Compared with the total population, MNI thickness shows equal or slightly higher mean values and for bladelets, a higher standard deviation (Table 43; Figure 60). Differences are however not statistically significant. This shows that breakage does not influence significantly the main trends observed in terms of thickness in the sample considered. Blade and bladelet thickness samples clearly differ but their standard deviations overlap. The thickness histogram is perhaps weakly bimodal showing a first mode of less than 10 mm and a second mode of more than 10 mm. The MNI, although based on less numerous measurements, shows a similar distribution to the total sample population.

	Population			MNI		
	Total	Blade	Bladelet	Total	Blade	Bladelet
Sample size	148	123	25	80	69	11
Mean (mm)	7.8	8.5	4	8.1	8.5	5.1
Standard deviation (mm)	4	3.6	3.6	4.2	3.9	5.1
Range (mm)	19.8 to 1	19.8 to 1.9	19.5 to 1	19.8 to 1.7	19.8 to 1.9	19.5 to 1.7

Table 43: Kara-Bom, OH5, blank thickness

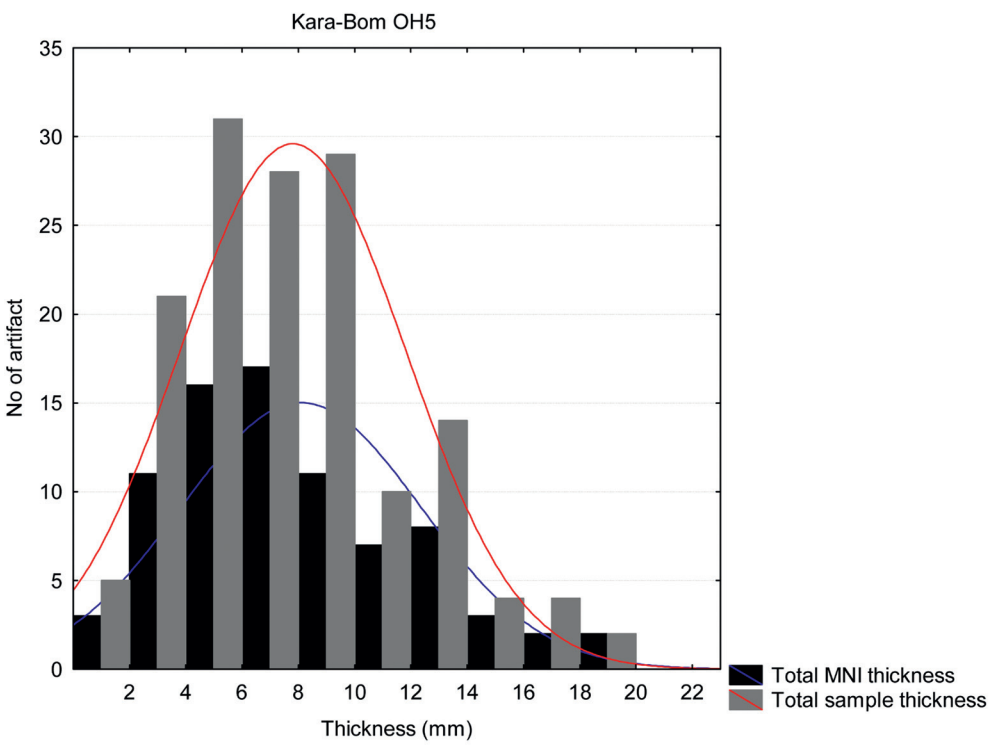


Figure 60: OH5, blank thickness distribution

Dorsal scar pattern

A discrete occurrence of cortex occurs on both unidirectional and bidirectional blanks, indicating that some initial phases of reduction took place on site, which seems to be confirmed by the presence of an initial crested blade and a second bladelet (Table 44). Neo-crested blanks are also well represented, mainly among blades, suggesting that core management operations took place on site. For the total sample, as for the blades, unidirectional dorsal scar patterns dominate. Bladelets show a majority of bidirectional scar patterns, although the difference is minor and mainly visible due to the reduced sample size.

As underlined by others (*e.g.* Bar-Yosef and Van Peer, 2009), blank fragmentation may artificially increase the frequency of unidirectional blanks. So, our

	Total		Blade		Bladelet	
	N	*f*	N	*f*	N	*f*
Unidirectional	71	48%	62	50%	9	36%
Unidirectional and cortex	5	3%	4	3%	1	4%
Bidirectional	52	35%	41	33%	11	44%
Bidirectional and cortex	4	3%	4	3%	0	0%
Crest	1	1%	1	1%	0	0%
Second Crest	1	1%	0	0%	1	4%
Neo-crest	9	6%	8	7%	1	4%
Undetermined	5	3%	3	2%	2	8%
	148	100%	123	100%	25	100%

Table 44: Kara-Bom, OH5, dorsal scar pattern

	Complete blank		Complete blade		Complete bladelet	
	N	*f*	N	*f*	N	*f*
Unidirectional	12	31%	10	31%	2	29%
Bidirectional	20	51%	17	53%	3	43%
Crested	4	10%	4	13%	0	0%
Undetermined	3	8%	1	3%	2	29%
	39	100%	32	100%	7	100%

Table 45: Kara Bom, OH5, dorsal scar pattern of complete blanks

observations are repeated based on complete blanks only, sharply reducing the sample (N=39)(Table 46).

Considering only complete elements, a significant decrease in the unidirectional pattern frequency (χ^2 (1)= 5.2, p= <.05) can be observed. Meanwhile, the decrease of bidirectional is noticeable, but less sharp and not significant in statistical terms. As a result, bidirectional dorsal scar pattern becomes dominant at the expense of the unidirectional ones, but the difference between frequencies remains statistically insignificant.

Cross-section

The cross-sections are mainly trapezoidal in both blade (χ^2 (1)= 27.4, p= <.05) and total sample categories (χ^2 (1)= 13.9, p= <.05) (Table 46).

	Total		Blade		Bladelet	
	N	*f*	N	*f*	N	*f*
Flat	7	5%	5	4%	2	6%
Rectangular	0	0%	0	0%	0	0%
Triangular	53	36%	37	30%	16	44%
Trapezoidal	85	57%	78	63%	7	19%
Polyhedric	3	2%	3	2%	0	0%
	148	100%	123	100%	25	69%

Table 46: Kara-Bom, OH5, type of cross-section

	Total		Blade		Bladelet	
	N	*f*	N	*f*	N	*f*
Straight	96	65%	82	67%	14	56%
Slightly Curved	36	24%	28	23%	8	32%
Curved	5	3%	5	4%	0	0%
Twisted	8	5%	5	4%	3	12%
Undet	3	2%	3	2%	0	0%
	148	100%	123	100%	25	100%

Table 47: Kara-Bom, OH5, type of profile

	Total		Blade		Bladelet	
	N	*f*	N	*f*	N	*f*
Straight	44	55%	39	57%	5	45%
Slightly Curved	25	31%	20	29%	5	45%
Curved	4	5%	4	6%	0	0%
Twisted	6	8%	5	7%	1	9%
Undet	1	1%	1	1%	0	0%
	80	100%	69	100%	11	100%

Table 48: Kara-Bom, OH5, type of profile based on MNI

However, within the bladelet category the triangular elements are significantly dominant ($\chi^2(1)= 6.5$, $p= <.05$), indicating the frequent use of a single guiding ridge during the production of small laminar blanks.

Profile

All categories show a general preference for straight profiles, directly followed by slightly curved profiles (Table 47). This trend is remains visible when looking at the MNI; however, the straight profiles are a little less numerous and the slightly curved profile frequency shows a minor increase (Table 48). Thus, this shows that fragmentation has only a minor effect on the identification of the profiles.

Orientation

Blanks are mainly axially orientated, as shown by the frequencies observed in all categories (Table 49). A few blanks are orientated to the right or to the left, and they are equally represented. However, a large number of blanks have an undetermined orientation.

When considering a sample reduced to MNI, the frequency of undetermined elements decreases (Table 50). However, the trends observed on the total sample does not change significantly. Blanks remain mainly axial, the rest of the sample being equally shared by right and left oriented ones.

	Total		Blade		Bladelet	
	N	*f*	N	*f*	N	*f*
Right	19	13%	18	15%	1	4%
Left	14	9%	13	11%	1	4%
None	88	59%	65	53%	13	52%
Undet	27	18%	27	22%	10	40%
	148	100%	123	100%	25	100%

Table 49: Kara-Bom, OH5, blank orientation

	Total		Blade		Bladelet	
	N	*f*	N	*f*	N	*f*
Right	17	21%	17	25%	0	0%
Left	12	15%	12	17%	0	0%
None	43	54%	33	48%	10	91%
Undet	8	10%	7	10%	1	9%
	80	100%	69	100%	11	100%

Table 50: Kara-Bom, OH5, blank orientation based on MNI

	n	%
A1		
A2		
A3		
A4	1	10%
A5		
A6	1	10%
A7		
A8		
A9		
A10		
A11		
A12		
B1	3	30%
B2		
B3	1	10%
B4		
B5	2	20%
B6	1	10%
B7	1	10%
	10	100%

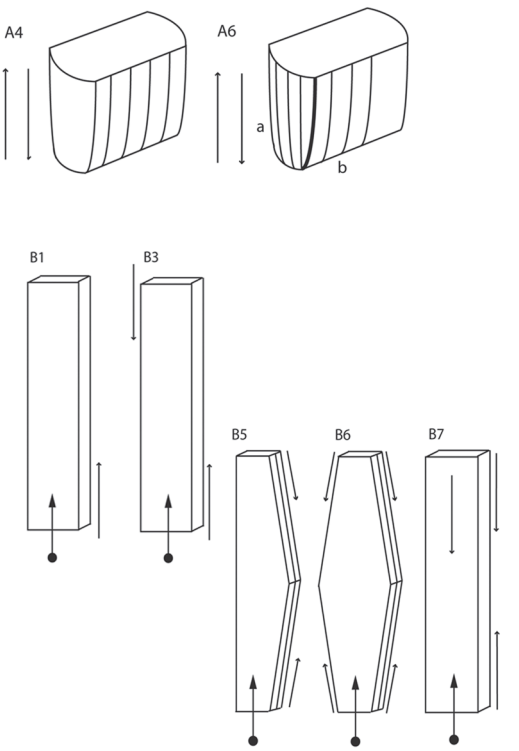


Figure 61: OH5, frequencies of cores per Mode

3.4.2 CORES: REDUCTION PATTERNS AND SIZE ATTRIBUTES

Ten cores have been identified within OH5. Two are on block or flake blanks (Mode A) and the others are on laminar blanks (Mode B) (Figure 61). Mode A cores show the occurrence of bidirectional reduction from a broad face and from two separated flaking surfaces. The Mode B cores illustrate different stages of reduction from single platform and single flaking surface, to cores bearing two platforms and two flaking surfaces.

Size attributes

Measurements and observations on nine cores are presented here, one of the Mode B cores is excluded as it could not be measured (KB-91.L9.3.5.11069). All measurements are recorded according to the system described in Chapter 2 which does not take into account the type of blank on which the core is produced. As a result, measurements are comparable, but in the case of Mode B cores, the thickness corresponds to the length of the blade blank, and the length of the core represents the thickness of the blade. Due to the small sample size of Mode A cores, comparisons with Mode B are not tested statistically. It is, however, possible to make some basic observations (Table 51). Core length appears smaller on Mode B cores as it depends on the thickness of the blade blank. Similar observation can be made

	Mode A			Mode B		
	Mean	σ	N	Mean	σ	N
Core length	37.7	2.1	2	15.5	4.2	7
Core width	43.1	14.5	2	29.2	9.6	7
Core thickness	74.9	9.3	2	73.3	12.9	7
Flaking surface length	63.3	5.2	2	60.6	11.8	7
Flaking surface width	42	17.4	2	12.5	4.7	7
Last removal length	51.3	5.5	2	46.9	10.4	6
Last removal width	17.9	10.4	2	9.3	2	6

Table 51: Kara-Bom, OH5, general size values (mm) per core Mode

regarding the core width with blocks tending to be wider than blades. The thickness values are similar for both Modes, which is confirmed by the flaking surface length. The flaking surface and last removal width are also smaller in Mode B cores, which is due to the fact that flaking surfaces are generally located along a narrow edge of the blade blank. Last removals were measured on five Mode B cores, one of them (KB-92.YO5.18/200.655) providing two measurable removals. The large standard deviation for Mode A last removal width is related to the small sample size, one of the removals being 11 mm wide, and the other being around 30 mm.

Striking platform preparation

Similar frequencies of facetted and plain platforms are observed. The sample size is, however, too small to make comparisons between modes. Profiles of the Mode A last removals are straight (N=2) and in Mode B, they are straight (N=2), twisted (N=1), and undetermined (N=4).

	Total		Mode A		Mode B	
	N	%	N	%	N	%
Plain	4	44%	0	0%	4	57%
Facetted	3	33%	2	100%	1	14%
Reshaped	0	0%	0	0%	0	0%
Undetermined	2	22%	0	0%	2	29%
	9	100%	2	100%	7	100%

Table 52: Kara-Bom, OH5, core striking platform preparation

Core descriptions

Mode A4 (N=1)

∗ KB-92.YO5.Z6.3.802

This core is produced on a block and displays a single flaking surface on the broad side of the core blank (Figure 62). The back is in part shaped by a radial flake removal showing a deep *contre-bulbe*. The rest of the face still shows naturally weathered surfaces and cortex. The flaking surface is shaped by faceting on the external edge; and the rest is still unprepared and naturally flat. The flaking surface illustrates a sequence of five removals (1-4). The first phase is represented by a removal detached from the right side of the flaking surface. The second phase includes two removals (2), one detached from a provisionary opposed platform on the right end of the flaking surface and the other by a removal from the left side of the flaking surface. This phase is followed by a laminar blank struck from the left side of the flaking surface (3) and by a pointed laminar flake detached from the very center of the flaking surface (4). The latter blank was identified within the same assemblage and has been refitted. The last removals are hinged and visible at the left edge of the flaking surface (5-8). They likely represent a failed attempt to remove a thick side blade in order to reshape the flaking surface convexity. This example illustrates the occasional use of a provisionary opposed platform involved in the shaping of a triangular flaking surface. The distal convergence facilitates the production of pointed blanks. However, no bidirectional removals occur on the dorsal face of the blank.

Mode A6 (N=1)

∗ KB-92.YO5.J64.1792

This core is produced on a thick flake blank (Figure 63). A flaking surface is located along the left edge of the flake blank and is reduced from a single striking platform, reshaped by frontal and lateral removals, and prepared by faceting along the external platform edge. The earliest observable removals (1) are located in the central part and on the right edge of flaking surface. This is followed by a series of three remov-

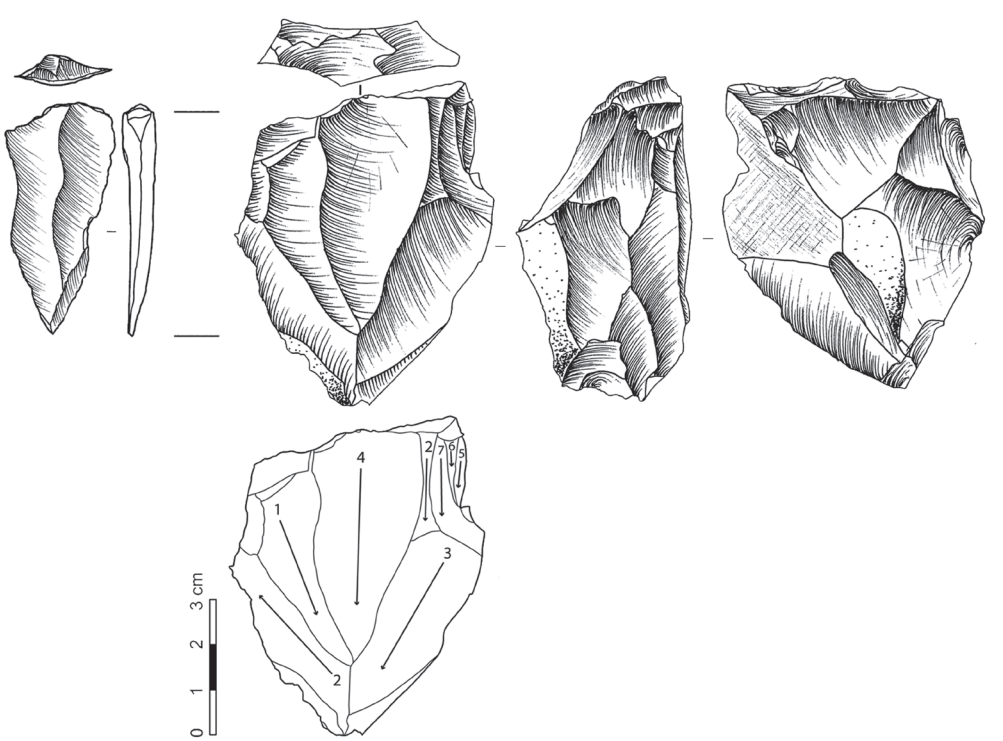


Figure 62: Kara-Bom, OH5, KB-92.YO5.Z6.3.802

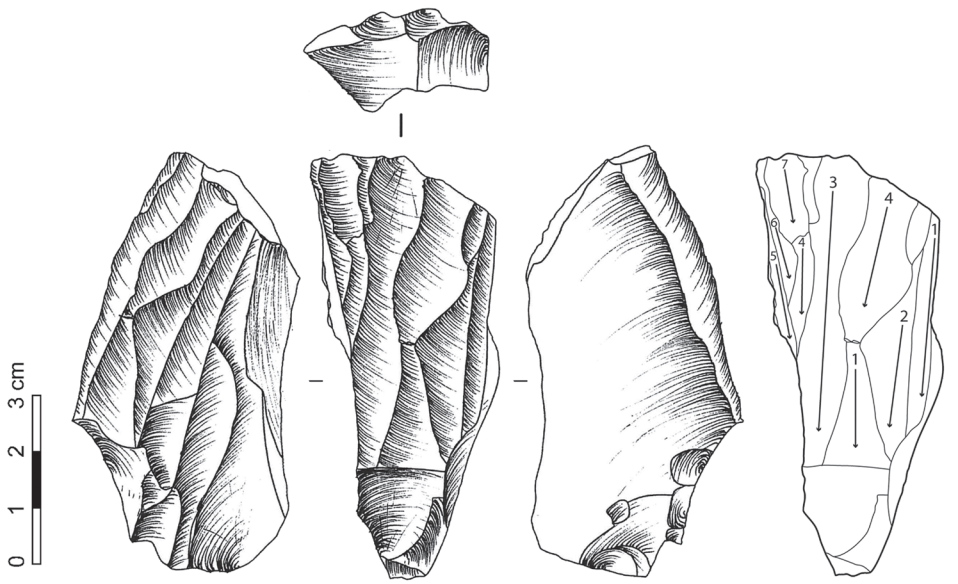


Figure 63: Kara-Bom, OH5, KB-92.YO5.J64.1792

als, respectively on the right (2), on the left (3) and then in the middle (4), following the ridge made by the negative of the previous removal. One additional long removal is detached from the middle part of the flaking surface (3). A second series of three removals (4-6) takes place on the right corner of the flaking surface and the reduction ends by with a hinged fracture (7). A series of removals visible on the left edge were detached from an opposed platform located on the dorsal face of the core blank, and testify to a previous phase of reduction that would have taken place on the broad dorsal face of the core blank. Remains of a crest are observed on the distal part of the flaking surface. This core is remarkable by its volumetric conception and by the triangular shape of the flaking surface. The reduction pattern is slightly convergent. No abrasion is observed on the external edge of the striking platform, the latter being rather irregular due to the presence of relatively deep *contre-bulbe*.

Mode B1 (N=3)

* KB-92.YO5.J8.37.1853

This core shows a single removal detached from the ventral face of a blade blank and struck from the proximal end (Figure 64). The morphology of the negative indicates the production of a narrow and elongated bladelet, pointed at its distal end.

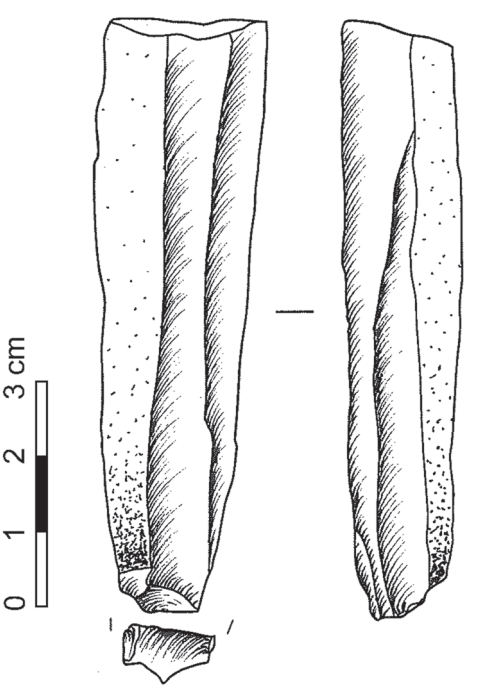


Figure 64: Kara-Bom, OH5, KB-92.YO5.J8.37.1853

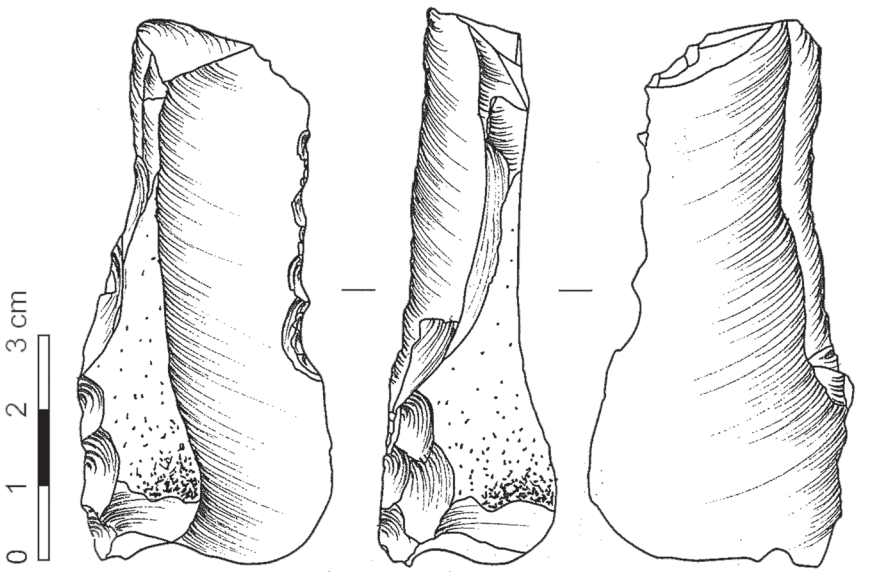


Figure 65: Kara-Bom, OH5, KB-92.YO5.48.28.22

∗ KB-92.YO5.48.28.22

This core is produced on a thick cortical blade and shows a removal negative following two hinged removals along the right edge of the blank (Figure 65). Removals are detached from a plain striking platform located on the proximal part of the blank. The mesiodistal part of the flaking surface displays the remains of an initial crest indicating that the reduction sequence was rather short.

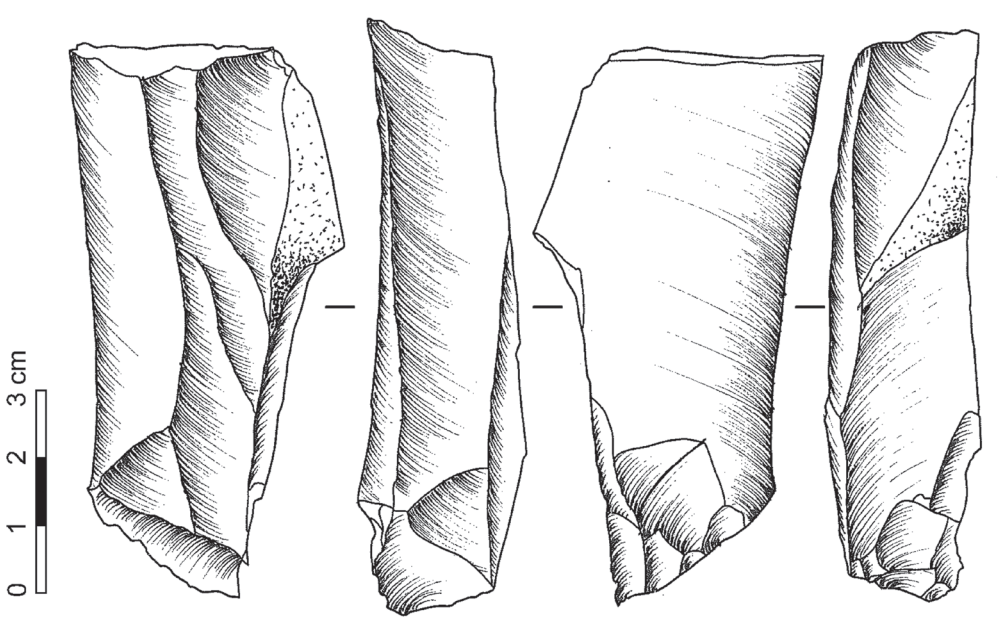


Figure 66: Kara-Bom, OH5, KB-92.YO5.Z8.23.1765

* KB-92.YO5.Z8.23.1765

This artifact illustrates the initial phases of reduction of Mode B cores (Figure 66). A plain striking platform is located on the proximal part of a thick cortical blank. A series of hinged removals are located at the corner between the ventral face and the left edge of the blank.

Mode B3 (N=1)

* KB-92.YO5.18/200.655

This core is produced on a blade blank and shows two opposed facetted striking platforms from which removals are detached following the ridge at the intersection between surfaces (Figure 67). This core was likely discarded due to hinge fractures.

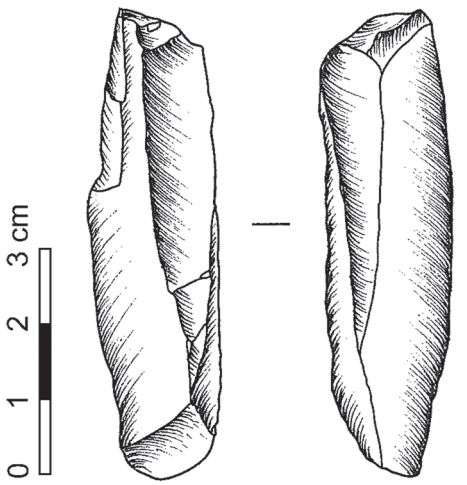


Figure 67: Kara-Bom, OH5, KB-92.YO5.18/200.655

Mode B5 (N=2)

* KB-92.YO5.Z6.12.130

This core is produced on a blade blank that, although showing a significant maximum thickness (19.6 mm), is still relatively thin along the edges (Figure 68). The left edge is used as a flaking surface dis-

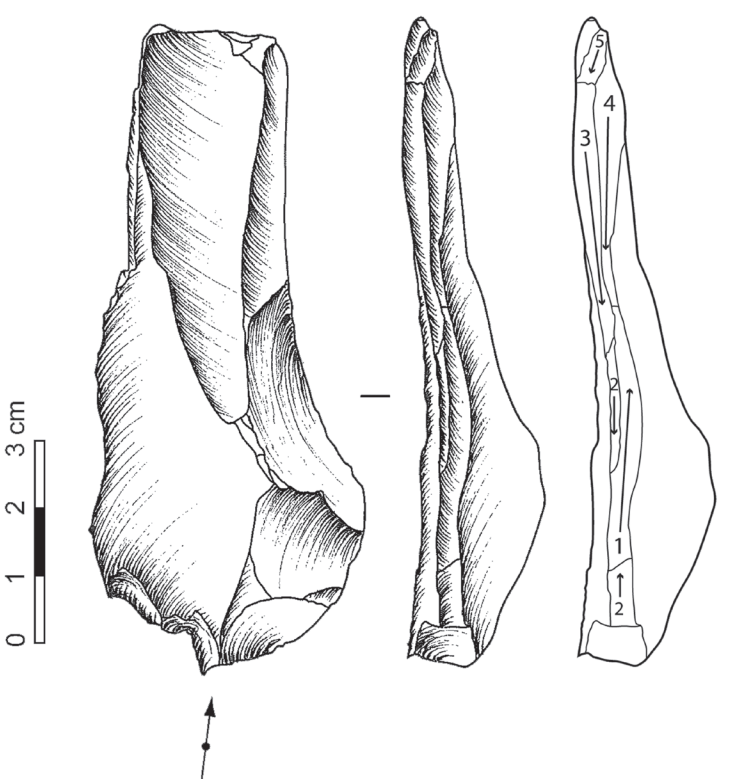


Figure 68: Kara-Bom, OH5, KB-92.YO5.Z6.12.130

playing bladelet removals parallel to the longitudinal axis of the blank and detached from two opposed platforms. The reduction starts from the proximal part of the blank by one removal (1) followed by a hinged fracture (2) and then a switch to the upper platform (2-4), with a series of three removals, ending on another hinged fracture (5).

∗ KB-92.YO5.I6.16.368

This core is on a blade blank showing a single flaking surface along the right edge, reduced from two opposed striking platforms. The flaking surface mainly extends on the dorsal face (1-4) of the blank. The ventral face displays a single bladelet removal (1). It is not possible to determine if the reduction sequence follows an alternate bidirectional path or if it consists of two series of 3-4 removals before the platform switch occurs. The upper platform is shaped by a small flake removal and the lower one by a truncation.

Mode B6 (N=1)

∗ KB-92.Y05.Z7.12.40

This core is produced on a thick laminar blank and reduced from two opposed platforms along both edges (Figure 70). The right edge bear a series of four removals from a proximal platform (1-4), the two last being hinged. The opposed platform shows two small hinged removals that illustrate attempts to resume the reduction sequence. The left edge displays two removals detached from the upper platform followed by severe hinge fractures, some of which are interpreted as removals of crested blanks from the intersection of the two surfaces. Then, a switch to the lower platform occurs with a series of removals detached at the intersection between the narrow edge and the ventral face of the blank. The sequence ends on a deep hinge fracture on the lower platform.

The lower striking platform shows negatives of a partial tablet removal detached laterally, and the upper striking platform shows a lateral impact point that may indicate either a tablet removal or a snapping of the blade blank by percussion.

Mode B7 (N=1)

∗ KB-91.L9.3.5.11069

This core is produced on a laminar blank reduced from two independent flaking surfaces (Figure 71). The narrow face shows an alternate bidirectional reduction with two platform switches for four blanks

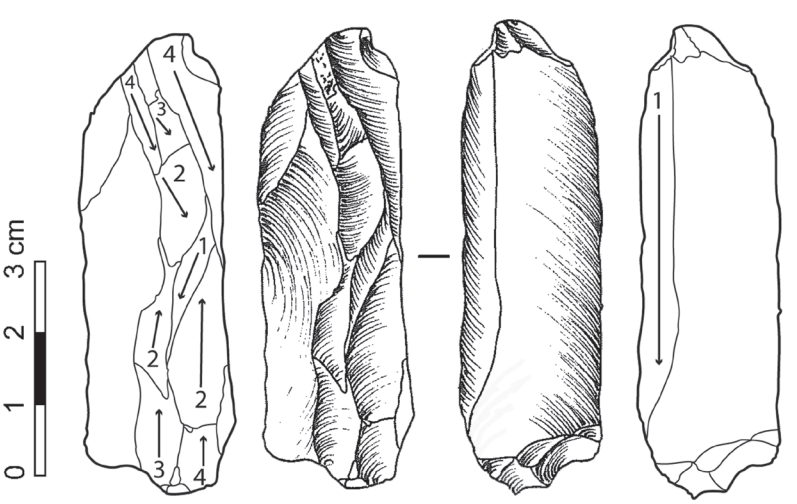


Figure 69: Kara-Bom, OH5, KB-92.YO5.I6.16.368

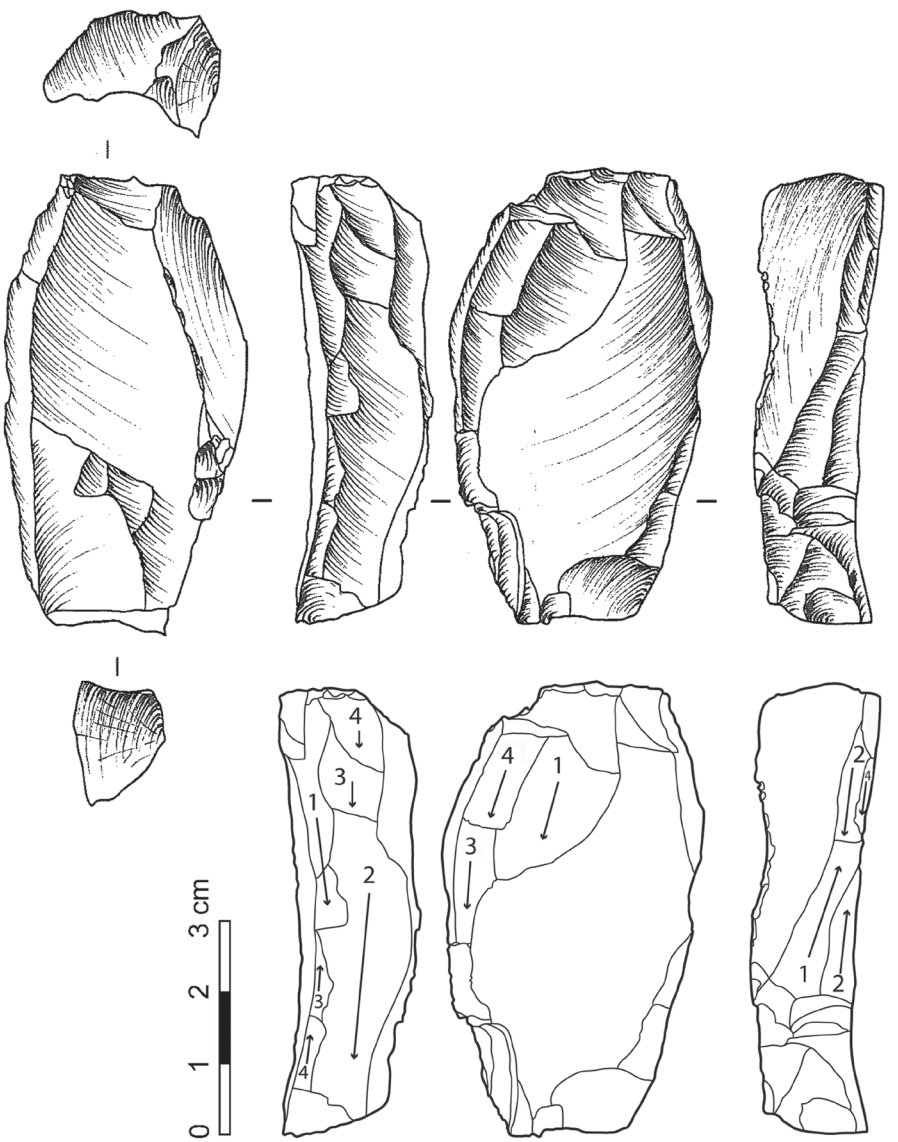


Figure 70: Kara-Bom, OH5, KB-92.Y05.Z7.12.40

detached. The last blank has a rather irregular shape in the distal part. The broad face shows two main negatives detached from the upper platform; however, negatives visible on the distal part of the flaking surface indicate previous phases of reduction from the lower platform. The back, located along the left edge of the blank, is crested and shows removal negatives. The upper platform is prepared by faceting. This pattern of reduction is rather unusual for Mode B cores and could be linked to the advanced stage of reduction.

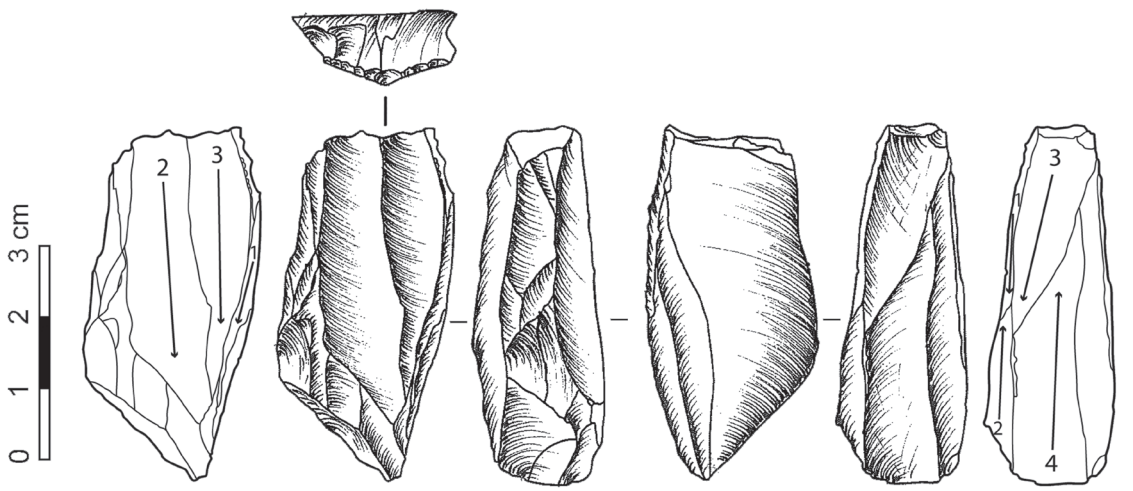


Figure 71: Kara-Bom, OH5, KB-91.L9.3.5.11069

3.4.3 REDUCTION SEQUENCE RECONSTRUCTION

Following the results of the blank attribute analysis and the core descriptions, an analytical reconstruction of the individual reduction sequences is proposed.

Laminar blanks with parallel edges

From a morphological point of view two main types of blades are recognized. The first category corresponds to artifacts displaying parallel edges starting from the mesial part. This represents the majority of the assemblage and shows a coexistence of uni- and bidirectional reduction processes. The largest complete examples show that the maximum length of such blades sometimes reaches 180 mm. A single laminar element presenting up to 80% cortex on its dorsal face, a single two-sided crested blade and a secondary crest on a bladelet illustrate different initial phases of the reduction process. In addition, just a few blanks have cortex preserved on their dorsal face (N=8), indicating that the first cortical blanks detached do not occur in the sample or that blocks were at least partially shaped off-site. Neo-crested elements ranging from 60 to 90 mm in length show that management operation are pursued on relatively small cores. Naturally backed elements, correspond to a more opportunistic exploitation of available edges at the intersection between core surfaces. Some show remains of the ventral face of the core blank (N=10). Only one spall shows a double back, indicating that it was detached from a narrow side (24 mm width flaking surface) of a core on a flake/blade blank. In other cases, the back is cortical (N=3) and is more likely to be detached from a block. In the sample, only one core can be associated with a production of large/medium size blades. It is a Mode A6 core which displays two independent flaking surfaces reduced successively from two opposed striking platforms. However, the last flaking surface is rather convergent and shows two series of unidirectional removals following a three-step path (one from the left, one from the right and then one from the middle). It is then possible that this core, in the last stages of reduction, was more orientated to a production of blanks with convergent edges. The frequencies of bidirectional and uni-directional blanks likely reflect a reduction by short sequences of 2-3 removals between platform switches following one or several ridges.

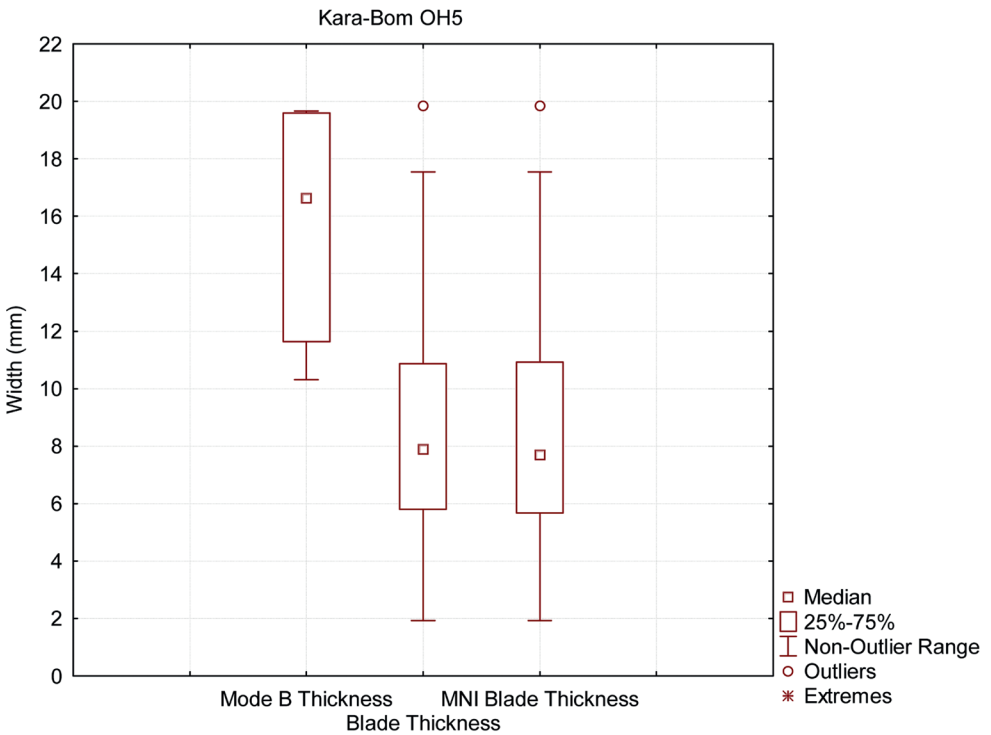


Figure 72: Kara-Bom, OH5, thickness of Mode B blanks compared with the blade thickness (total sample and MNI)

Mode B cores are produced on the thickest of the large/medium size blade blanks. As shown in Figure 72, the blanks are clearly selected among the outliers of the blade population, with a minimum thickness of 10 mm. Mode B1 cores represent the first stages of reduction as generally they bear not more than two removals detached from the thickest edge of the blade blank, following its longitudinal axis, from a striking platform located at its proximal end and using the angle between two surfaces as a ridge. A switch to an opposed striking platform leads to the re-exploitation of the previous flaking surface or to the exploitation of a new one along the other edge of the core blank. This latter fact, together with the length of some of the negatives (Figure 72), indicates that reduction proceeded by short sequences of 2-3 removals before a platform switch occurs. The edge of the core blank is, therefore, used as a single flaking surface, tending to be reduced on its whole length. Only one core illustrates clearly a genuine alternate bidirectional patterning at its last stage of reduction (KB-91.L9.3.5.11069). In this case, even though two opposed removals divide the flaking surface, they tend to extend across the whole length.

The reduction is mainly frontal but several cores display removals either extending on to the dorsal or the ventral face of the core blank. In some cases, it is hard to determine if these removals represent an attempt to detach blanks or if they are linked with core management operations. Such management could reshape the lateral convexity of the flaking surface or could create a ridge enhancing the angle made by the intersection of the two surfaces. Only one core displays evidence for a reduction on a wide and a narrow face of the core, however, the two surfaces are treated independently rather than following a semi-turning reduction pattern. More generally, cores displaying removals extending on to the wide face seem to represent a rather advanced stage of reduction. So, it is assumed that blank production mainly takes place along the edge of the core blank and at its corners. When comparing widths between Mode A and Mode B flaking surfaces and the MNI laminar popu-

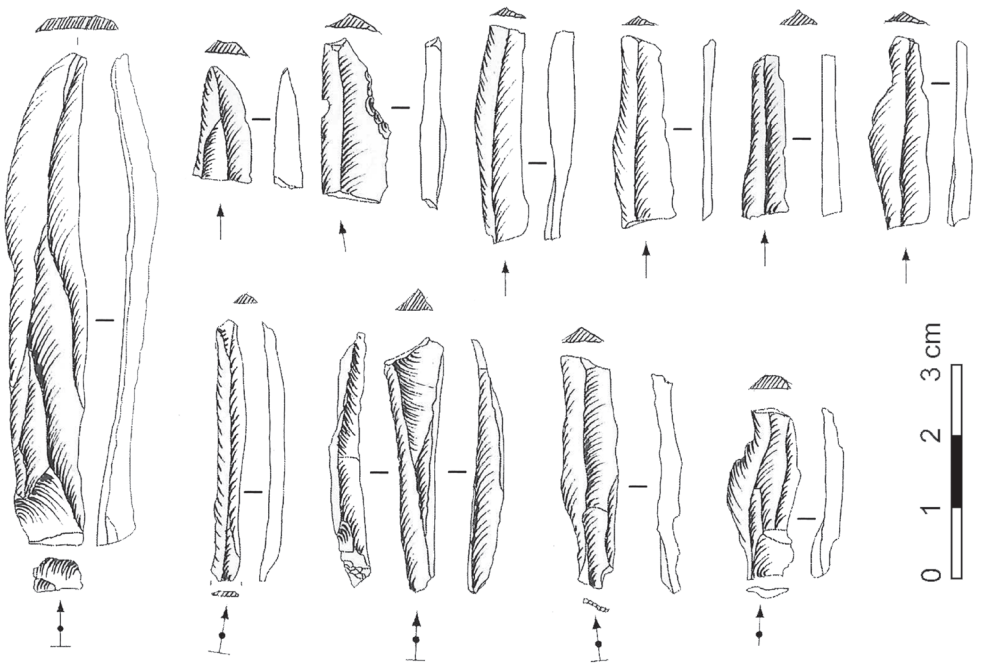


Figure 73: Kara-Bom, OH5, small blade/ bladelet blanks

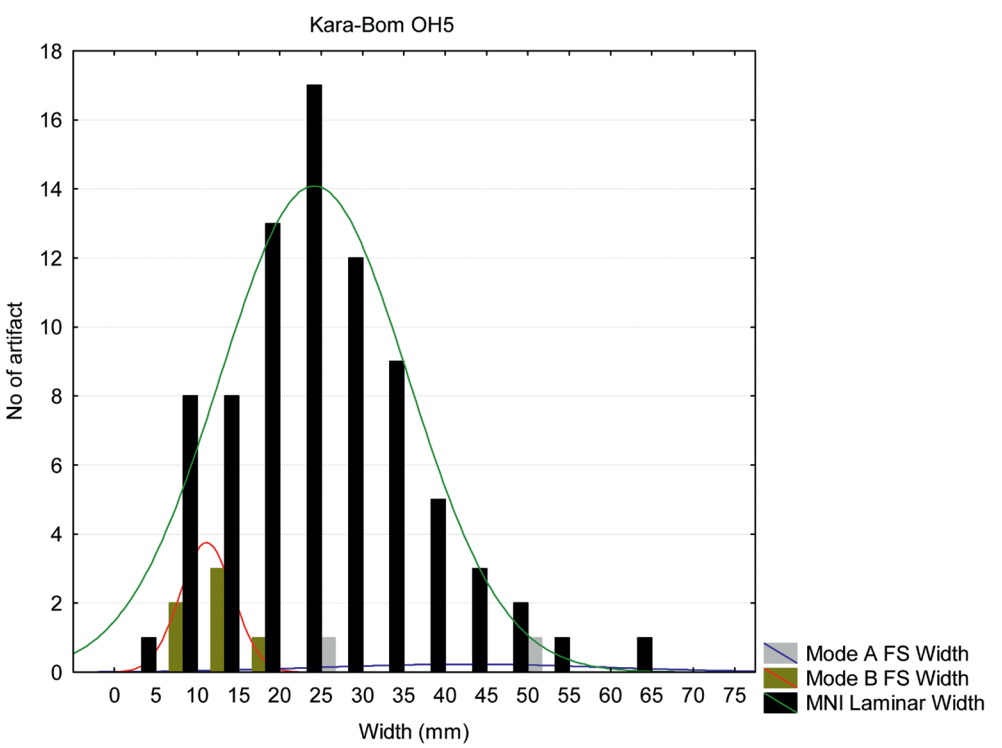


Figure 74: Kara-Bom, OH5, Mode A and Mode B flaking surface width and MNI width

lation width, a distinction between the two modes is visible. Mode A cores, in spite of the sample size, appear more variable and generally larger than the flaking surface from the Mode B cores (Figure 74).

MNI width distribution is not as clearly bimodal as the whole laminar sample, although it still displays a discrete peak between 5 and 15 mm width, which overlaps with the main mode peaking around 25 mm in width. Mode B core flaking surfaces and last removals widths match with the narrowest part of the laminar population. Morphologically, two main types of blank are detached from Mode B cores. Some blanks are naturally backed with thick triangular sections and are struck from a corner of the flaking surface. The second type is detached from the central part of the flaking surface and usually shows a rather flat and thin triangular or trapezoidal section. Both types of blank do not match with arbitrarily defined categories such as blade and bladelet and are not part of a comtinuum of reduction starting with the large blades.

Convergent blanks

Among the laminar elements, a few are characterized by their convergent edges (N=5). Three are complete and two are mesial and mesiodistal fragments. The complete elements have a length between 29 and 60 mm. Four of the five blanks have a width ranging from 21 to 32 mm, the last one having a width circa 13.5 mm. Their thicknesses vary from 4.7 to 6.9 mm, and their section is mostly trapezoidal with two being triangular. Among the observable platforms, two are facetted and one is plain. They all have a straight profile and, except one, they display a bidirectional scar patterning. The only bidirectional blank refits with the Mode A4 core KB-92.YO5.Z6.3.802 (Figure 62). It was struck from a broad side of a bidirectional core. Although a previous removal was struck from the distal part of the flaking surface, it is not visible on the dorsal face of the blank. It has a facetted platform although the impact point is located on a rather prominent and plain facet. This is the only technological refit that provides direct information about the production of the convergent blanks which are likely associated with Mode A cores, as they may display a broad flaking surface. The production of such a blank requires a series of 2-4 removals, some of which give the distal part of the flaking surface a triangular shape. Although in this case the cross-section of the blank is triangular, the previous removals likely create a convergent guiding ridge at the distal end of the flaking surface. Like in Levallois technology, this preparation leads to the production of a naturally pointed blank with convergent edges. However, the core described here differs from the classic Levallois examples as it shows a series of hinged fractures indicating an attempt to produce removals from a narrow edge of the core. This gives to the core a sub-prismatic morphology. Unfortunately, long refitted sequences are lacking and this single example can hardly be generalized to all convergent blanks from the sample.

Platform preparation and percussion technique

Regarding the technique of percussion, several observations can be discussed. First, thin abrasion of the external platform edge is totally absent, although some blanks (N=5) bear traces of a strong abrasion smoothing the EPA until the latter show a rounded edge. Such a preparation occurs on medium/large laminar elements, uni- and bidirectional, with plain and facetted platforms. It is associated with one naturally backed blank. The mean of blade platform thickness is above the 4 mm limit defined by Pelegrin (1995) as a thick platform *(talon épais)*. Third, facetted platforms are at least as frequent as the plain platforms, no matter the size of the blank. Among the facetted platforms, some bear only a partial faceting affecting mainly the EPA and the point of percussion is located on a slightly prominent plain surface. Moreover, flaking on the bulb (circa 17% of the blade MNI) and lip (circa 18% of the blade MNI) occur sporadically on the blanks. Considering all these observations together, it appears that typical features associated with the use of an organic hammer are almost absent. Discrete features associated with the use of a soft-stone hammer occur sporadically and typical features associated with hard hammer occur significantly. Therefore, a general use of hard-hammer likely associated with some soft-stone hammer is proposed as a hypothesis to categorize the technique of percussion used in OH5.

Retouched tools

The main categories of retouched tools include here only tools on laminar elements. For OH5, one of the retouched points was produced from a laminar flake and is included in the list (Table 53). It is then no surprise to see the retouched blades as dominant in the sample. Also, the approach adopted here is conservative and tries to leave out ambiguous tool types such as notches, or denticulates, as they may be the result of mechanical edge damage.

Tool breakage differs from what can be observed on the unretouched blanks. The mesioproximal fragments dominate the set, but for the rest, no clear pattern can be observed (Table 54).

There is no clear pattern of blank size selection regarding the width (Figure 75) or thickness, and the sample is too small to observe such a pattern on the length values.

	N	*f* (among tools)	*f* (from total, n=174)
Retouched blade	18	69%	10%
Retouched bladelet	1	4%	1%
Retouched point	5	19%	3%
Endscraper	2	8%	1%
Other	0	0%	0%
	26	100%	15%

Table 53: Kara-Bom, OH5, frequency of major retouched tool types

Among the retouched blades, the most typical type is the so-called 'sickle-like blade' (N=2). These tools are produced on bidirectional blanks and show a continuous retouch along a convex edge, opposed to a slightly retouched or natural straight/convex edge.

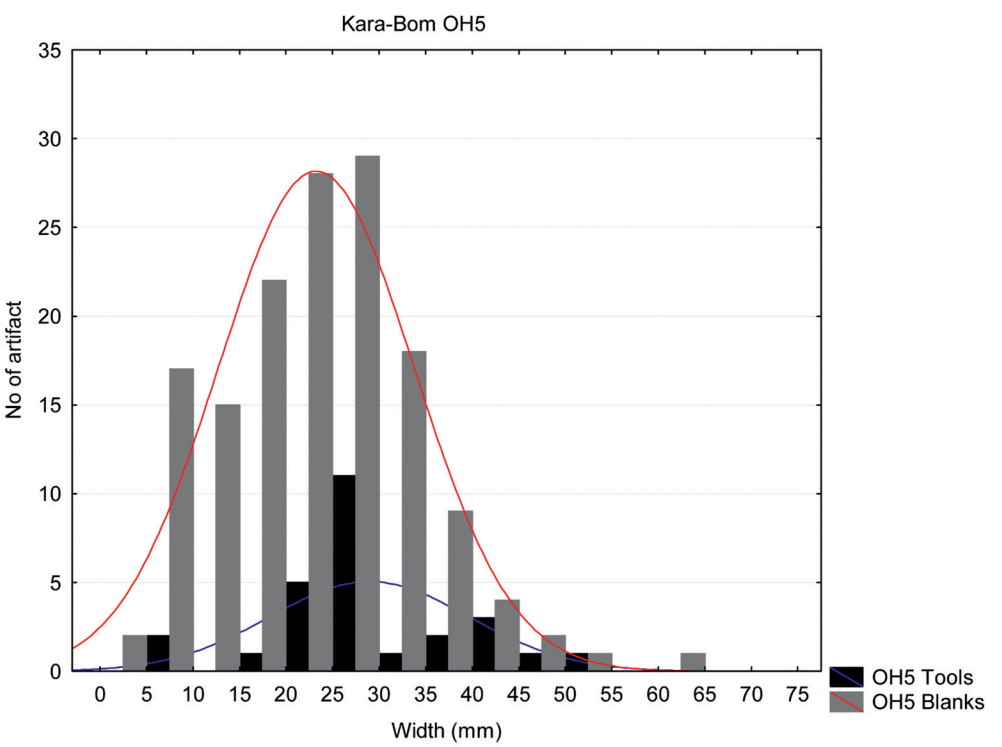


Figure 75: Kara-Bom, OH5, width histogram comparing retouched tools and blanks

	N	*f*
Distal	2	8%
Mesiodistal	5	19%
Mesial	4	15%
Mesioproximal	10	38%
Proximal	1	4%
Complete	4	15%
	26	100%

Table 54: Kara Bom, OH5, retouched tools breakage

The general arched morphology appears roughly similar to the sickle blade from the Neolithic from the Near-East (*e.g.* Rosen, 1982, 1997), although in this case, they do not bear any traces of the typical polish reflecting their intensive use on vegetal material.

These were first named sickle-like blade by Derevianko and colleagues (1993) when they reported the artifact illustrate here in Figure 76, num.4, but the refit of two artifact fragments (Figure 76: 5), previously considered as a point and a tool on blade (Derevianko *et al.*, 1998, Fig. 43, num. 3 and 9), illustrate a second complete sickle blade of circa 180 mm long, 25 mm width and 12 mm thick. One additional mesioproximal fragment (KB-92.Y05.E8.7) likely belongs to the same category. It is produced on a side blade showing a 20 mm thick natural back along a slightly convex right edge showing irregular scaled retouch opposed to a convex edge bearing continuous steep/semi-steep retouch (see Derevianko *et al.*, 1998, Fig. 42 num. 6). This type of artifact occurs only within the OH5 sample and, therefore, can be considered as typical for this assemblage. One genuine notched blade also occurs among the retouched blades. Among the set of tools, convergent laminar elements are also present, including two Mousterian points on bidirectional blanks, one of which shows a notch on the left side of the proximal part, struck

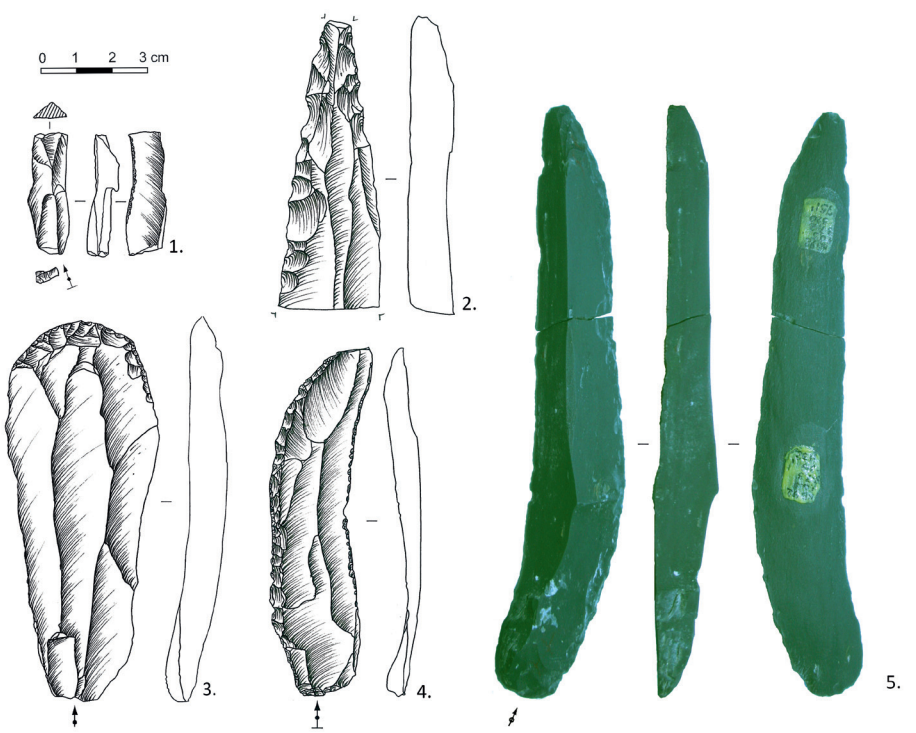


Figure 76: Kara-Bom, OH5, retouched tools

from the ventral side, and a direct continuous thin retouch along the right edge (see Derevianko *et al.*, 1998, Fig. 43, num. 6). Another point is represented by the mesioproximal end of a bidirectional laminar blank modified by a semi-invasive scaled retouch (Figure 76: 2). Two endscrapers are also listed, one being on a mesioproximal cortical and bidirectional blade fragment, with a combination of thin and semi-steep retouch on the proximal end. The second one is complete and produced on an unidirectional blade with a semicircular front located on the distal end with scaled and thin retouch (Figure 76: 3). Burins are absent, those previously illustrated are either considered as cores, or have the removal of the burin spall is anterior to the removal of the blank.

	N	*f*
Plain	5	19%
Facetted	5	19%
Dihedral Flat	1	4%
Undetermined	15	58%
	26	100%

Table 55: Kara Bom, OH5, retouched tools, platform preparation

Plain and facetted platform frequencies are equal but the number of undetermined platforms is relatively high due to missing or retouched platforms (Table 55). In fact, the tool MNI (N=15) includes identifiable (N=11), retouched (N=1) and undetermined platforms (N=3). A single artifact shows a smoothed EPA. Dorsal scar patterns are mostly bidirectional (85 %). A low frequency of unidirectional (8%) is observed. Although a large number of undetermined orientations may blur the trends, axial tools dominate the set but not significantly (Table 56).

Retouch is mainly direct with only two blades showing inverse retouch (Table 57). One is a small size bidirectional blank bearing thin semi-continuous retouch along the right edge. The blank is rather atypical as it shows a deep hinge fracture on the dorsal face. The other tool with inverse retouch is a larger

	N	*f*
Right	6	21%
Left	3	10%
None	8	28%
Undetermined	9	31%
	26	100%

Table 56: Kara Bom, OH5, retouched tools, orientation

blade displaying scaled retouch. Types of direct retouch vary from steep to thin but a frequent use of the scaled retouch is noticeable. This type of retouch also occurs combined with thin retouch (*e.g.* Figure 76: 3-5). One notched blade and two denticulate pieces (including one on a Mousterian point) are part of the toolkit. One borer is shaped on the distal end of a bidirectional blank by steep retouch (Derevianko *et al.*, 1998, Fig.43, num. 5).

	N	*f*
Direct	24	92%
Inverse	2	8%
Alternate	0	0%
	26	100%

Table 57: Kara Bom, OH5, retouche location (face)

There is no apparent pattern of retouch distribution along edges. However, continuous retouch is well represented compared to the other categories (Table 58).

Among the smaller blanks, some of them have been left out of the tool category as the intensity and regularity of their retouch is questionable. However, some of them are intriguing by the location of their 'pseudo-retouch'. The three examples presented in Figure 77 are pointed blanks showing notches made by single blows located on their proximal and mesial ends. In the context of an assemblage with pointed

	Dorsal		Ventral	
	N	*f*	N	*f*
Distal	4	17%	0	0%
Mesial	6	25%	1	0%
Proximal	4	17%	0	50%
Combination	1	4%	0	0%
Continuous	9	38%	1	50%
Undermined	0	0%	0	0%
	24	100%	2	100%

Table 58: Kara Bom, OH5, retouch location (edge)

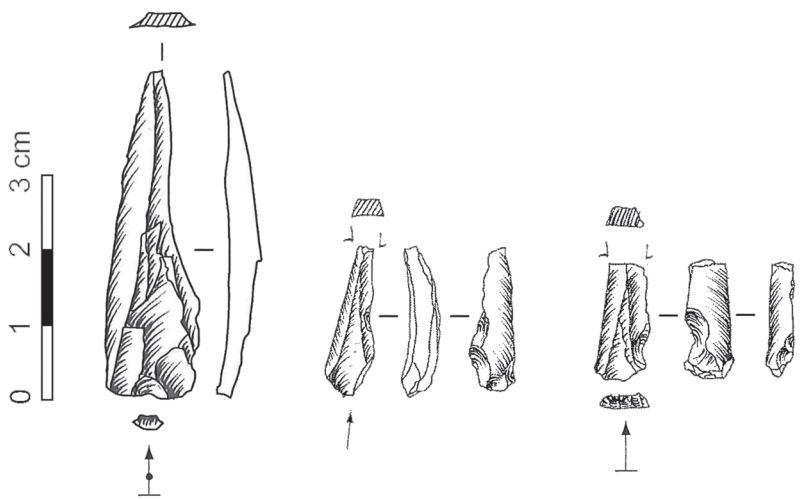


Figure 77: Kara-Bom, OH5, small laminar elements with possible proximal retouch

elements and frequent proximal modifications, perhaps these artifacts are worth mentioning; however, their tool status remains uncertain. Similar artifacts may occur in OH6 (see Figure 52, second row, second from the left).

3.5 LAMINAR TECHNOLOGY: OH4

3.5.1 BLANK ATTRIBUTES

The OH4 sample is significantly smaller than OH5 and OH6. The quantitative aspects of the analysis should, therefore, be interpreted accordingly. Some of the statistical tests used on other samples are absent in this section, as the sample size does not fit with their requirements.

	Total		Blade		Bladelet	
	N	*f*	N	*f*	N	*f*
Distal	2	5%	1	3%	1	20%
Mesiodistal	2	5%	1	3%	1	20%
Mesial	12	31%	11	32%	1	20%
Mesioproximal	9	23%	9	26%	0	0%
Proximal	0	0%	0	0%	0	0%
Complete	14	36%	12	35%	2	40%
	39	100%	34	100%	5	100%

Table 59: Kara-Bom, OH4, breakage

Breakage

Laminar blanks are mainly mesial and mesioproximal fragments (Table 59). Based on these observations, an MNI of 19 blades and 4 bladelets is calculated on a total of 39 laminar blanks recorded.

Platform: size and preparation

Considered as a whole, laminar blank platforms show similar frequencies although plain platforms occur more often than facetted ones (Table 60). This observation is balanced by the small sample size. A few dihedral platforms occur among the blades, and the bladelets are exclusively plain. The mean platform thickness is 5.2 ± 4.1 mm and the mean platform width is 11.8 ± 8.3 mm. For the blade category, the mean platform thickness is 6.2 ± 4.1 mm and the mean width is 13.9 ± 8.3 mm. Bladelet mean platform thickness is 2.2 ± 0.7 mm and the mean width is 4.6 ± 2.1 mm. Measurements are listed per morphological types.

The thickness of facetted platforms is described for the blades only as no bladelets show such a platform (Table 61).

Plain platforms are significantly less thick than the facetted platforms (Mann-Whitney, T=Ub=9, p=<.05), although due to the small sample size, this observation is hard to interpret (Table 62). No traces of abrasion could be observed on the blanks external

	Total		Blade		Bladelet	
	N	*f*	N	*f*	N	*f*
Plain	9	39%	5	26%	4	100%
Facetted	6	26%	6	32%	0	0%
Dihedral Flat	2	9%	2	11%	0	0%
Undetermined	6	26%	6	32%	0	0%
	23	100%	19	100%	4	100%

Table 60: Kara-Bom, OH4, platform preparation

Facetted platform	Total (=blade)	
	Thickness	Width
Sample size	6	
Mean (mm)	7.9	16.2
Standard deviation (mm)	5.3	8.2
Range (mm)	2.9 to 15.7	7.3 to 30.1

Table 61: Kara-Bom, OH4, facetted platform size

Plain platform	Total		Blade		Bladelet	
	Thickness	Width	Thickness	Width	Thickness	Width
Sample size	9	5	4			
Mean (mm)	3.2	8.2	4.6	11.1	1.6	4.6
Standard deviation (mm)	2.7	7.8	3.2	9.7	0.7	2.1
Range (mm)	0.8 to 8.7	1.7 to 26.1	0.8 to 8.7	26.1 to 55.7	0.8 to 2.2	1.7 to 6.7

Table 62: Kara-Bom, OH4, plain platform size

platform edge, with the only exception of a single blade showing a strong abrasion smoothing the EPA.

Blank size attributes

Length

Due to the sample size, the data set is rather poor but still provides a general idea of the variability in OH4 blanks ranging from 20 to 153 mm long and averaging 75 mm (Table 63, Figure 78).

Width

When comparing mean width and standard deviations from the total sample and from the MNI, it appears that MNI values are either equal or higher than the total sample (Table 64). However, differences are not statistically significant. In other words,

	Total	Blade	Bladelet
Sample size	14	10	4
Mean (mm)	74.6	89.1	38.1
Standard deviation (mm)	41.2	39.5	13.3
Range (mm)	20.1 to 152.5	49.8 to 152. 5	20.1 to 52

Table 63:Kara-Bom, OH4, blank length

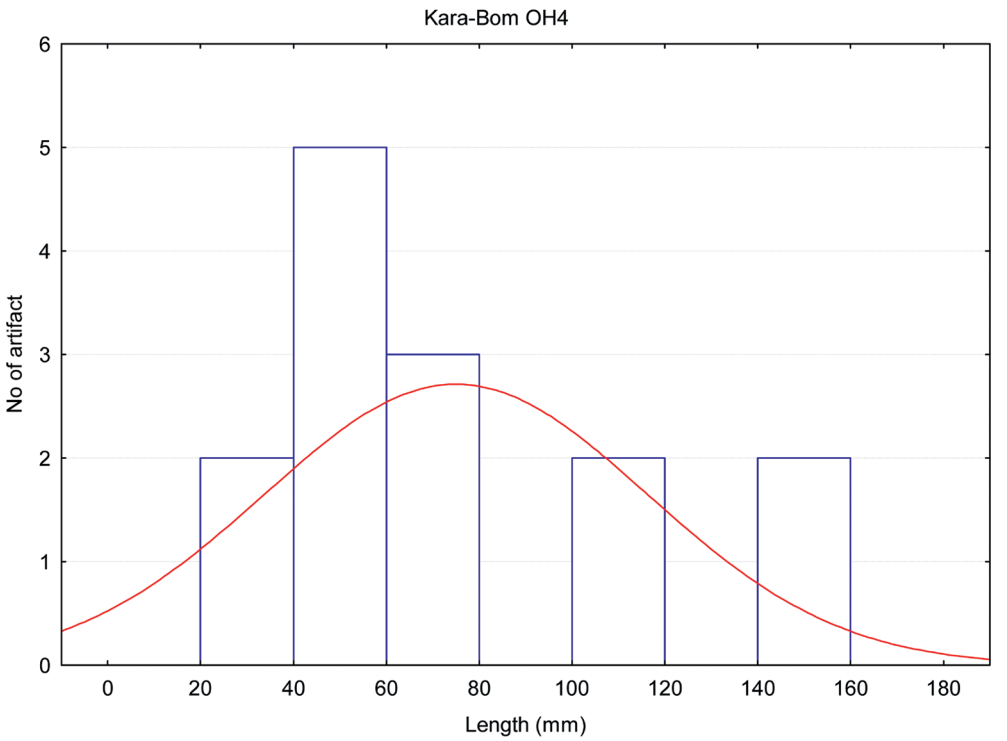


Figure 78: Kara-Bom, OH4, blank length distribution

	Population			MNI		
	Total	Blade	Bladelet	Total	Blade	Bladelet
Sample size	39	32	7	23	19	4
Mean (mm)	23.6	26.9	8.9	24.8	28.1	9.4
Standard deviation (mm)	12.1	11	1	12.4	11.1	1
Range (mm)	7.7 to 51.2	12.6 to 51.2	7.7 to 10.6	8.6 to 49	12.6 to 49	8.6 to 10.6

Table 64: Kara-Bom, OH4, blank width

measurements of the maximum blank width are not significantly affected by breakage. The distribution is bimodal with a cut-off point around 20 mm (Figure 79). The first mode is between 5-15 mm, and the second is close to the mean.

Thickness

Compared with the total population, MNI thickness shows equal or slightly higher mean values. Differences are, however, not statistically significant (Table 65). This shows that breakage does not influence significantly the main trends observed in thickness in the sample considered (Figure 80).

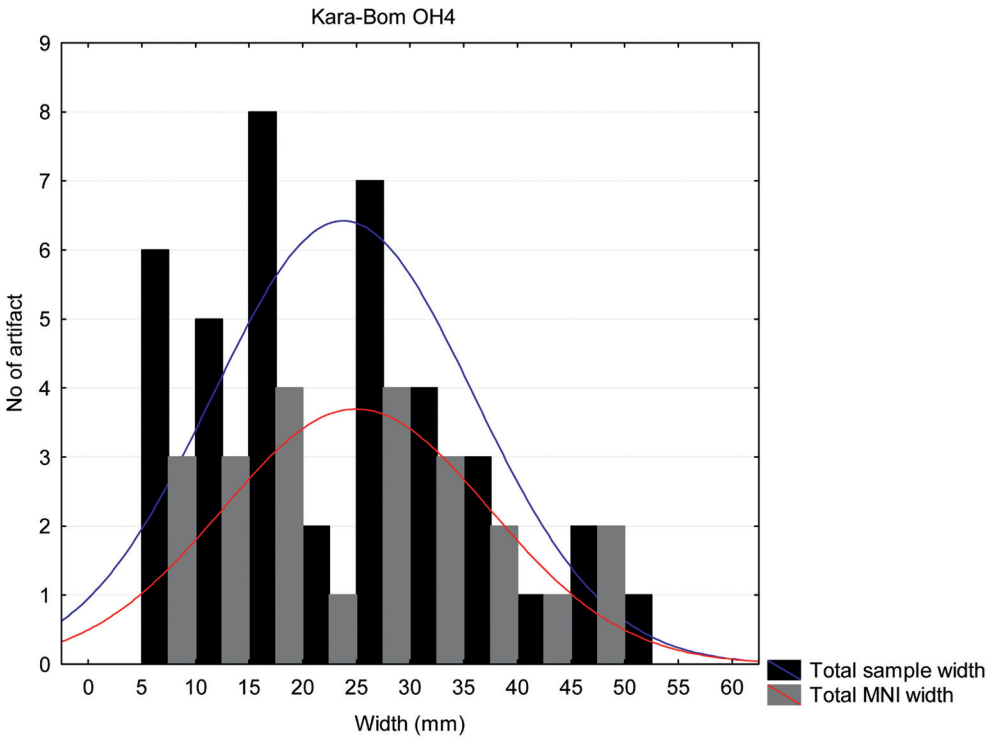


Figure 79: Kara-Bom, OH4, blank width distribution

	Population			MNI		
	Total	Blade	Bladelet	Total	Blade	Bladelet
Sample size	39	32	7	23	19	4
Mean (mm)	9.8	11.2	3.7	10.8	12.3	3.5
Standard deviation (mm)	6	5.8	1.6	6.7	6.3	1.5
Range (mm)	1.6 to 24.9	5.2 to 24.9	1.6 to 5.8	2.3 to 24.9	6.5 to 24.9	2.3 to 5.54

Table 65: Kara-Bom, OH4, blank thickness

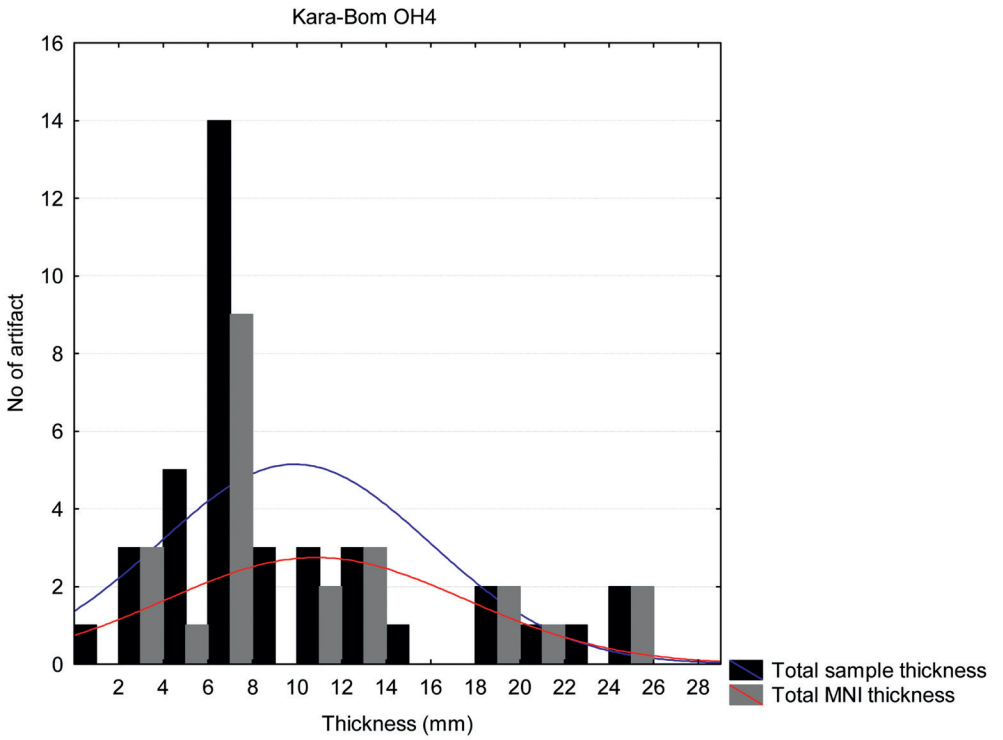


Figure 80: Kara-Bom, OH4, blank thickness distribution

	Total		Blade		Bladelet	
	N	*f*	N	*f*	N	*f*
Unidirectional	7	18%	6	19%	1	14%
Unidirectional and cortex	0	0%	0	0%	0	0%
Bidirectional	25	64%	19	59%	6	86%
Bidirectional and cortex	4	10%	4	13%	0	0%
Crest	0	0%	0	0%	0	0%
Second Crest	2	5%	2	6%	0	0%
Neo-crest	1	3%	1	3%	0	0%
Undet	0	0%	0	0%	0	0%
	39	100%	32	100%	7	100%

Table 66: Kara-Bom, OH4, dorsal scar pattern

	Complete blank		Complete blade		Complete bladelet	
	N	*f*	N	*f*	N	*f*
Unidirectional	3	21%	2	20%	1	25%
Bidirectional	10	71%	7	70%	3	75%
Crested	1	7%	1	10%	0	0%
	14	100%	10	100%	4	100%

Table 67: Kara-Bom, OH4, dorsal scar patter frequencies for the complete blanks

Dorsal scar pattern

The OH4 sample shows a clear dominance of bidirectional scar patterns, a few of them bearing cortex (Table 66). A unidirectional pattern is uncommon, and a few crested elements indicate core management operations. Considering only the complete artifacts, bidirectional scar pattern still dominate in both blade and bladelet categories (Table 67).

Profile

Most of the profiles are straight or only sometimes slightly curved (Table 70). However, the difference is sharply reduced when considering the MNI sample even if the trends remain the same (Table 71). Straight are the most common (N=11), followed by the slightly curved ones (N=8). Two of the bladelets are slightly curved. One is straight and one is twisted.

Cross-section

The majority of the cross-sections are trapezoidal or triangular (Table 68). This trend is mainly expressed in the blade category and appears similar when considering the MNI (Table 69).

Orientation

Artifacts are mainly axial, a few being equally orientated either on the right or on the left (Table 72). This trend is observed in all categories and in both total sample and MNI (Table 73).

	Total		Blade		Bladelet	
	N	*f*	N	*f*	N	*f*
Flat	0	0%	0	0%	0	0%
Rectangular	0	0%	0	0%	0	0%
Triangular	16	41%	11	34%	5	71%
Trapezoidal	23	59%	21	66%	2	29%
Polyhedric	0	0%	0	0%	0	0%
	39	100%	32	100%	7	100%

Table 68: Kara-Bom, OH4, type of cross-section

	Total		Blade		Bladelet	
	N	*f*	N	*f*	N	*f*
Flat	0	0%	0	0%	0	0%
Rectangular	0	0%	0	0%	0	0%
Triangular	9	39%	7	37%	2	50%
Trapezoidal	14	61%	12	63%	2	50%
Polyhedral	0	0%	0	0%	0	0%
	23	100%	19	100%	4	100%

Table 69: Kara-Bom, OH4, type of cross-section based on the MNI

	Total		Blade		Bladelet	
	N	%	N	%	N	%
Straight	26	67%	22	69%	4	57%
Slightly Curved	8	21%	6	19%	2	29%
Curved	4	10%	4	13%	0	0%
Twisted	1	3%	0	0%	1	14%
Undetermined	0	0%	0	0%	0	0%
	39	100%	32	100%	7	100%

Table 70: Kara-Bom, OH4, type of profile

	Total		Blade		Bladelet	
	N	*f*	N	*f*	N	*f*
Straight	11	34%	10	53%	1	25%
Slightly Curved	8	25%	6	32%	2	50%
Curved	3	9%	3	16%	0	0%
Twisted	1	3%	0	0%	1	25%
Undetermined	0	0%	0	0%	0	0%
	23	100%	19	100%	4	100%

Table 71: Kara-Bom, OH4, type of profile based on the MNI

	Total		Blade		Bladelet	
	N	*f*	N	*f*	N	*f*
Right	7	18%	6	19%	1	14%
Left	5	13%	3	9%	2	29%
None	24	62%	21	66%	3	43%
Undetermined	3	8%	2	6%	1	14%
	39	100%	32	100%	7	100%

Table 72: Kara-Bom, OH4, blank orientation

	Total		Blade		Bladelet	
	N	*f*	N	*f*	N	*f*
Right	6	26%	5	26%	1	25%
Left	4	17%	3	16%	1	25%
None	13	57%	11	58%	2	50%
Undetermined	0	0%	0	0%	0	0%
	23	100%	19	100%	4	100%

Table 73: Kara-Bom, OH4, blank orientation based on the MNI

3.5.2 CORES: REDUCTION PATTERNS AND SIZE ATTRIBUTES

Only one core is associated with OH4 sample.

3.5.3 CORE DESCRIPTION

Mode A2 (N=1)

* KB-91.M8.26.10906

The core blank is a Kombewa *débordant* flake which displays a single flaking surface along its left edge, from which blanks are detached from two opposed striking platforms (Figure 81). The two earliest removals (1 and 2) illustrate a platform switch followed by a series of removals for which the chronology could not be determined. Striking platforms are reshaped by frontal or lateral partial tablets. The general morphology of the core blank and the removals visible on the débordant section may indicate that it was originally a core tablet. Although some of the removals extend on the ventral face, the main pattern of reduction is frontal and, therefore, this core is categorized as Mode A2. The core blank by its morphology is comparable to a blade core tablet.

3.5.4 REDUCTION SEQUENCE RECONSTRUCTION

The reconstruction proposed here is mainly based on the laminar blanks, as only one core can be associated with the OH4 assemblage.

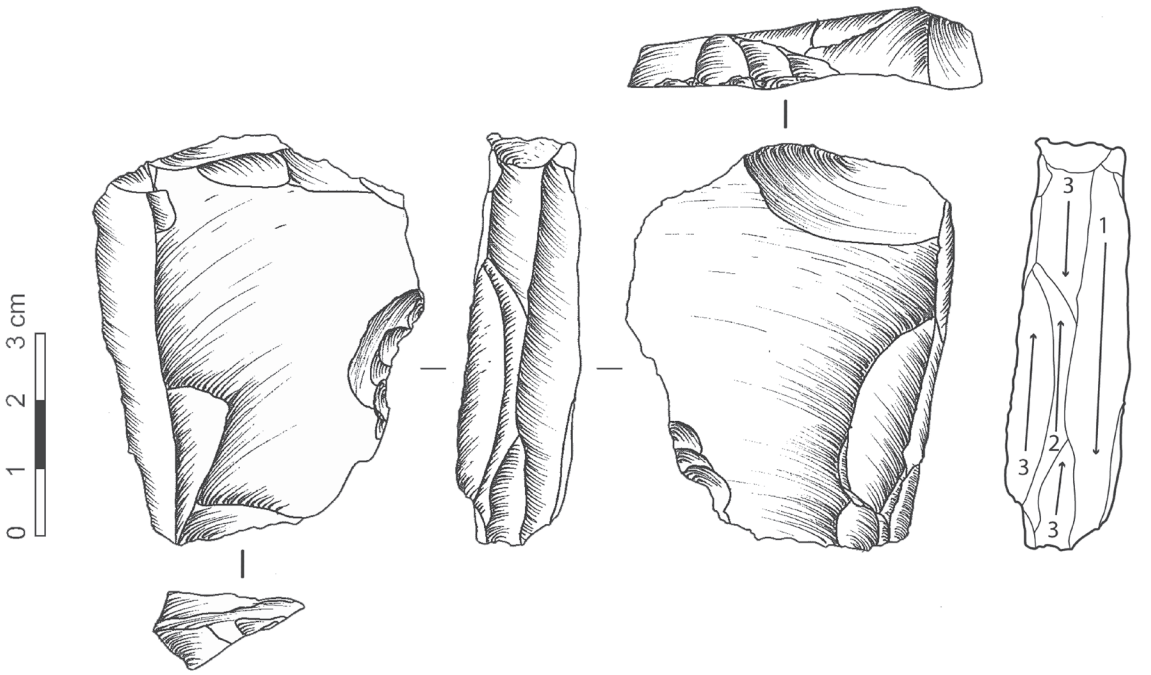


Figure 81: Kara-Bom, OH4, KB-91.M8.26.10906

Laminar blanks with parallel edges

The majority of the sample is composed of laminar elements displaying parallel edges, mainly produced by bidirectional reduction sequences. Some of these sequences may have been initiated on the site, as shown by the presence of a cortical secondary crest. Blanks are struck from two opposed platforms from the earliest stages of reduction, as indicated by blanks displaying a combination of bidirectional scar patterns and cortex. Judging by the significant frequency of bidirectional dorsal scar patterns, platform switches may have been relatively frequent, indicating short unidirectional sequences and maybe occasional alternate bidirectionality. The occurrence of crested elements indicates occasional core management taking place at the corner of the flaking surface. Removals are mostly detached following multiple ridges, especially in the blade category. Some of the small blades and bladelets (N=4) present a natural back, which may indicate that they were detached from a relatively narrow flaking surface, or from the corner of a wider one. One is clearly similar to a classic burin spall with a thick triangular section and a ventral face opposed to a two-sided dorsal face that partially preserves the ventral side of the core-blank. The majority of the blanks have a straight profile and an axial orientation.

Convergent blanks

A single artifact is categorized as a convergent blank (KB-92.Y04.I8.25) (Derevianko *et al.*, 1998, Fig. 46, num. 5). The blank is 68 mm long, 34 mm wide and 14 mm thick and bears unidirectional dorsal scar patterns. The platform is plain, 9 mm thick, and 26 mm wide.

Platforms are plain and facetted, the mean thickness of facetted platforms is above 4 mm and can be qualified as thick *(talon épais)* (Pelegrin, 1995). The mean thickness of plain platforms is lower than 4 mm. No abrasion of the external platform edge is observed except in one case where the blade shows a strong abrasion. Based on such as small sample size, it is difficult to identify the technique of percussion,

although the features observed on the blanks seem to indicate a frequent use of hard hammer.

Retouched tools

All retouched tools are produced on blades including one endscraper on a blade and one notched blade.

	N	*f* (among tools)	*f* (from total, n=55)
Retouched blade	12	75%	22%
Retouched bladelet	0	0%	0%
Retouched point	2	13%	4%
Endscraper	1	6%	2%
Other	1	6%	2%
	16	100%	29%

Table 74: Kara-Bom, OH4, frequency of major retouched tool types

One blade has a mesiodistal truncation giving the distal end an asymmetric pointed shape (Figure 83, center); however, only two artifacts had a clear pointed shape before being retouched. Some of the blanks have convergent edges without presenting a sharp pointed distal edge (Figure 83, left). Retouched small laminar blanks are almost absent, the only exception being a fragment of small blade showing a rather irregular continuous inverse retouch along the left edge (Figure 83, right).

	N	*f*
Distal	0	0%
Mesiodistal	4	25%
Mesial	5	31%
Mesioproximal	2	13%
Proximal	0	0%
Complete	5	31%
	16	100%

Table 75: Kara-Bom, OH4, retouched tools breakage

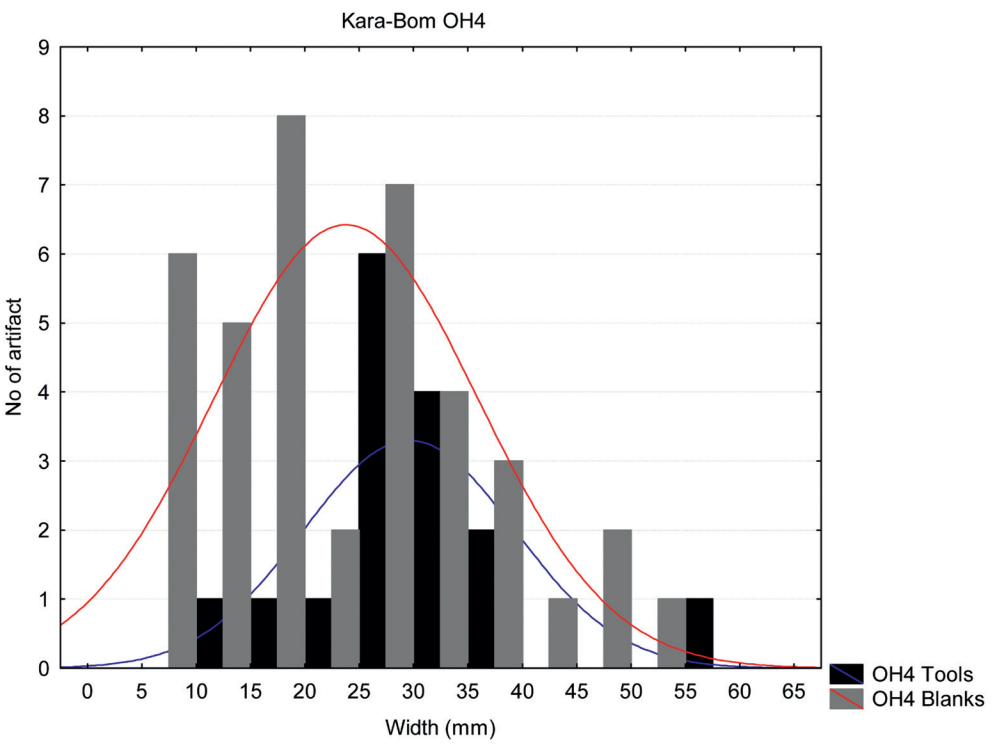


Figure 82: OH4, width histogram comparing retouched tools and blanks

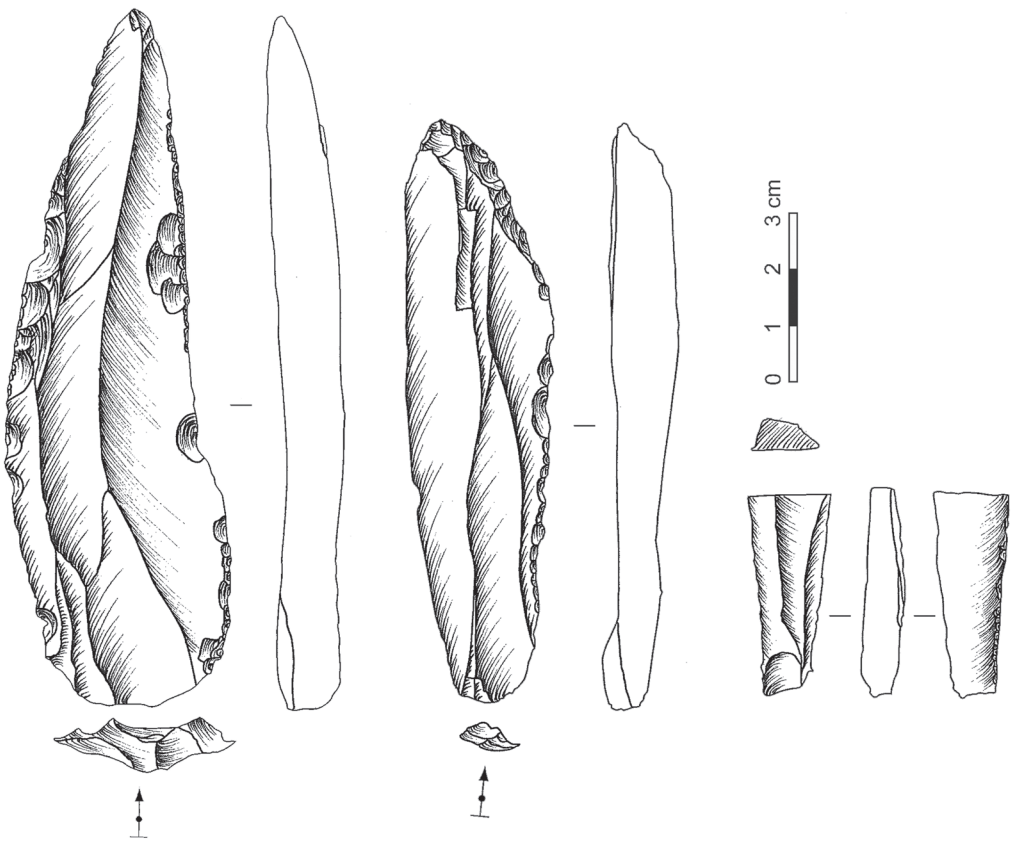


Figure 83: OH4, retouched tools

Along with complete artifacts, mesial and mesio-distal tool fragments are the most common (Table 75). All platforms are facetted except one which is dihedral. The mean thickness is 7.1 ± 5 mm. The mean is strongly influenced by the presence of an outlier (circa 17 mm), as the median is 5.4 mm. The mean platform width is 16 ± 10.2 mm. Half of the cross-sections are triangular, the other half being trapezoidal. Blanks are axial (N=6), oriented on the right (N=3) or on the left (N=1), with the rest being undetermined.

No clear pattern of blank selection related to size is observed. It seems that the tools are slightly wider than the blank mean width (Figure 82).

Retouch is mainly direct, with two examples being inverse and one being alternate (Table 76). Thin retouch is the most common (N=8), a few examples of scaled retouch also occur alone (N=2) or combined with thin retouch (N=1) (Figure 83, left). Semi-steep and steep retouch occurs only in combination with thin retouch (N=3) (Figure 83, center).

	N	*f*
Direct	13	81%
Inverse	2	13%
Alternate	1	6%
	16	100%

Table 76: Kara-Bom, OH4, retouche location (face)

Retouch shows no pattern of location along the edges (Table 77). Although retouch occurs quite often

	Dorsal		Ventral	
	N	*f*	N	*f*
Distal	4	29%	0	0%
Mesial	2	14%	1	33%
Proximal	1	7%	2	67%
Combination	1	7%	0	0%
Continuous	5	36%	0	0%
Undermined	1	7%	0	0%
	14	100%	3	100%

Table 77: Kara-Bom, OH4, retouch location (edge)

along the left edge (N=6), no clear pattern of lateral location can be observed.

3.6 ADDITIONAL ARTIFACTS

Following the description of the material sampled, this section consists of the description of 22 artifacts coming the 1987-1993 excavation campaigns. They could not be localized precisely or come from the 1980's Okladnikov's test pit. Artifacts attributed to Okladnikov's layers 1 to 4 and located between squares Z-N and lines 3-12 are most probably attributed to OH4-OH6, as MPH1 and MPH2 have not been reached in this area (Okladnikov, 1983). These artifacts were selected on the basis of strong similarities with the assemblage from OH5 and OH6. With respect to taphonomic issues, and in light of the results obtained on the sample, it is suggested that this material could be attributed to one of these occupation levels. Although no quantitative data are presented from this old collection, qualitative descriptions are used to illustrate the expectable range of technological variability of the described reduction sequences.

3.6.1 CORES

Core description

Mode A6 (N=2)

∗ KB-92.YO5.Z6.1

This core was previously attributed to OH5 but the spatial coordinates are not consistent with this attribution and likely indicate a problem in the data recording. It is a core on block with a cortical back and two flaking surfaces, one on the broad side of the core and one on the right lateral face. It displays two opposed platforms shaped by crude flaking (Figure 84). The left edge of the broad face show traces of radial flaking probably designed as a preparation of the surface convexity. A series of three removals are detached on the broad flaking surface from the lower platform (1-3), one on the left, one on the right and then one in the middle. The three following removals are detached from different platform. The one from the upper platform is fragmentary and hard to interpret, and the two others are struck for the lower platform, at the intersection between two surfaces (4). One more removal (5) is then detached from the lower platform at the right edge of the lateral flaking surface. The next removals are detached from the upper platform on the narrow flaking surface (6, 7),

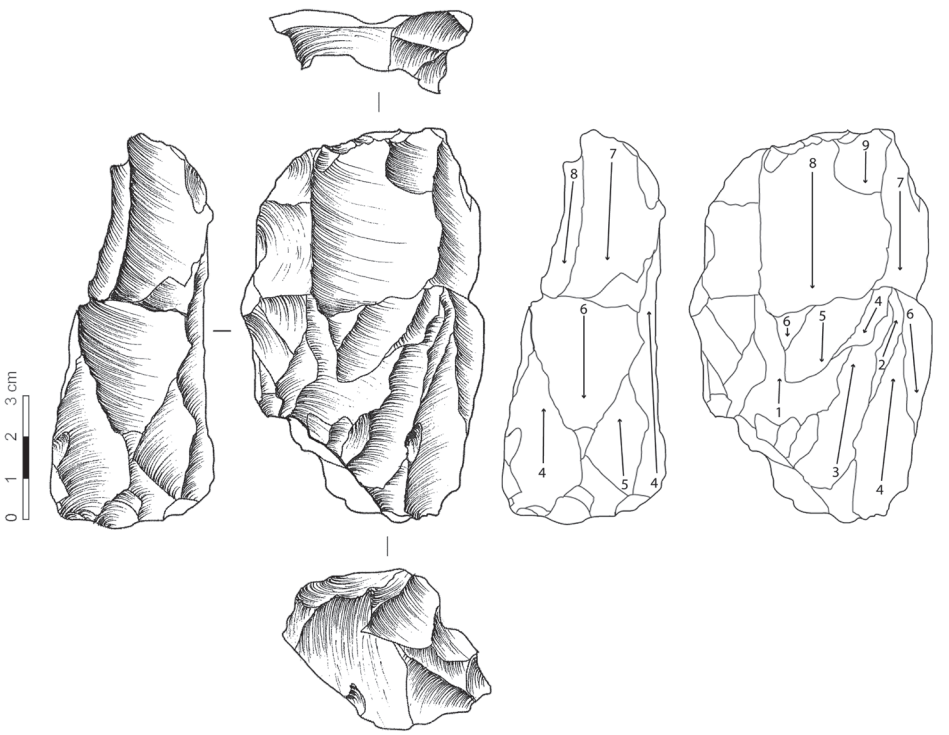


Figure 84: Kara-Bom, KB-92.YO5.Z6.1

the second one being hinged and ending the reduction on the lateral flaking surface. Alternatively, or after stopping on the lateral surface, two removals are detached from the broad surface (5, 6). However, the two last removals are struck from the upper platform on the broad face (7, 8). This core illustrates the alternating use of two related surfaces and two platforms, as opposed to a semi-turning reduction.

∗ KB-80.I11/2A.2381

This core is produced on a block and shows two flaking surfaces and two opposed platforms (Figure 85). The main flaking surface is located on a broad, slightly convex surface. The earliest phase of reduction (1) is located on the two lateral extremities and on the proximal part of the flaking surface, and blanks are struck from both platforms. This is followed by a series of three removals (2-3-4) finishing on a hinged fracture. One removal associated with phase 2 is struck from the upper platform. The reduction ends by two attempts to remove a blade at the left corner of the broad flaking surface (5-6). The second flaking surface is located along the right narrow edge of the core and is posterior to the phase 2 of reduction from the broad surface. It likely represents an attempt to remove a side blade from the right corner after the reduction on the broad face ended, in order to reshape convexities and resume the reduction process. The blanks detached from the broad face are probably flat and elongated with convergent edges as the side removals more likely show a thick triangular trapezoidal section.

Mode B1 (N=1)

∗ KB-88 (RA-80).98Y.I10/2

This artifact is a thick mesioproximal blade fragment with a dorsal patterning showing a cortex-like inclusion which occurs after the detachment of a lateral removal visible along the right mesial part of the blank (Figure 86). Two crest-like blows show attempts to remove it before the blade is detached.

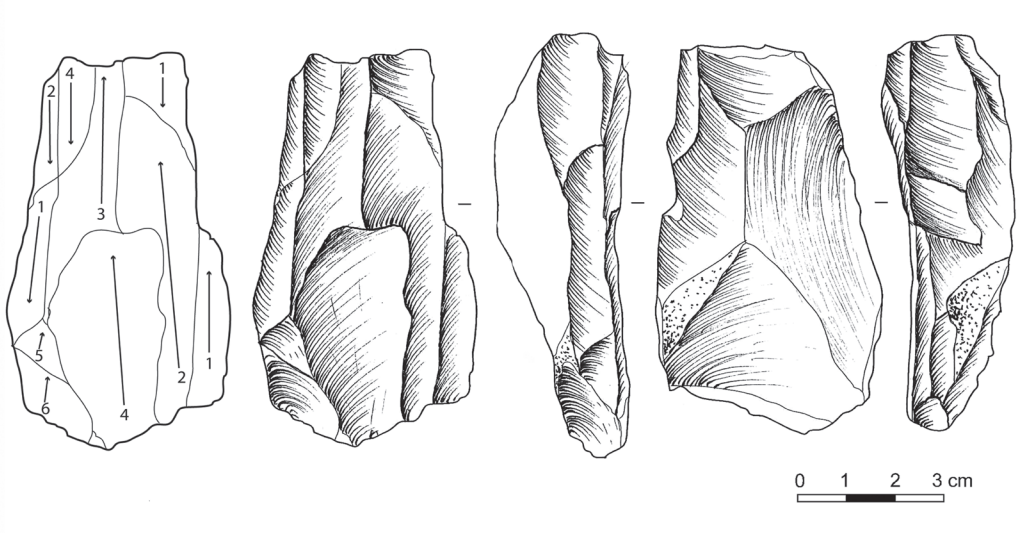


Figure 85: Kara-Bom, KB-80.I11/2A.2381

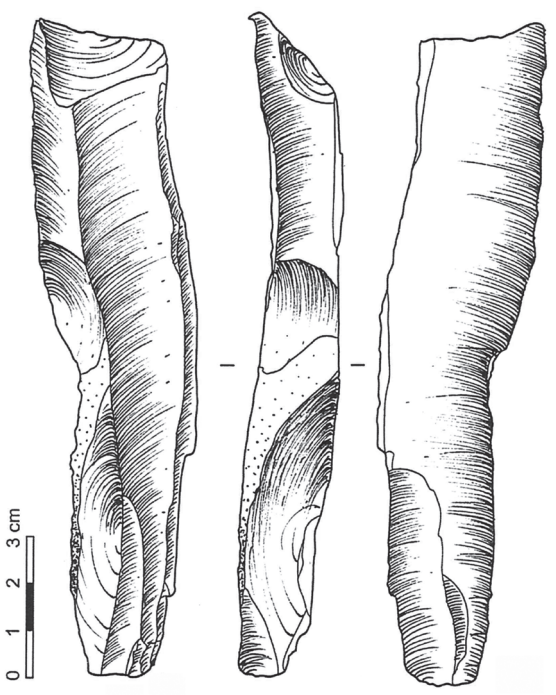


Figure 86: Kara-Bom, KB-88 (RA-80).98Y.I10/2

Three removals show attempts to detach thin spalls along the left edge. In this case, it seems to represent the initial stage of a Mode B reduction.

Mode B2 (N=3)

∗ KB.1043.10/3.1939

This core is made on a thick blade/laminar flake which bear negatives of convergent removals on the dorsal face and a series of sporadic direct retouch along the left edge and on the proximal right end (Figure 87). It also display a distal truncation posterior to a snap/break. Four hinged negatives show repeated attempts to remove spalls along the retouched right edge. This artifact could also be typed as a burin on a truncation.

∗ KB-80.1Hor.I/8.4419

This artifact is on a cortical blade blank with unidirectional convergent removals, a notch, some retouch along the proximal left edge, a series of retouch on the right edge, and a single retouch on the platform (Figure 88). Several sub-cortical hinged removals are visible along the thickest edge of the blank, detached from a plain platform. This artifact is typed as a *burin d'angle*.

∗ KB-80.1Hor.M14.4775

This artifact is on a laminar flake bearing a combination of cortex, natural surface and a single removal

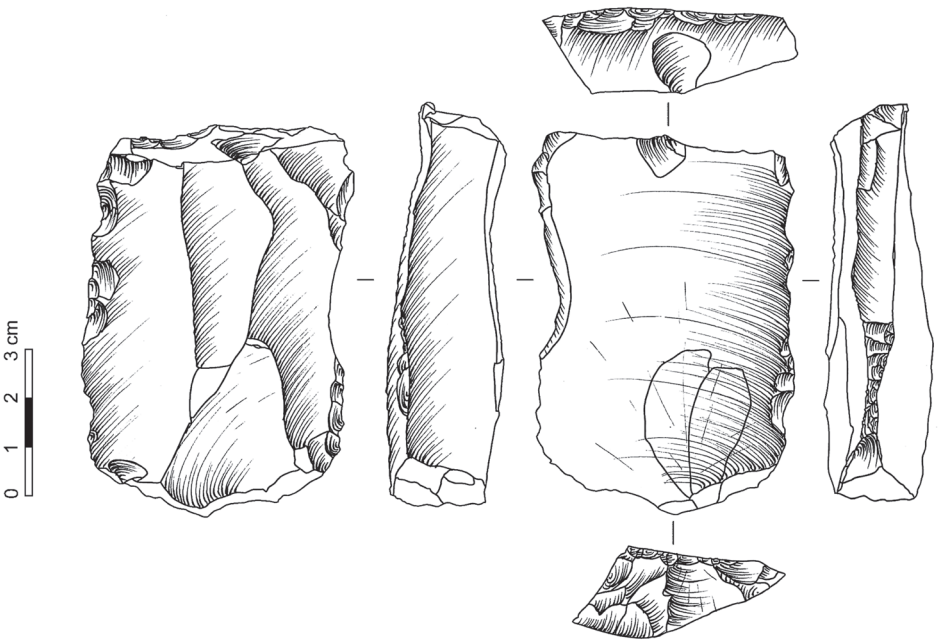


Figure 87: Kara-Bom, KB.1043.10/3.1939

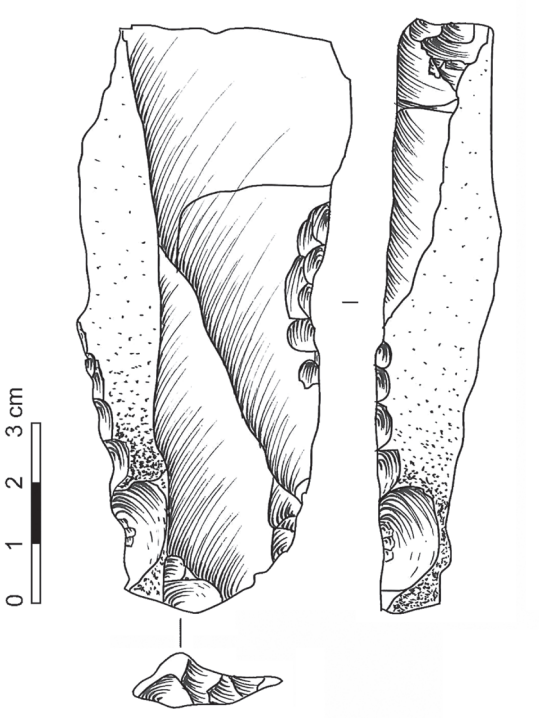


Figure 88: Kara-Bom, KB-80.1Hor.I/8.4419

on its dorsal face (Figure 89). It has a particularly thick hinge removal along the left edge opposed to a right edge bearing a combination of direct retouch and an inverse notch (edge damage?). A striking platform is prepared in the distal part by a series of removals, struck from the dorsal face and from the side, followed by a series of sub-cortical hinged removals. Although typologically it can be considered as a *burin d'angle*, the preparation of the platform and the fact that spalls are detached from the thickest edge indicates instead an initial stage of Mode B core reduction.

Mode B5 (N=10)

* KB.2831.I10/1A.3739

This core is on a second crested blade and shows a single flaking surface along its right edge (Figure 90). Two opposed platforms are used, one of which probably benefits from the thicknes of a core blank plunged morphology. The reduction sequence is mainly conducted from the upper platform and shows a series of unidirectional removals, some of them exploiting the entire length of the flaking surface (1,

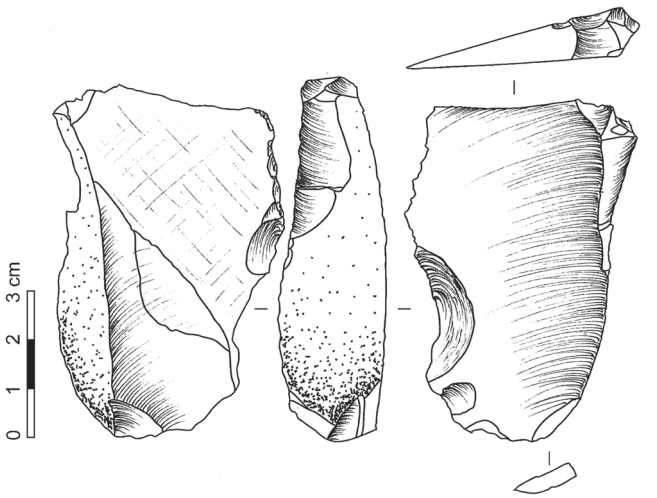


Figure 89: KB-80.1Hor.M14.4775

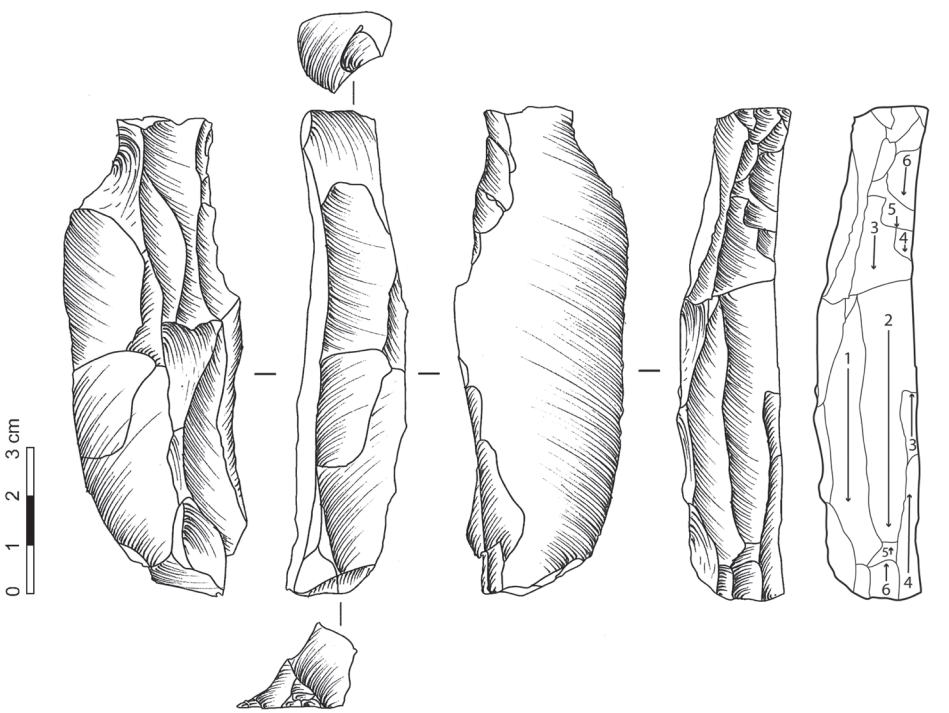


Figure 90: Kara-Bom, KB.2831.I10/1A.3739

2). It is then followed by a series of hinged fractures struck from both striking platforms (3-6) and slightly expanding on the ventral face, although it is not clear when the platform switch occured. The upper striking platform is plain and the lower platform shows preparation and reshaping with flakes being struck from the ventral face.

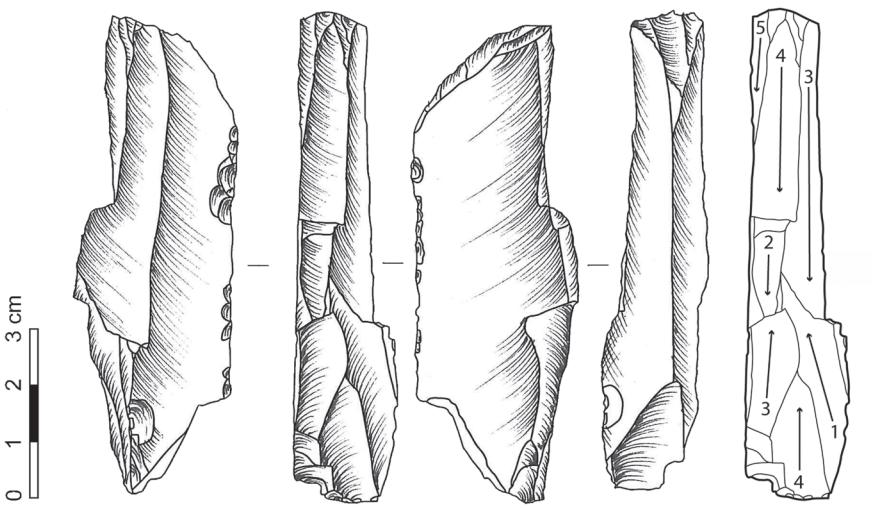


Figure 91: Kara-Bom, KB.RA-87.Sl3.M9.33.10

∗ KB.RA-87.Sl3.M9.33.10

This core is a unidirectional blade with a single flaking surface located along its right edge (Figure 91). The left edge displays alternate retouch. The flaking surface is reduced using two opposed flaking surfaces. The earliest removal is detached from the lower platform and is followed by a platform switch (2). Then a series of removals are struck from the upper platform and from the left edge to the right one (3-5). Two removals are detached from the lower platform (3, 4). The upper platform is shaped by small removals giving it a somewhat carinated morphology. The lower platform is shaped by a single blow.

∗ KB-80.Hor3.I/5.5596

This core is produced on a unidirectional blade which shows a direct truncation at its proximal end (Figure 92). A single flaking surface is located along

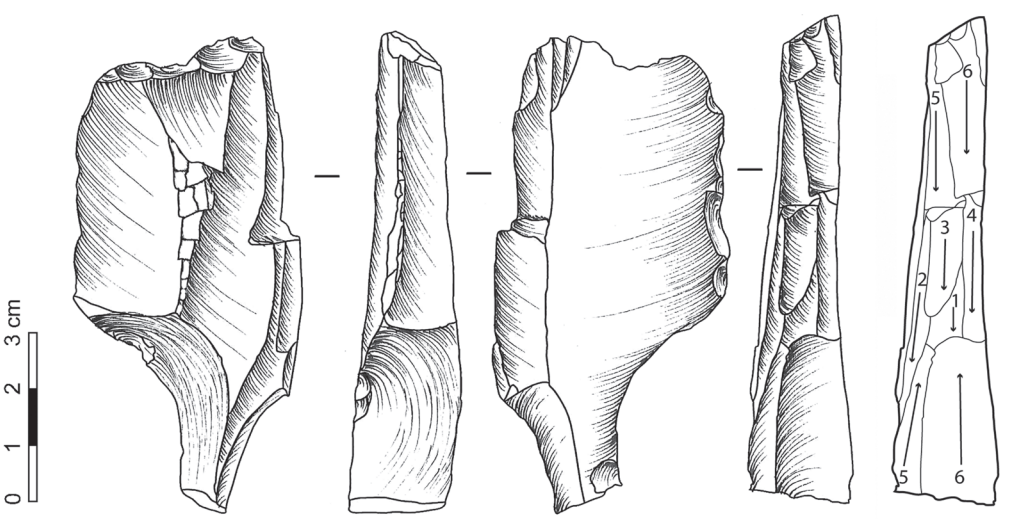


Figure 92: Kara-Bom, KB-80.Hor3.I/5.5596

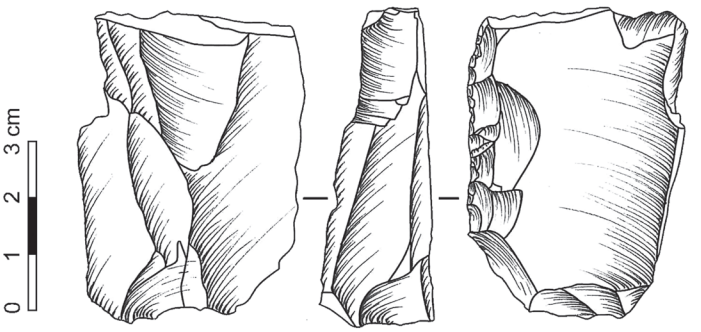


Figure 93: Kara-Bom, KB-80.Hor1.J7.4864

the right edge of the blank and is reduced from two opposed platform. A series of unidirectional removals are struck from the upper platform (1-6), some of them covering the entire flaking surface length (2). Two hinged removals are struck from the lower platform at the end of the reduction sequence. The small removals extending on the ventral face are detached from the upper platform and may indicate the use of the intersection between two surfaces as a natural crest.

∗ KB-80.Hor1.J7.4864

This core is produced on a bidirectional blade blank showing a proximal truncation and bearing a combination of thin and scaled inverse retouch along the right edge (Figure 93). A flaking surface located along the left edge is reduced by bidirectional removals detached from two opposed platforms. The left edge indicates that the first phase of reduction uses the lower platform. The upper platform is shaped by a removal perpendicular to the axis of the blank which is followed by two hinged removals, ending the reduction sequence.

∗ KB-RA-80.2526.I10/1.3444

This core represents initial stages of Mode B reduction on a bidirectional large blade (Figure 94). It shows the remains of a crest along the distal part of the right edge and a single flaking surface along the left edge, reduced from two opposed striking platforms. Three spalls are detached from the lower platform and two hinged removals are struck from the upper one. Platforms are prepared by removals on both ends.

∗ KB-92.450

This core is produced on a second-crest blade blank and displays a flaking surface located on its left edge (Figure 95). Reduction comes from two opposed flaking. The upper one is plain and the lower one is missing. The two earliest (1-2) removals illustrate a platform switch followed by two hinge fractures (3). The upper platform displays a clear impact point on the breakage surface that may indicate snapping by percussion.

∗ KB-80.2039.Z10/2.2955

This core is produced on a thick bi-directional blade blank with a single flaking surface, located along the right edge and reduced from two opposed striking platforms (Figure 96). Earliest phases of reduction show a use of the upper platform (1-2) followed by a switch to the lower platform and a series of hinged removals ending the reduction process. The upper platform shows a plain surface bearing traces of a lateral impact probably linked with the snapping event and a frontal removal corresponding to the detachment of a partial tablet.

∗ KB-80.Hor1.I/9.Y528

This core is on a unidirectional blade blank and shows a single flaking surface located along its left edge (Figure 97). Two opposed facetted striking plat-

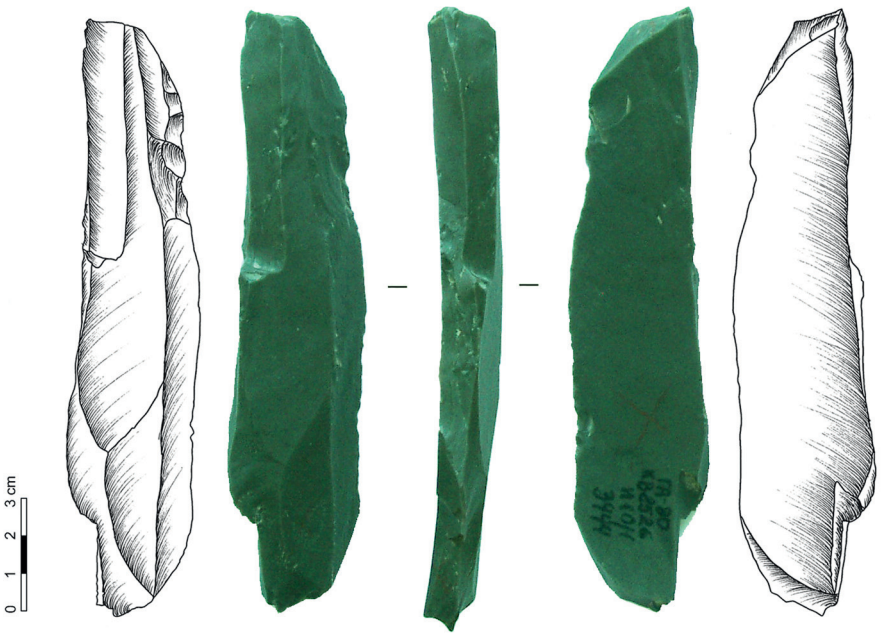


Figure 94: Kara-Bom, KB-RA-80.2526.I10/1.3444

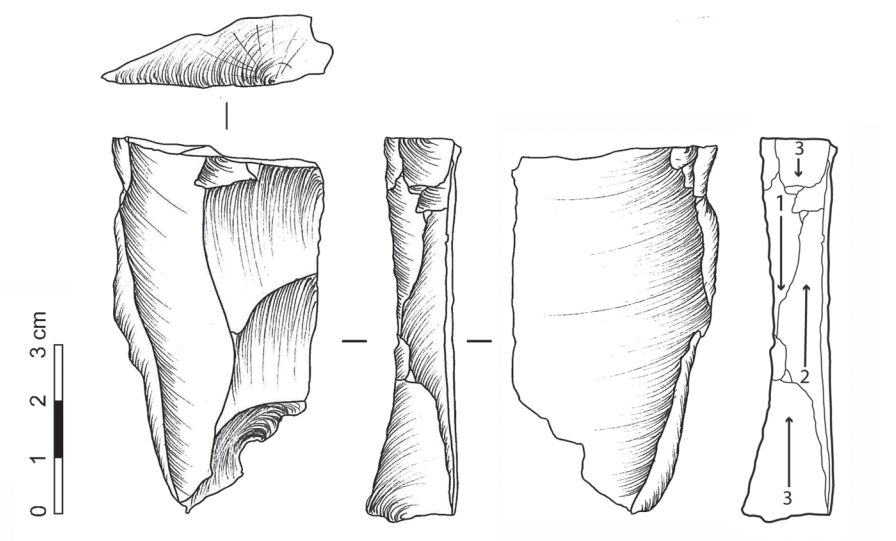


Figure 95: Kara-Bom, KB-92.450

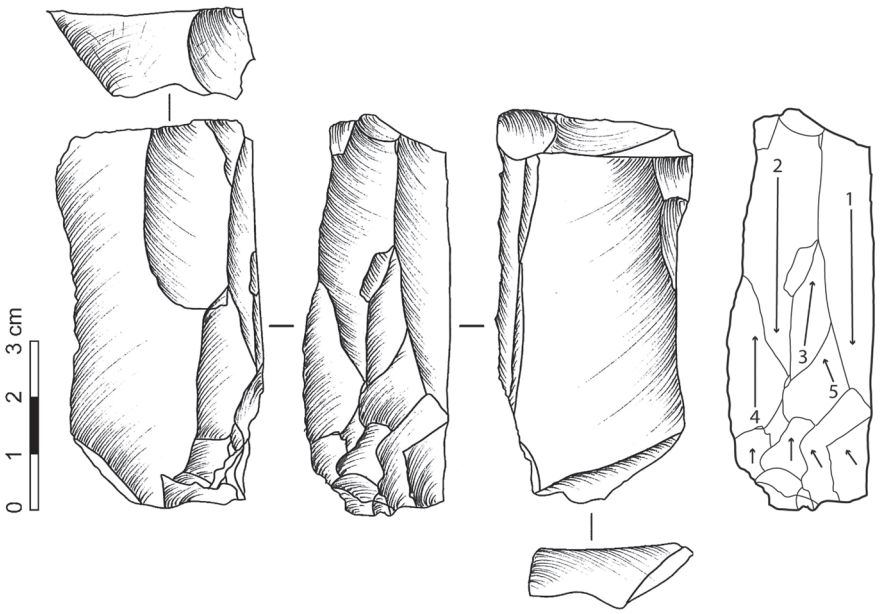


Figure 96: Kara-Bom, KB-80.2039.Z10/2.2955

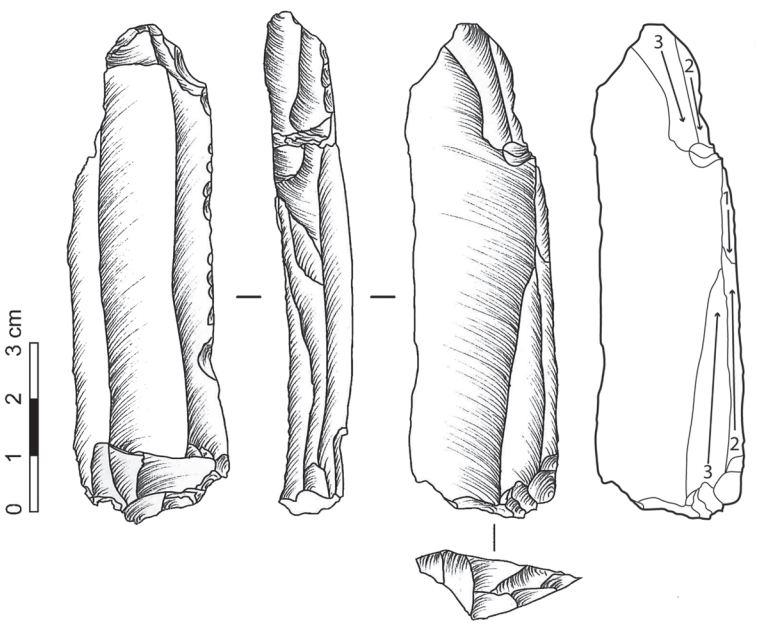


Figure 97: Kara-Bom, KB-80.Hor1.I/9.Y528

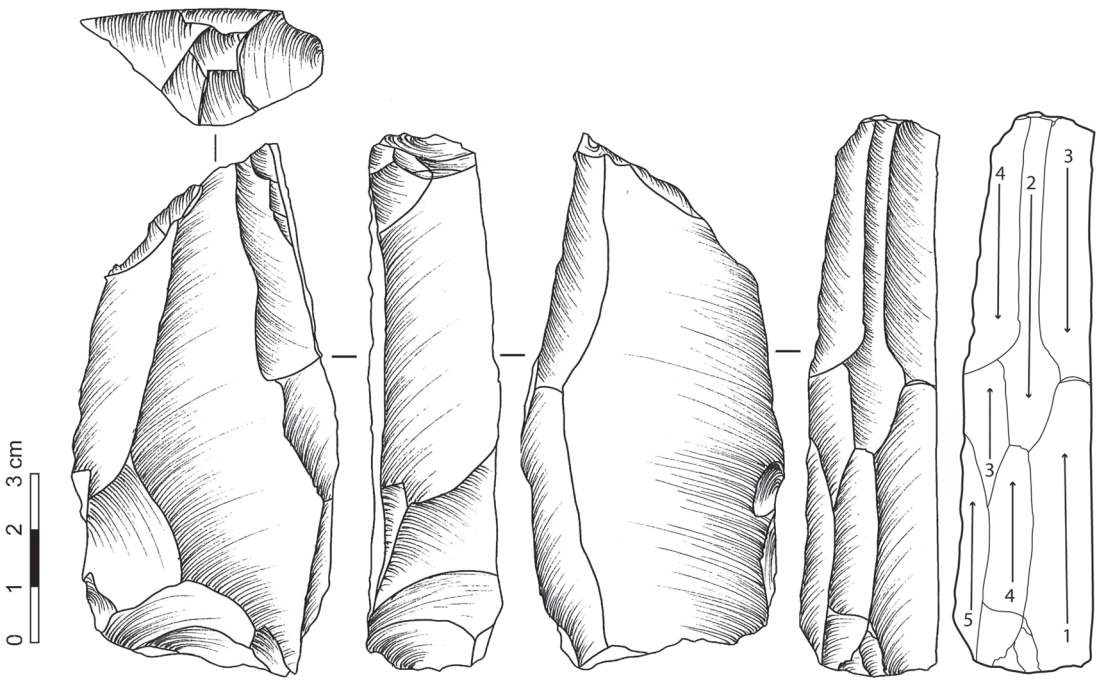


Figure 98: Kara-Bom, KB-80.Hor1.L/9.4378

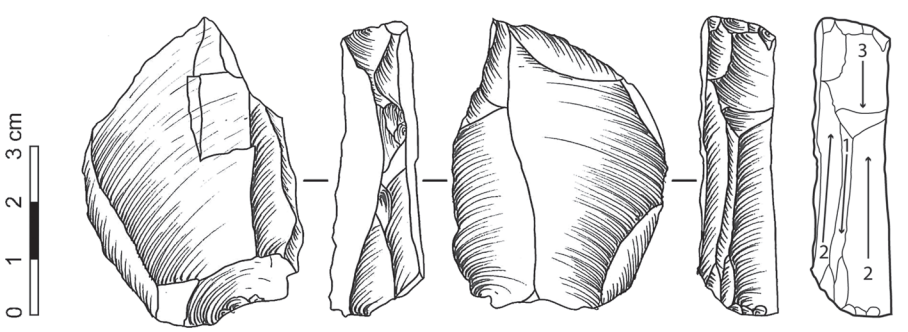


Figure 99:Kara-Bom, KB-87.SL3.I/54.N11.K8.327

forms are used, and removals are detached from the middle part of the flaking surface (1, 2) and from the corner with the ventral face (3). Upper platform reduction ends with two deep, hinged removals.

∗ KB-80.Hor1.L/9.4378

This core is produced on a large laminar blank and shows a single flaking surface located along the right edge (Figure 98). Two opposed striking platforms illustrate a bidirectional reduction sequence. The earliest phase (1) uses the lower striking platform and is followed by a switch to the upper platform (2). This is followed by two series of two and three removals from respectively the upper and the lower platforms (3-5); however, the chronology of the platform switches remains unclear. The upper flaking surface displays negatives of several frontal tablet removals.

∗ KB-87.SL3.I/54.N11.K8.327

This core is made on a laminar flake with a single flaking surface located on its right edge (Figure 99). The flaking surface is reduced from two opposed platforms, with a first removal (1) struck from the upper platform, followed by a platform switch with two more removals (2) detached from the lower platform. One of these clearly extends on the ventral face. Then another platform switch occurs as shown by the final hinged removals (3).

Mode B6 (N=2)

∗ KB-80.2472.I10/1.3890

This core is produced on a thick cortical laminar flake displaying a truncation on the proximal part (Figure 100). It has two independent flaking surfaces parallel to the longitudinal axis of the blank. The flaking surface on the right edge is flaked from two opposed striking platforms. The earliest phase of reduction consists of a series of two removals struck from the lower platform (1, 2) followed by a platform switch (3) and three hinged removals (4, 5). The flaking surface along the left edge shows the preparation of a crest, still visible on the distal end, and two hinged removals detached from both upper and lower platforms. The upper platform is shaped by a lateral removal with a combination of scaled and thin retouch, and the lower platform is shaped by a lateral flake removal and a frontal partial tablet removal.

∗ KB-91.YO5.Z6.1.P8.49.11342

This core is on a cortical bidirectional blade and has two independent flaking surfaces located parallel to its longitudinal axis (Figure 101). Along the right edge, the flaking surface is mainly unidirectional, with three removals tending to cover its whole length. A deep hinged removal is then detached from the lower platform. Both platforms are plain. The second flaking surface displays two hinged removals, struck from the upper platform. The latter is heavily prepared by a series of removals.

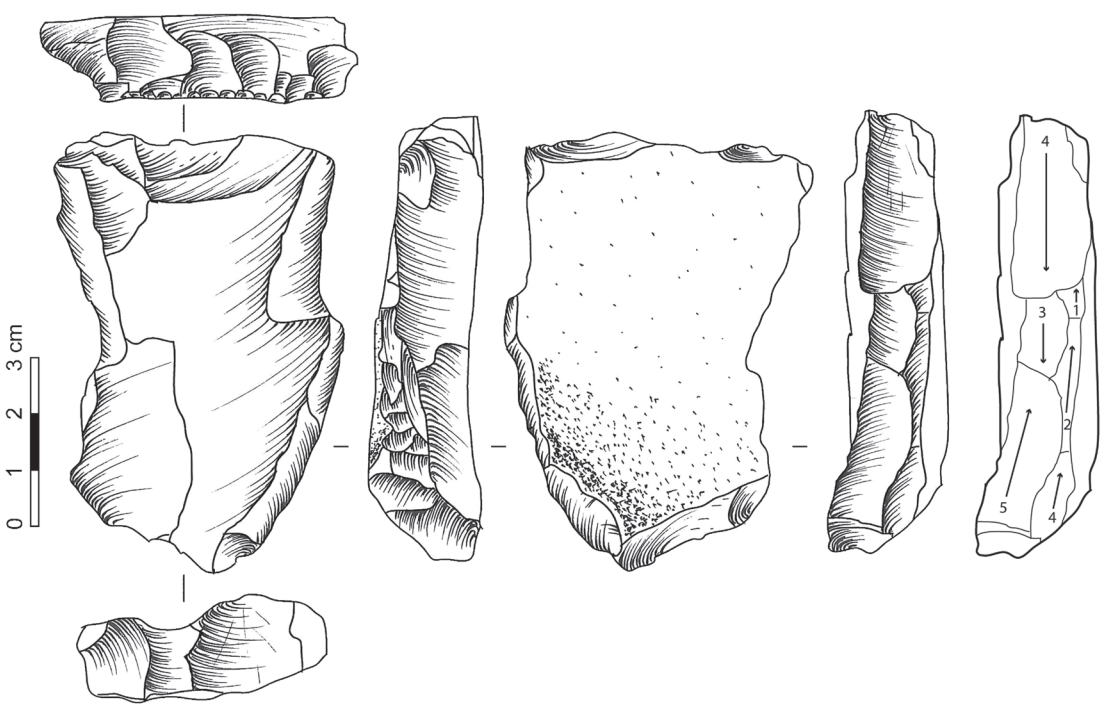


Figure 100: Kara-Bom, KB-80.2472.I10/1.3890

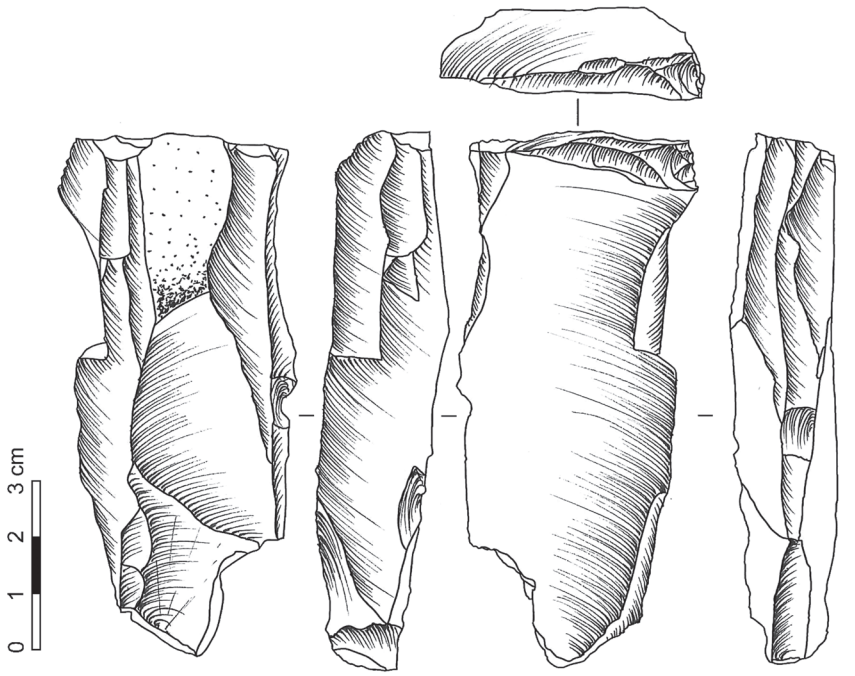


Figure 101: Kara-Bom, KB-91.YO5.Z6.1.P8.49.1134

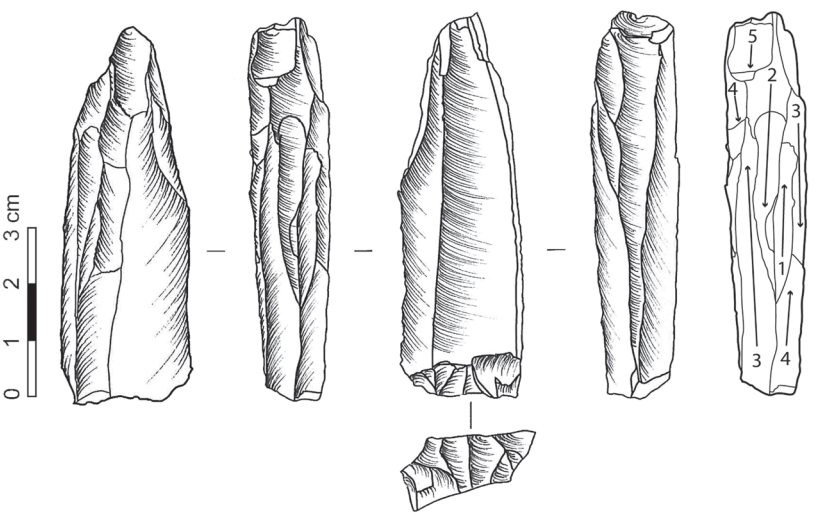


Figure 102: Kara-Bom, KB-80.Hor3.K6/5627

∗ KB-80.Hor3.K6/5627

This core is produced on a unidirectional blade with two flaking surfaces along both the right and left edges (Figure 102). The left edge shows the most intensive reduction from two opposed platforms. An early platform switch (1-2) is followed by three removals from the upper platform and two from the lower (3-5). The last phases clearly extends to the ventral face of the blank. The second flaking surface

shows a succession of three removals, one covering the whole length of the edge. This flaking surface is exploited prior to the left edge and is used as a striking platform for the right one. The lover striking platform is a truncation.

Others (N=1)

* KB.RA87.I/53.K8.SL3.1.RL.323

This core is produced and shows a variant of the A10 Mode on a laminar flake. It shows a bidirectional reduction system on a broad surface in a rather semi-turning fashion. It expands on the left edge of the blank (Figure 103). The earliest removals are struck from both the upper and lower platform, showing an alternate bidirectional sequence. Platforms are mainly truncations, and this artifact can be typed as a truncated-facetted piece.

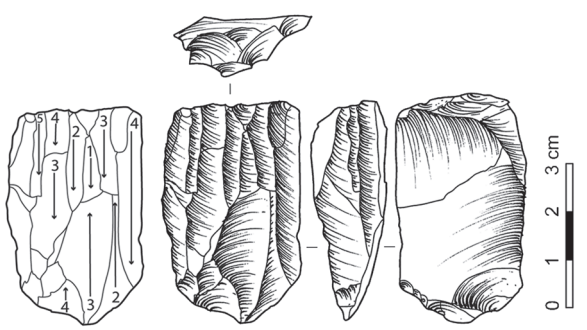


Figure 103: Kara-Bom, KB.RA87.I/53.K8.SL3.1.RL.323

Core-like tool (N=2)

* KB.259.L10/2.1152

This artifact is listed here as a possible core. It is produced on a bidirectional blade blank showing a semi-continuous direct retouch extending from the proximal part along the left edge (Figure 104). An inverse proximal truncation is observed, as the distal part show negatives of hinged removals. In this case, the artifact can be typed as a truncated-facetted piece, but the removals show an irregular morphology that could also be characterized as scaled. So, it illustrates the variability observed among the truncated-facetted pieces, some being tool-like cores and some being clearly cores.

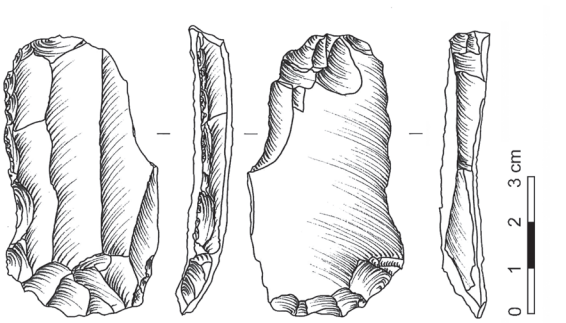


Figure 104: KB.259.L10/2.1152

* KB-80.279.L10/4.1171

This artifact is a blade with a cortical platform, a trapezoidal section and a unidirectional cortical dorsal scar patterning. It has an abrupt cortical right edge. It bears sporadic retouch on both the right and left edges (Figure 105). A striking platform is prepared by a removal perpendicular to the axis of the blank, followed by three sub-cortical, hinged removals. This artifact can be typed a dihedral burin *(burin dièdre d'angle)*.

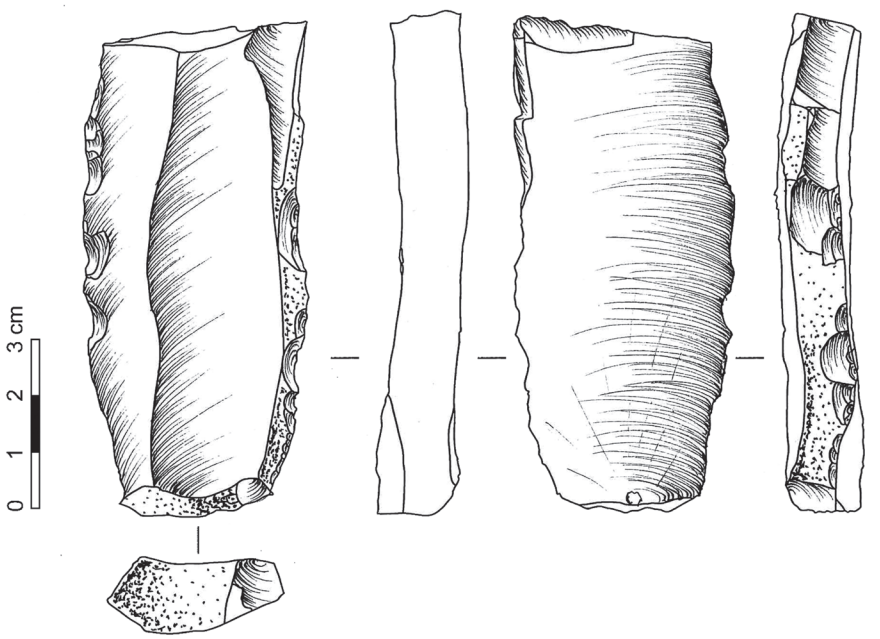


Figure 105: KB-80.279.L10/4.1171

3.7 KARA-BOM: MPH1, OH6, OH5 AND OH4 SAMPLE COMPARISONS

Based on the dataset described in the previous sections, the main characteristic of the archeological assemblages are compared.

3.7.1 BLANK ATTRIBUTES

Platform size and preparation

The platform preparation appears to show an association between plain and facetted platforms in each level. In both OH6 and OH5, the majority of platforms are facetted directly followed by plain platforms. MPH1 and OH4 show a majority of plain platforms followed by facetted ones; however, they both represent the smallest samples. The frequency of facetted (χ^2=(3) 2, p=0.57) and plain (χ^2=(3) 1.28, p=0.73) platforms, although showing variability, do not differ significantly from one assemblage to another. Dihedral platforms also have a similar frequency in all assemblages. Notable is the occurrence of partial faceting in both OH6 and OH5, a platform preparation that is not observed in MPH1 and OH4. Strong abrasion of the external platform is absent from MPH1, but occurs occasionally in OH4. Therefore, from a general point of view, platform preparation is quite similar throughout the described samples, and specific features seem to indicate a higher degree of similarity between OH6 and OH5.

Considered as a whole, the platform thickness between levels does not vary significantly ($F(3, 173) = 0.64$, $p = .59$). OH6 and OH5 tend to have more outliers, which may result from a larger sample size. An opposite situation is observed in MPH1, for which the narrow range of thickness might be linked with the small sample size. As stated in the blank attribute sections, based on medians, plain platforms are statistically less thick than the facetted ones in OH6, OH5 and OH4. The MPH1 sample size is too small to be tested.

Based on the platform surface, OH6 and OH5 are similar in terms of size distribution although the facetted platforms tend to show more variability.

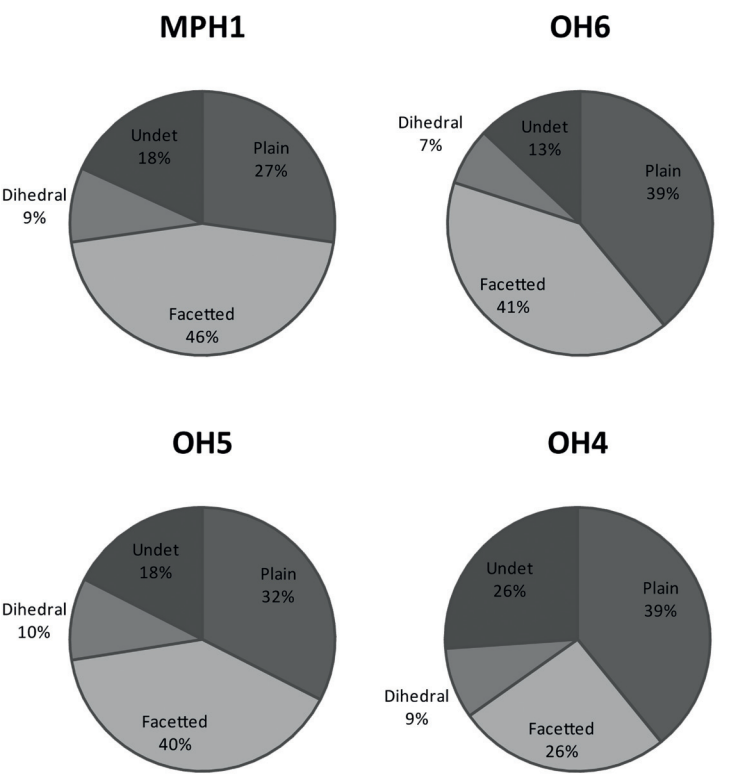


Figure 106: Kara-Bom, comparison of platform preparation between samples

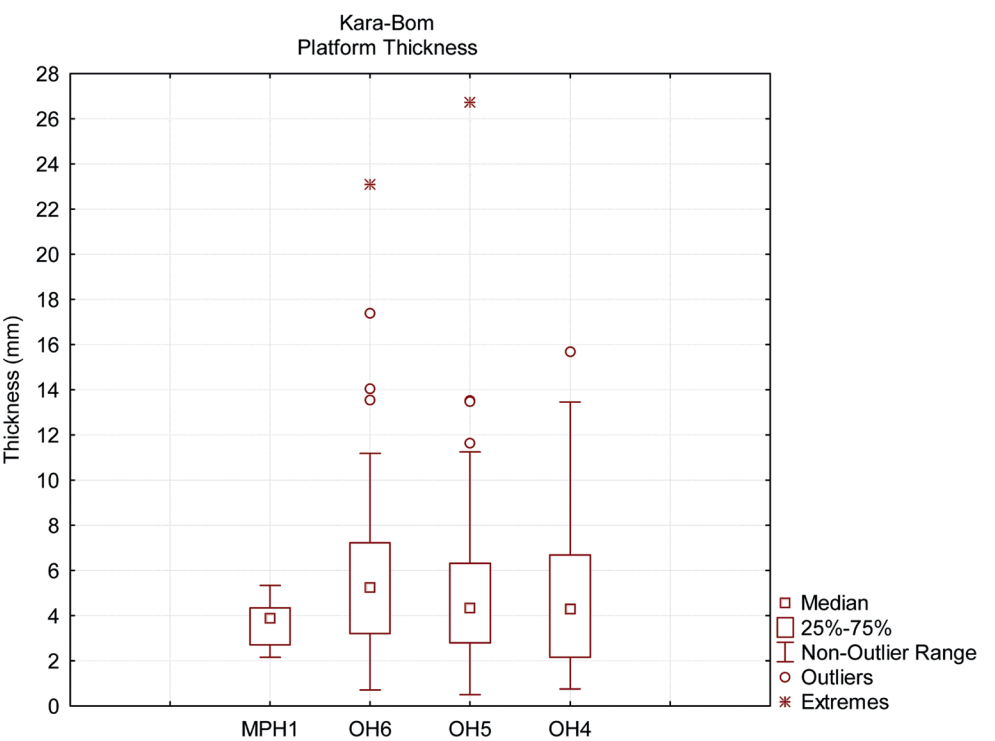


Figure 107: Kara-Bom, platform thickness, comparison between samples

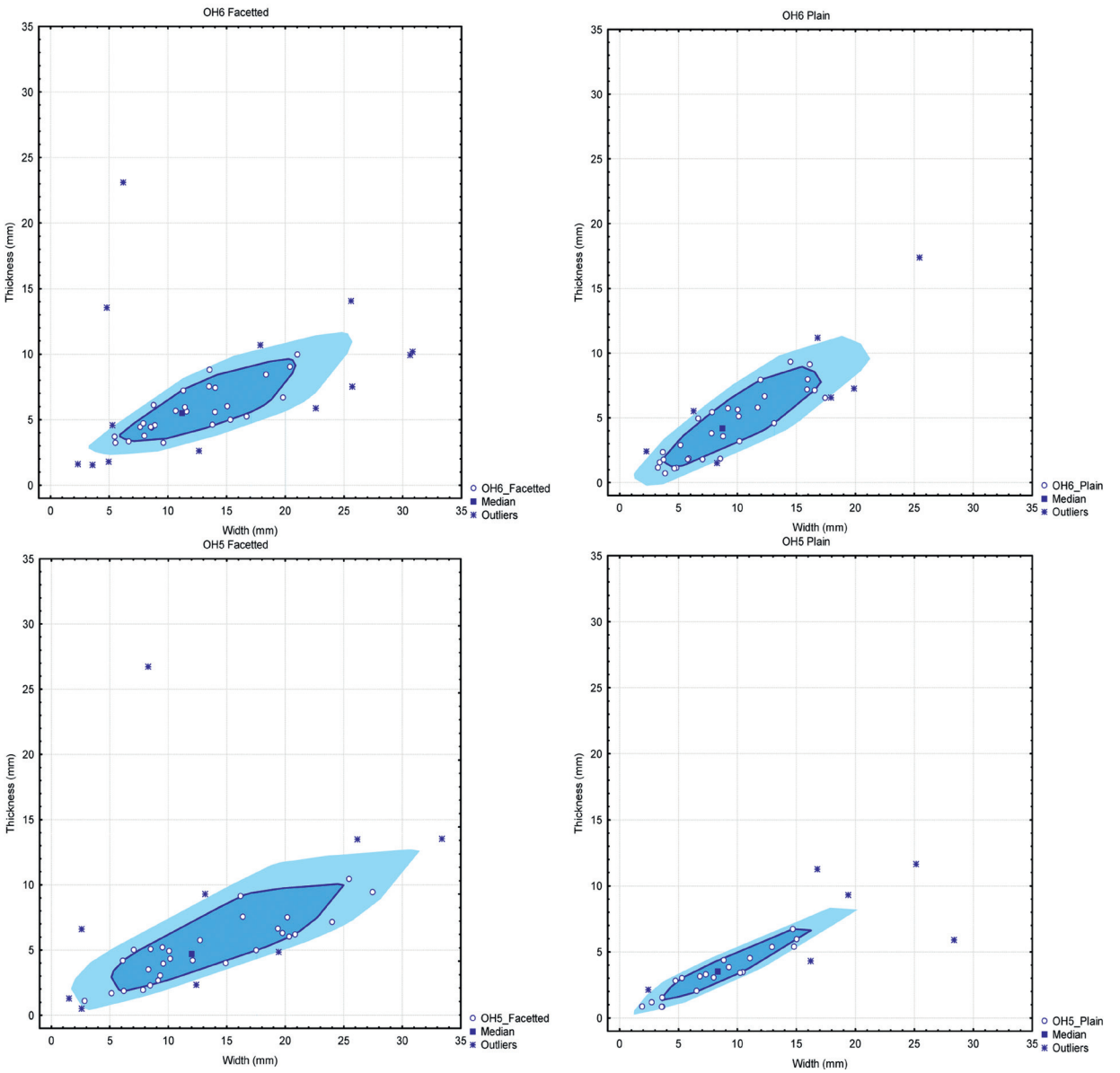


Figure 108: Kara-Bom, platform surface, comparison between OH6 and OH4

OH4 is based on a smaller sample and does not seem to differ from OH6 and OH5. Bag plots illustrate this situation (Figure 108). The first convex polygon (the bag) represents 50% of the data points which are located around the median, and the second polygon (the fence) corresponds to the bag extended by a factor of 1.5. Outliers are rejected statistically when they fall outside the fence. No bags could be drawn for the OH4 assemblage due to the small sample size.

It is however clear that facetted and plain platform medians differ. Facetted platforms are significantly thicker and wider than the plain ones.

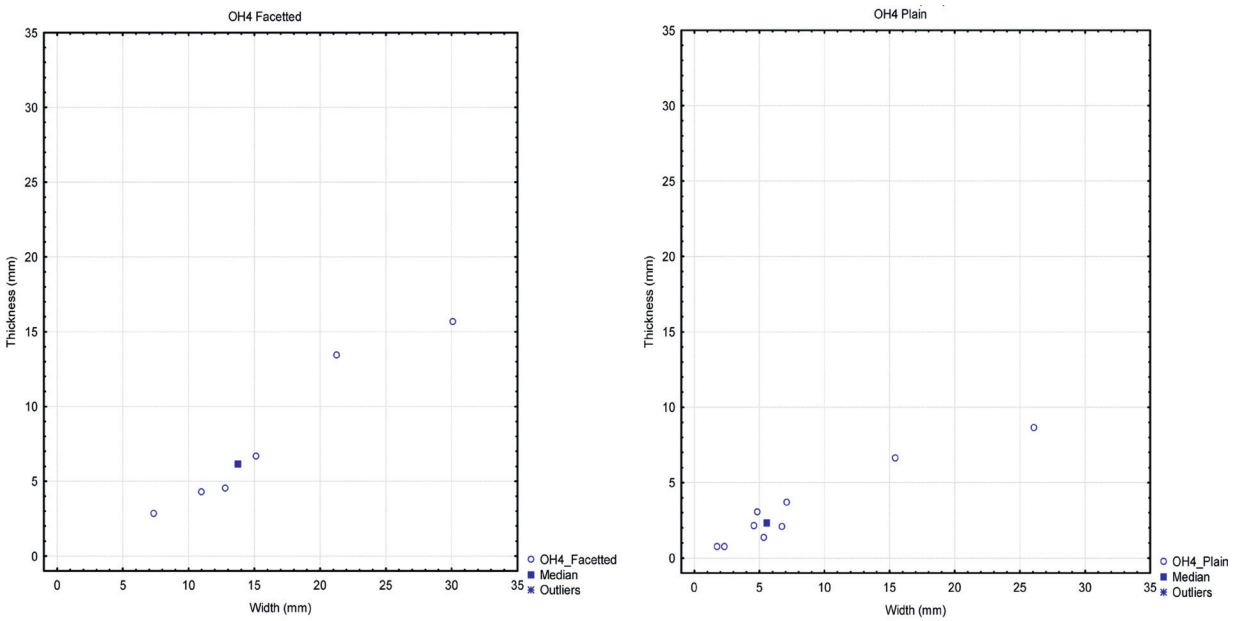


Figure 109: Kara-Bom, platform surface, OH4

Blank size attributes

LENGTH

Blank length mean does not differ from one assemblage to another ($F(2, 114) = 0.36$, $p = .69$). MPH1 could not be included in the test due to the small sample size.

WIDTH

Blank width means are similar between assemblages ($F(3, 363) = 0.38$, $p = .76$). OH6 and OH4 show a little positive skewness. Notable is the large variability observed in all assemblages except in MPH1.

THICKNESS

The mean blank thickness does not differ significantly from one level to another when considered as a whole ($F(3, 362) = 2.55$, $p = .56$).

Dorsal scar pattern

The dorsal scar patterns show similarities but also differences between assemblages. OH6 and OH5 show striking similarities for both categories and frequencies of patterning. They show a balance between uni- and bidirectional blank patterning, together with a variety of crested elements occurring in a rather low frequency. Differences between these two assemblages are minor and consist of an occurrence of bi-directional cortical elements in OH5 and a slightly higher frequency of bidirectional blanks in OH6. As previously shown, the OH5 bidirectional frequency is biased by the occurrence of numerous broken elements in the sample. The situation is reversed when considering only complete blanks; bidirectional ones becoming then statistically dominant in OH6. The MPH1 analysis is based on a small sample size and differs by a lower frequency of bidirectional blanks, by a reduced representation of crested elements and by a higher frequency of undetermined elements. OH4 shows a significant majority of bidirectional elements, including well represented bidirectional cortical blanks. Crested blank frequency is comparable to OH5 and OH6 and the unidirectional blank

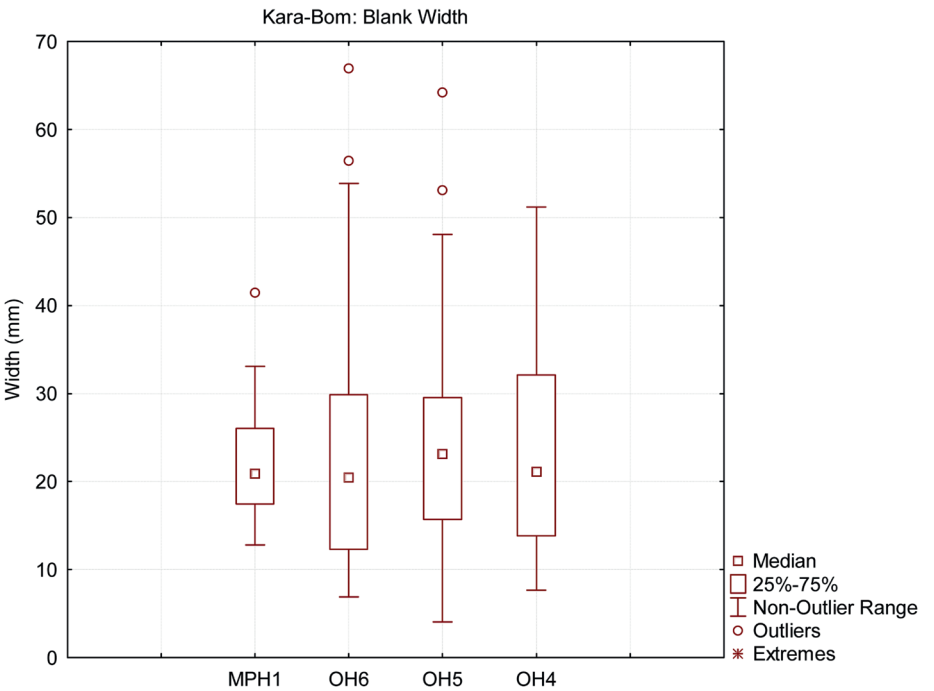


Figure 110: Kara-Bom, blank width, comparison between samples

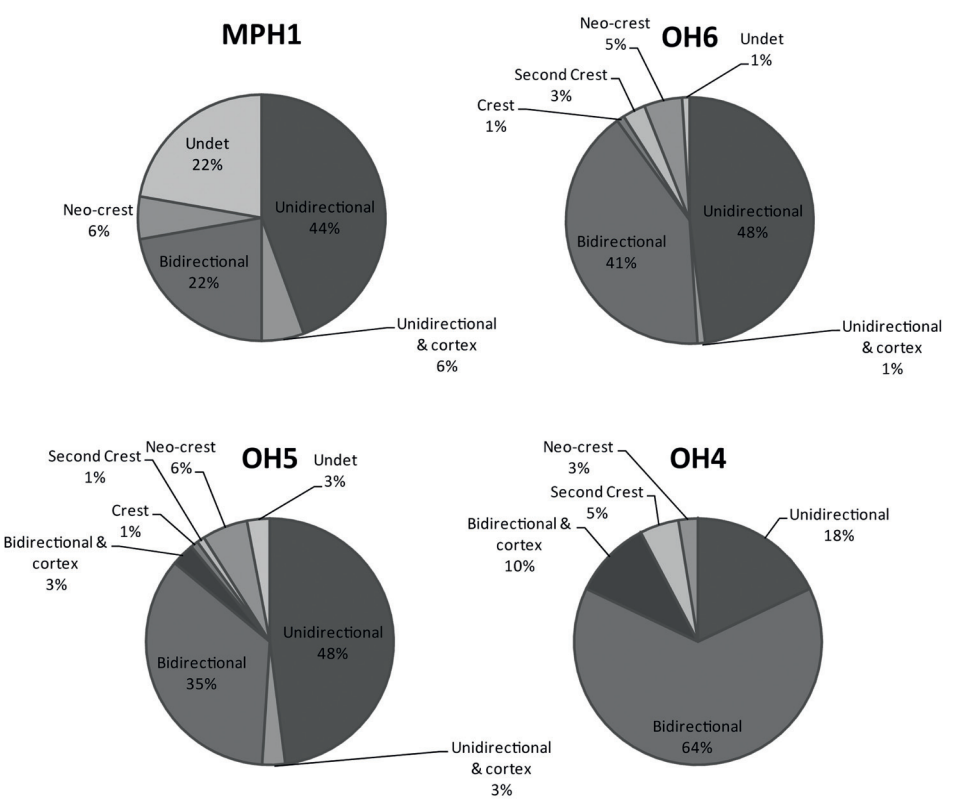


Figure 111: Kara-Bom, dorsal scar patterning, comparison between samples

frequency is significantly lower than in any of the three other assemblages.

Cross-section

MPH1 shows a majority of trapezoidal sections, although triangular ones are well represented. The situation in the OH6 assemblage is different. When considering the assemblage as a whole, triangular cross-sections are the most common, but their frequency does not statistically differ from the trapezoidal ones. The situation is similar when looking at the blade category, but the bladelets show a significant domination of triangular section. In OH5, the total sample and the blade category display a significant majority of trapezoidal sections, a situation which is reversed in the bladelet category where the triangular sections dominate significantly. OH4 shows a similar pattern with a majority of trapezoidal cross-section in the total sample and in the blade category, but the bladelet category is dominated by triangular cross-sections. So it seems that a consistent pattern is observed in the OH6, OH5 and OH4 assemblages with small laminar elements being more often produced using a single dorsal scar. MPH1 does not have any bladelets and is, therefore, not comparable.

Profile

All assemblages show a clear majority of straight profiles, usually followed by slightly curved ones. Frequencies of the other types of profile are trivial. The slight curvature of some of the blanks appears to be linked to the minimum bending or convexity of the core flaking surface necessary to proceed with a blade production, rather than a clear production oriented toward curved elements.

Orientation

Blanks are axially oriented in all the considered assemblage. No systematic off-axis blank production could be observed, although those elements occur infrequently within all assemblages.

3.7.2 CORES: REDUCTION PATTERNS AND SIZE ATTRIBUTES

The distribution of core types is uneven through the assemblage and leads to several observations.

- MPH1: the sample has yielded only two clearly identified cores. These are flake cores with one displaying radial flake scars on its dorsal face. The second one has a sub-triangular flaking surface and is mainly reduced from a single platform, although a second perpendicular platform seems to have been used to produce guiding scars. Two additional core-like tools are described. Although they look similar to Mode B cores, their core status could not be assessed.

- OH6: 29% (N=4) of the cores are classified as Mode A. The 71 % (N=10) remaining are Mode B cores.

- OH5: 20% (N=2) of the cores are classified as Mode A. The remaining 80% (N=8) are classified as Mode B cores.

- OH4: the sample includes a single core which, as it is produced on a Kombewa flake blank, is classified as Mode A.

Additional artifacts: relevant artifacts with problematic provenience, or belonging to the 1980-90 collections, although not included in the sample, are described. This set includes 10 % of Mode A cores (N=2), 76% of Mode B cores (N=16), core-like tools (N=2) and a single unclassified Mode B core.

Although this component is not directly related to laminar technology, an attempt to identify such cores in other assemblages led to the conclusion that genuine flake cores occur only within the MPH1 sample. Their frequency should be interpreted carefully as the sample size for this assemblage is rather low. They are not included in our Mode system that was designed for the categorization of blade cores. Mode A cores occur in a relatively low frequency in all assemblages except in MPH1. However, in OH4, Mode A does represent the only cores from our sam-

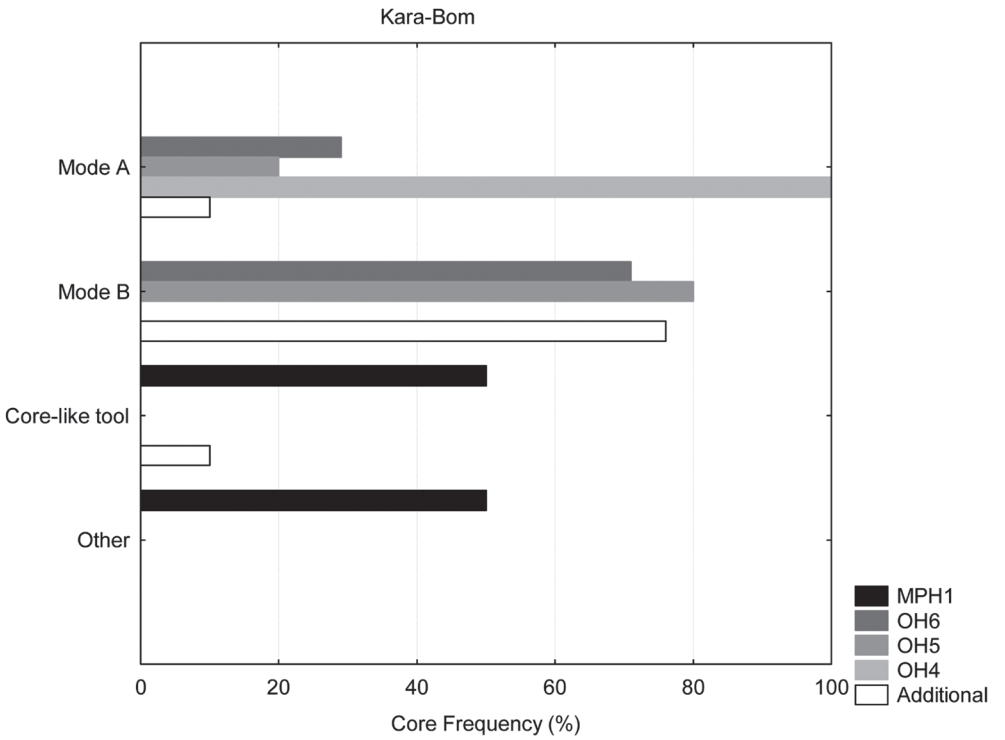


Figure 112: Kara-Bom, core Mode frequency, comparison between samples

ple and therefore, has a 100 % frequency. Mode B cores are clearly associated with OH6 and OH5, and they represent the majority of the cores. They are, however, absent in MPH1 and OH4 samples.

In OH6, differences between Mode A and Mode B cores are significant in terms of core length and flaking surface width. These differences are also observed in OH5, although their significance is not tested due to the small sample size. According to the measurement protocol described in Chapter 2, the Mode B core length is related to the thickness of the blade blank. As Mode B cores present almost exclusively a flaking surface on the narrow edge of the blank (with the exception of Mode B7), the flaking surface width depends on the blank thickness/core length. The statistical differences between core length and flaking surface width between Mode A and Mode B are then related to the type of core blanks but also reflect a reduction pattern. In fact, Mode B cores tend to show a main flaking surface on a broad face with an occasional use of a narrow face, as opposed to Mode B cores from which blanks are removed from a narrow face only.

The use of different faces is illustrated in Figure 113, where it appears that flaking surfaces do not differ in length but rather in width. 95 % confidence ellipses are drawn around each level using the full range of the axis. No ellipse was drawn for OH5 Mode A as only two data points were available. The latter, however, fall in a cluster with the OH6 Mode A ellipse. One Mode B core from OH6 falls in the range of the Mode A. It corresponds to a truncated-facetted core, which although produced on a laminar blank, displays a flaking surface located on a broad face. It is balanced by the fact that one Mode A core from OH6 falls in the range of the Mode B cores. This is a rather exhausted A10 core for which the determination of the blank was difficult. The general picture observed is that the difference between Mode A and Mode B cores seems consistent between OH. Mode B cores from OH6 and OH5 are produced on blades with a similar thicknesses (Mann-Whitney,

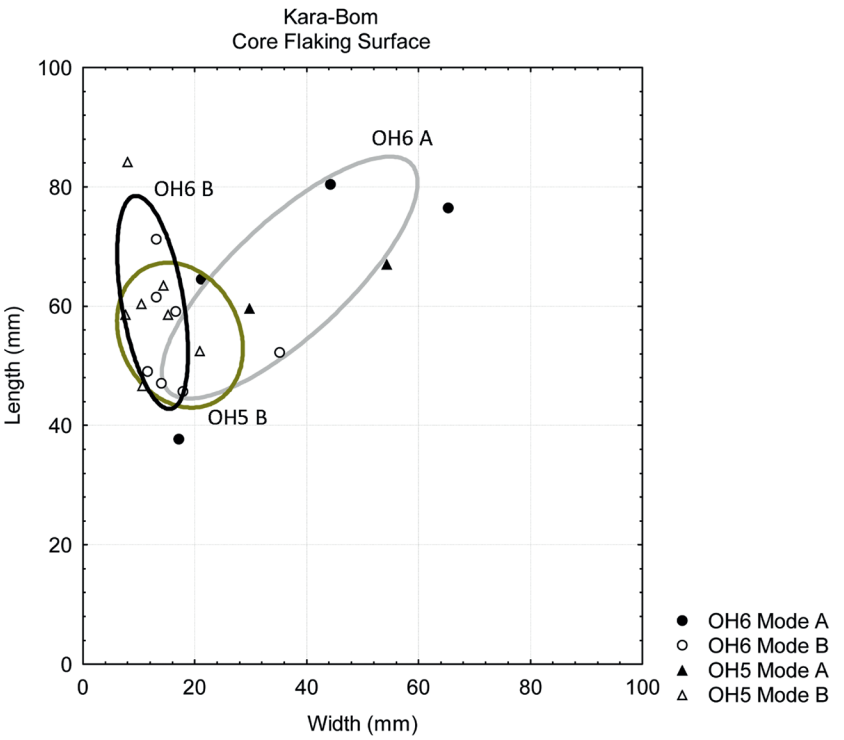


Figure 113: Kara-Bom, core flaking surface size and Mode reduction, comparisons between samples

T=Ub=30, p=.40) of minimum 10 mm. Even if they look similar between assemblages, Mode A size attributes are difficult to compare given their poor representation in the sample. Moreover, they likely represent an advanced stage of reduction and only provide a minimum size.

The only significant difference between OH5 and OH6 platform preparation stands in the Mode B cores, which are mainly facetted in OH6 (60%, N=6) and plain in OH5 (57%, N=4). A single facetted platform occurs in Mode B cores from OH5, and two plain reshaped platforms occur in OH6.

3.7.3 REDUCTION SEQUENCE RECONSTRUCTION: COMPARISONS

Blank production in MPH1 remains hard to assess. Flake production is attested to by the occurrence of radial and sub-triangular cores and occasional circular Levallois flakes and short convergent flakes. These coexist with a production of laminar elements. Laminar cores are absent from the sample, but the blank dorsal scar patterning seems to indicate a bi-directional core reduction system. This reduction system includes, at least occasionally, natural and shaped crested blanks. So the blanks used for Mode B cores are present although the two examples of core-like tools fail to be convincing enough to be considered as genuine Mode B. Small laminar blanks are not numerous. Platforms are mainly plain, but also facetted, the flake facetted platforms being significantly thicker than the laminar ones. All in all, the small sample from MPH1 does not allow a proper technological reconstruction.

Mode A cores from OH5 and OH6 show a certain degree of similarity. In OH6, they are classified as Mode A6. Mode A6 groups cores which presents two flaking surfaces treated independently. According to our analysis, the main flaking surface is located on the broad face. A second flaking surface seems to

be linked with the detachment of thick blanks, located at the intersection between the two surfaces, using a natural or a prepared crest as guiding ridge for the removal. The exploitation of the second flaking surface occurs mainly during the last stages of reduction. In both OH6 and OH5, two main types of blanks are produced.

Laminar blanks with parallel edges

Large blades are likely produced from Mode A cores, following the detachment of an initial crested blade. Judging by the dorsal scar patterning, the reduction is mainly bi-directional, showing platform switches after a short series of unidirectional removals. In the case of OH5, it seems that a platform switch may occur quickly after the beginning of the reduction, as some large blades bear on their dorsal face a combination of bi-directional scars and cortex. The occurrence of neo-crested blades of various sizes in both assemblages indicates rather frequent side preparation of the core during the course of the reduction process. Some of the largest blades can reach proportions tending to gigantism with a length reaching 180 mm. Some of the blades with a minimum of 10 mm thickness are selected and transformed into Mode B cores. These are snapped and flaked along their longitudinal axis. The variability in Mode B type is interpreted here as stages of reduction. In the sample studied, cores with a single striking platform are almost exclusively on the proximal part of the core blank (Mode B1). Mode B2 and B4, which would show respectively a single platform located on the distal part of the core blank and a flaking surface perpendicular to the axis of the core blank, are absent from both OH6 and OH5 assemblages. However, three examples are described in the additional artifact section, indicating that a distal reduction takes place when a truncation or a snapping event provides a surface thick enough to be used as a platform. Mode B5 is the most represented in both assemblages and shows a frequent switch of platform on the same flaking surface. The flaking surface is used on its entire length to detach blanks by a short series of unidirectional removals and only occasionally by an alternate bidirectional system.

The cores show, therefore, two kinds of blank production; a large blade production from which the technical blanks are used as core blanks to produce smaller laminar blanks. In such situations, a bimodal size distribution is expected. In OH6, although length and thickness show a unimodal distribution, a bimodal distribution is observed for the width. The first mode matches the size of the Mode B flaking surfaces and last removals. The second mode corresponds to the mean of the sample. In OH5, the situation is less clear. Although some signs that could indicate a bimodal distribution can be observed in the width distribution, they consist of a few artifacts only and are too weak to be significant. This could reflect the apparent overlap of flaking surface width between Mode A and Mode B. As previously mentioned, Mode B is well constrained by the thickness of the core blank, thus the width distribution of Mode A shows a greater variability. In other words, reduced Mode A cores can produce blanks comparable in size with the Mode B core early productions.

As for the large blades, small laminar blanks are detached from the intersection of two surfaces. They then display a thick triangular or trapezoidal cross-section or a natural back. Other small blanks are detached from the central part of the flaking surface and have a rather flat triangular or trapezoidal cross section. In both OH5 and OH6, cores but also blank dorsal patterning and cross-sections indicate, when possible, a rather significant number of blanks produced by Mode B cores. Cores with a few removals show traces of hinge fractures.

OH4 shows evidences of large blade production with parallel edges. As no cores can be associated with the largest artifacts, blanks only provide information on the reduction processes. Dorsal scar patterning indicates a predominance of bidirectionality. This feature is expressed more than in other assemblages.

The occurrence of bidirectional cortical blanks could indicate a use of bidirectionality in early stages of reduction. Crested artifacts and naturally backed blades indirectly indicate a sub-volumetric reduction system, with occasional readjustment of the bending and the convexities by removing thick blanks along an edge of the flaking surface. This technology pro-

duces thick blades that could potentially be used as Mode B core blanks although Mode B cores are absent. Small laminar blanks occur in the sample, some of them displaying a natural back. The only core associated with OH4 is a Kombewa flake/core tablet with a flaking surface on its narrow edge, flaked from two opposed platforms. The width histogram shows a bimodal distribution; however, this could be due to the small sample size.

Convergent blanks

All assemblages described include blanks with convergent edges. In MPH1, these are produced on short or relatively thick flakes by uni- or bidirectional reduction. One of the flake cores shows a clear triangular negative that matches the morphology of the shortest blanks. The preparation of the second flake core gives the flaking surface a triangular shape. This supports the idea that it could also have produced convergent flakes. In OH6, most of the convergent elements are on laminar blanks and show various thicknesses. Unretouched blanks are rather thin and bear bidirectional dorsal scars. Although it could not be demonstrated directly due to the lack of refits, it is assumed that the largest blades are associated with Mode A cores, especially when they are reduced by bidirectional removals from the broad flaking surface.

Platform preparation and percussion technique

Identifying the technique of percussion is problematic in most of the levels due to the mosaic of features observed. From a general point of view, none of the assemblages show traces of thin abrasion usually associated with the organic hammer. OH6 and OH5 show clear similarities with a combination of thick (mean ≥ 4mm) facetted and plain platforms associated with an occasional strong abrasion of the platform edge. In addition, a peculiar preparation described here as partial faceting occurs in both assemblages. These features suggest the use of hard and soft stone hammers. OH4 has only one case of strong abrasion, no partial faceting and only the facetted platforms can be considered as thick. The sample is too small to propose a hammer type even if some similarities with OH6 and OH5 can be observed.

For the same reasons, although MPH1 shows similarities with the OH6-OH5 sample, the technique of percussion could not be assessed. Notable is the absence of features associated with the use of a soft hammer.

Retouched tools

Retouched tools show a similar width mean and median in all sampled assemblages ($F(3, 77) = 0.433$, $p = .73$), the main differences being related to the variability within the sample. MPH1 shows a relatively narrow variability that may reflect a small sample size. The distribution displays a positive skew towards narrow blanks. By contrast, OH6 illustrates the largest variability among the samples, followed by OH5. OH4 shows a rather similar range as MPH1 although it displays the widest outlier data point.

To illustrate these differences in terms of width variability, the coefficients of variation are compared between samples. As shown in (Table 78), OH6 has the highest coefficient of variation, as MPH1 show the most standardized tool widths. Coefficients of variation are compared using Fligner-Kileen test (Fligner and Killeen 1976). The results show that only the differences between OH6 and OH4 are significantly different. Surprisingly, differences between MPH1 and OH6 appear not significant. This result could reflect the effect of MPH1 small sample size (N=9) inducing a type II error.

The coefficient of variation is here proportional to the sample size. This could explain the highly reduced variability of MPH1 sample and the largest variability of OH6. However, when considering thickness values, the opposite situation is observed. Values are inversely proportional to the sample size. Differences are not significant except between OH5 and OH6 (Mann-Whitney, T=Ub=258.5, p=.02). Except for MPH1, a monotonic trend is observed between assemblages OH6 to OH4, the toolkit tending to be thicker. When comparing the thickness of the OH4 tool kit with the thickness of the laminar blanks, no

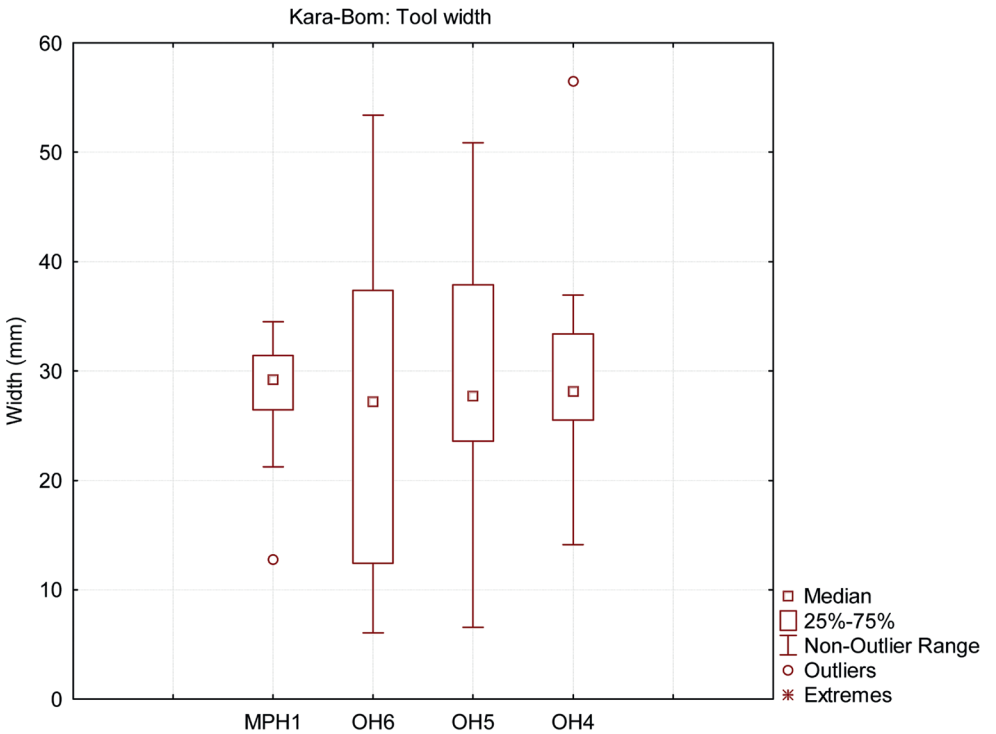


Figure 114: Kara-Bom, tool width, comparison between levels

Sample	Coefficient of variation	Fligner-Kileen test	one-tailed	two-tailed
MPH1	24%	MPH1 vs. OH6: T=2.47; E(T)=7.32; z=1.7	p=.05	p=.09
		MPH1 vs. OH5: T=5.44; E(T)=7.29; z=-0.65	p=.26	p=.51
OH6	50%	OH6 vs. OH5: T=17.25; E(T)=24.34; z=1.6	p=.05	p=.11
OH5	37%	OH5 vs. OH4: T=12.73; E(T)=13.83; z=0.3	p=.38	p=.76
OH4	32%	OH4 vs. MPH1: T=6.82; E(T)=7.06; z=-0.09	p=.46	p=.92
		OH4 vs. OH6 : T=6.35; E(T)=13.87; z=-2.04	p=.02	**p=.04**

Table 78: Kara-Bom, coefficient of variation (tool width), comparison between samples

significant difference is observed. When comparing length and width measurements between samples, it appears that OH6 differs from the other assemblages by the fact that it includes relatively small-sized tools. OH5 size distribution shows a different pattern mainly due to the occurrence of the sickle-like blades, one of which is particularly elongated and narrow. Only two MPH1 tools are complete. One is a retouched blade which matches with the OH6-OH4 range, the other one is produced on a Levallois flake blank and falls outside of all ranges, having a length roughly equal to its width.

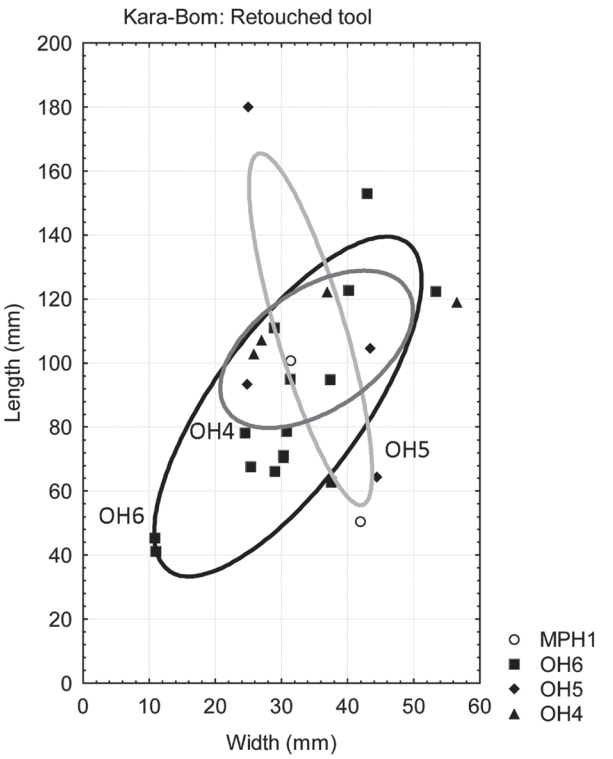


Figure 115: Kara-Bom, tool size, comparison between samples

The tool dorsal scar patterning shows a domination of bidirectional blanks, which tends to be more pronounced in the OH5 sample and less expressed in the OH6 sample. None of the differences observed are statistically significant. Artifacts bearing cortex on their dorsal face are occasionally retouched in OH5 and OH4.

The general composition of the tool kit described here shows the occurrence of retouched blades in every sample. Thet clearly dominate in MPH1, as only retouched tools are considered here. For example, Levallois flakes which are listed as tools according to Bordes's list (1961) are not included in our tool list, unless they display retouch. A single artifact is included in this category, namely a notched Levallois flake which is included in the category 'other'. The frequent occurrence of edge damage is another main feature that characterized the MPH1 toolkit. Identification of genuine retouch is not easy. Although three of the retouched blades have been typed as notched blades, they also display edge damaged along their edges.

One blade is pointed by a bilateral retouch on its distal end. The two core-like tools could represent an element of comparison with OH5 and OH6, but they could not be clearly identified as Mode B cores. The absence of retouched convergent blanks in MPH1 seems to illustrate a difference with the other assemblages. In OH6 to OH4, although a decrease of this category of tools is observed, differences in frequency between levels are not statistically significant (χ^2=(2) 168.1, p=.43). When looking at the retouched blade frequencies, there is a significant difference observed between OH6 and OH5-OH4 (χ^2=(2) 5.852, p=.05). Retouched bladelets are more frequent in OH6 than in OH5 (χ^2=(2) 3.694, p=.05) and are absent from the other samples. In fact, a single retouched bladelet occurs in OH5 and six are identified in OH6. Two Dufour bladelets (sub-type Dufour) and one atypical backed bladelet occur in OH6 sample. Due to the lack of systematic screening

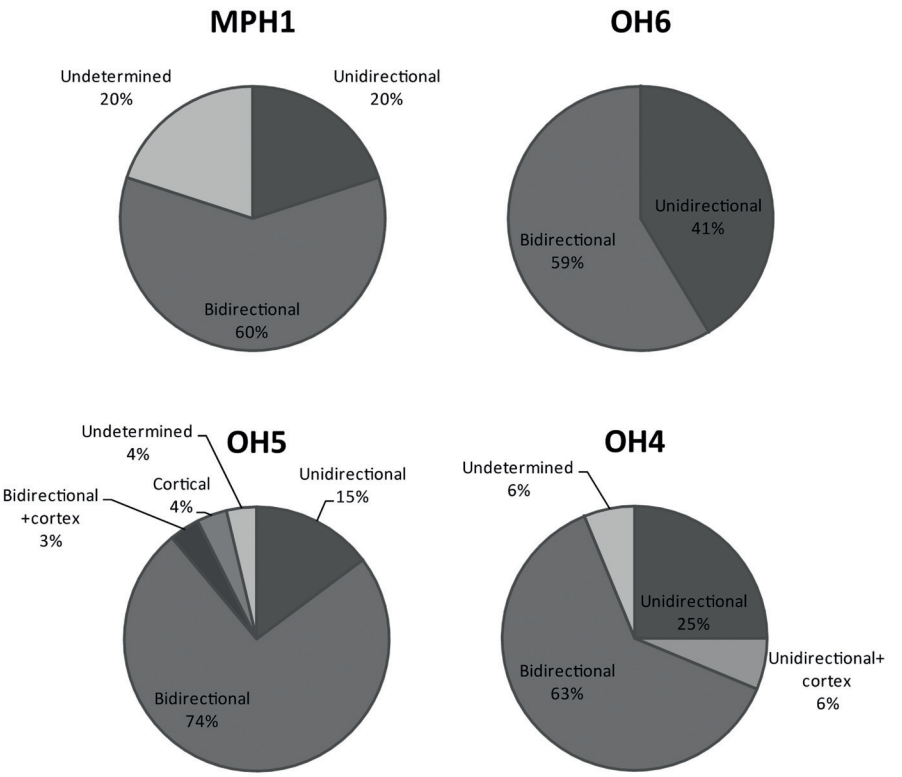


Figure 116: Kara-Bom, dorsal scar pattern, comparison between samples

during excavation campaigns, the frequency of small artifacts should be considered as a minimum.

In OH6, facetted platforms dominate but in OH5 they are as frequent as plain platforms. In OH4, all platforms are facetted with only one being dihedral. This difference may be significant; however, given the amount of undetermined platform type in OH6 and OH5, it cannot be properly tested. In MPH1, the majority of tools are mesial fragments. In OH6, retouch seems to be located mainly on the distal and proximal parts of the blanks, which could explain the lack of mesial tool fragments identified in that sample. In OH5, the retouch is mainly continuous although most of the fragments are mesio-proximal. In all samples, the retouch is mainly direct, with a infrequent occurrence of inverse retouch in OH6.

The types of retouch vary with a clear domination of thin retouch in OH6 and OH4. This observation is reinforced by the fact that combinations almost always include thin retouch. In OH6, they are associated with semi-steep retouch. In OH5 and OH4, it is associated with semi-steep, steep and scaled retouch. OH5 stands out as having significantly more scaled retouch than OH6 (χ^2=(1) 5.825, p=<.05) but this difference is not significant when compared with OH4. Notches are the most frequent type of retouch in MPH1, but they occur occasionally in other samples.

From a more general point of view, the quasi-absence of classic burin types on thin blanks is observed. No clear example of this tool class could be found in association with the studied samples. Pointed blades occur in every sample, even though they are generally not numerous. Some of these tools tend to resemble a retouched point, although they are originally produced on blanks with parallel edges. The sickle-like blades occur only in OH5 and can, therefore, be considered as typical of this assemblage.

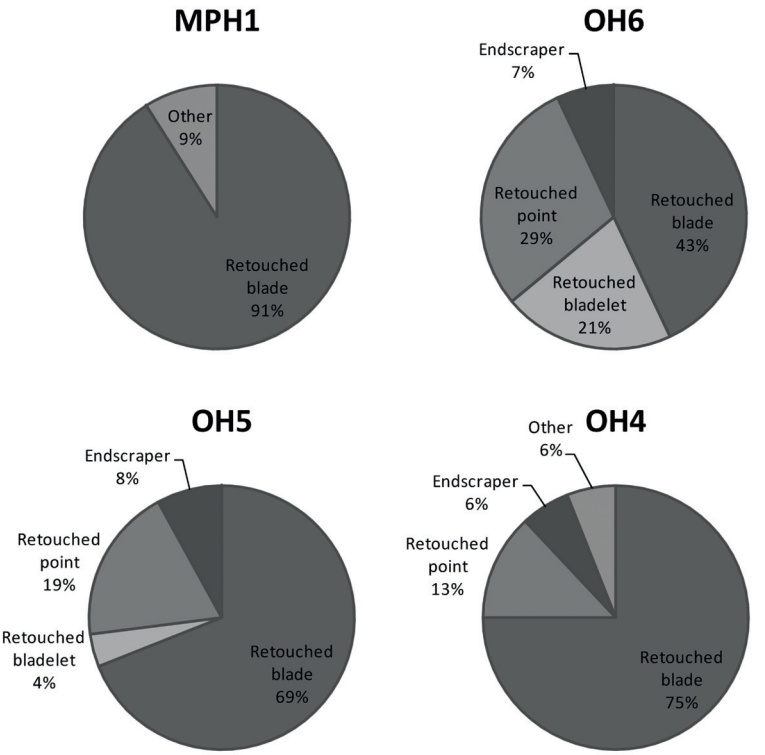


Figure 117: Kara-Bom, main categories of retouched tool, comparison between samples

	MPH1		OH6		OH5		OH4	
	N	%	N	%	N	%	N	%
Thin	1	10%	13	46%	3	12%	8	50%
Semi-steep	1	10%	2	7%	4	15%	0	0%
Steep	0	0%	0	0%	3	12%	0	0%
Scaled	0	0%	1	4%	7	27%	2	13%
Nocth	4	40%	4	14%	1	4%	1	6%
Combination	2	20%	8	29%	6	23%	4	25%
Other	2	20%	0	0%	2	8%	1	6%
	10	100%	28	100%	26	100%	16	100%

Table 79: Kara-Bom, main type of retouch, comparison between samples

	MPH1	OH6	OH5	OH4
Platform preparation	Plain + facetted	Facetted + plain	Facetted + plain	Plain + facetted
Dorsal scar pattern	Uni + bidirectional	Uni + bidirectional	Uni + bidirectional	Bidirectional
Cross-section	Trapezoidal	Triangular + trapezoidal	Trapezoidal + triangular	Trapezoidal + triangular
Profile	Straight	Straight	Straight	Straight
Orientation	None	None	None	None
Core Mode	Flake	Mode B + Mode A	Mode B + Mode A	Mode A?

Table 80: Kara-Bom, main characters of the blade production, comparison between samples

3.7.4 SUMMARY

From a technological point of view, OH6 and OH5 are highly similar. Both of these samples display an association of laminar blanks with parallel edges and laminar blanks with convergent edges. Blanks are produced following a bidirectional reduction sequence which includes Mode A sub-prismatic cores with a main flaking surface located on a broad side of the nodule interacting with a second flaking surface located on a narrow face of the nodule and likely involved in the management of convexities and bending of the broad flaking surface. Detached blanks detached are mainly large to medium size axial blades with a triangular or trapezoidal cross-section and a plain or facetted platform. Management operations occur in different stages of the reduction by the detachment of thick natural or prepared crested blades at the intersection of the two flaking surfaces. Some of the crested blades are then transformed into Mode B cores which morphologically fall into *burin d'angle* (Demars and Laurent, 1992) and *burin polyedrique* (Klaric, 2006, 2008; Klaric *et al.*, 2009) types. Those cores often illustrate a bidirectional reduction sequence system, following short series of unidirectional removals detached from two opposed platforms. The flaking surface is parallel to the longitudinal axis of the blank and is exploited on its whole length. Removals coming from the central part of the flaking surface have a triangular or trapezoidal and rather flat cross-section, as removals detached from the corner of the flaking surface are thicker and are similar to burin spalls, displaying a part of the dorsal or ventral side of the core. So far, Mode B cores can be only associated with OH6 and OH5 samples.

Convergent blanks are produced from the broad face of sub-prismatic cores, using a management system comparable with the one used for blanks with parallel edges, namely the detachment of thick side and crested blades. As the pattern of reduction is subparallel, convergent edges are likely linked with the bidirectional reduction sequence.

The MPH1 sample size is too small to offer the possibility to make robust quantified comparisons. However, it differs from OH5 and OH6 by the coexistence of a flake production from radial, flat-faced and bidirectional cores and blade blanks. Some of the flake blanks are likely Levallois flakes, showing a radial dorsal patterning and some may be represented in the sample as short convergent blanks. Blades show similarities with OH6 and OH5 in that they have a combination of uni- and bidirectional dorsal scar patterning, but also by the coexistence of plain and facetted platforms. Thick side blades and discrete crested elements may indirectly testify to a sub-volumetric reduction system. Small laminar elements are almost absent. The two core-like tools are not sufficient to suggest the use of Mode B cores,

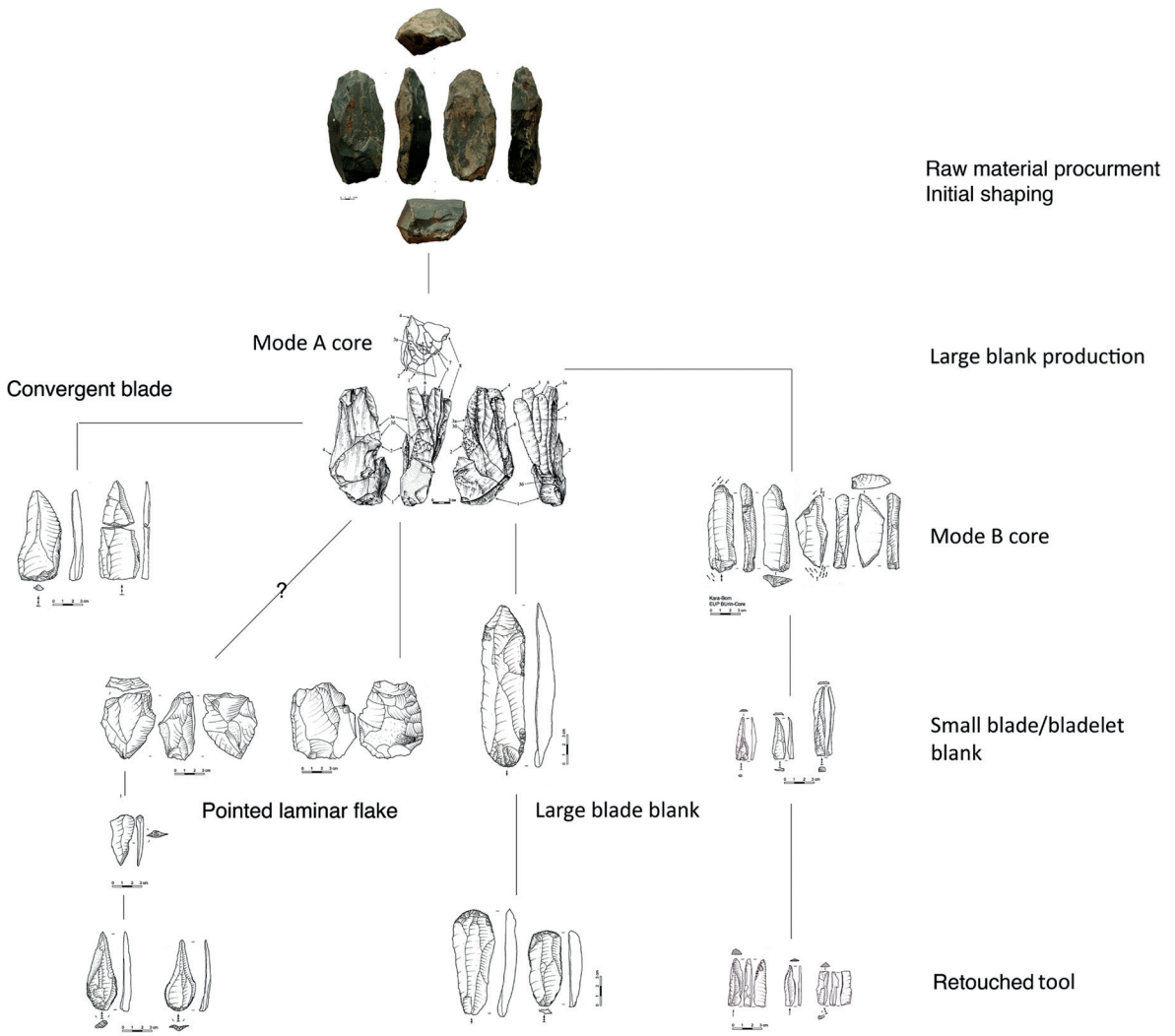


Figure 118: Kara-Bom, analytical reconstruction of the blade reduction systems from OH6 and OH5

although the situation could have been different with a larger sample.

The OH4 sample size, although larger than MPH1, remains insufficient to obtain a clear picture of the blade technology associated with this assemblage. The single Mode A core described is rather atypical and is hardly representative of the morphological diversity observed among the blanks. Blanks are similar to OH6 and OH5 except that they show a more pronounced bidirectional dorsal patterning. Platforms are facetted and plain, sometimes showing a *débordant* morphology, indicating a removal at the junction of two surfaces. Partial faceting is absent and a single blade shows strong abrasion on the platform edge. Crested, side blades and small laminar elements also occur. Looking at the general morphology of some of the small laminar blanks, a possible technology similar to Mode B is not excluded; however, none of these cores are found in association with our sample.

The MPH1 toolkit shows a frequent occurrence of edge damage on the retouched and unretouched

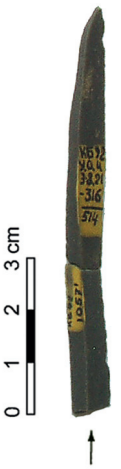


Figure 119: Kara-Bom, refitted fragments of a mesio-distal elongated spall from OH4

blanks, however, some notched tools seems to be produced intentionally. Retouched blades, especially pointed blades, are common in all samples. OH6 includes a significant series of retouched convergent blanks, showing retouch in their proximal and distal ends. The most typical elements in OH5 are the sickle-like blades, which are absent from the other samples. This sample also shows a significant amount of pieces modified by scaled retouch. Both OH6 and OH5 yielded endscrapers on medium/large blade blanks. OH4 tools are characterized by retouched blades, some being pointed by an asymmetrical truncation. Except for MPH1, all samples have yielded retouched convergent blades, however, the OH4 sample includes only a single example.

3.8 UST-KARAKOL 1 SITE DESCRIPTION AND TECHNOLOGICAL ANALYSIS OF OH5.4-5.5 ASSEMBLAGE (SECTOR1)

In this section, sector 1 (1986 excavation) and sector 2 (1993-1997 excavation) from the site of Ust-Karakol 1 are described in detail. The lithic analysis focuses on the Kara-Bom type assemblage OH5.4-5.5 from sector 1. Further descriptions of the Early Upper Paleolithic assemblages from sector 1 and sector 2 are provided in the forthcoming sections.

3.8.1 GEOGRAPHICAL SETTING

The site of Ust-Karakol 1 (51°22’ 50 N, 84° 41’ 20 E) is located 2 km southeast of Denisova Cave, at the confluence of the Karakol and Anuy rivers (Derevianko *et al.*, 1987, 2003; Derevianko, Markin, *et al.*, 2001). The Karakol and Anuy valleys cut into the relief with an approximate depth of 200 to 250 m. The geomorphology surrounding Ust-Karakol consists of an alluvial plain and steep hillside. The floodplain contains alluvial clay deposits overlying a layer of pebbles and gravels with a sandy filling. At about 7-10 m from the modern river level, the pebble layer overlies the bedrock and is located at the bottom of a 6.5 m sequence of deposits, from which about 5 m are attributed to the Pleistocene. The highest terraces reach the approximate elevation of 35-40 m above the river level (Derevianko, Markin, *et al.*, 2001; Derevianko *et al.*, 2003).

3.8.2 BACKGROUND

The site was discovered by Derevianko in 1984 and a first campaign of excavation took place in 1986, under the field direction of Markin (Derevianko *et al.*, 1987) . A surface of 120 m² (sector 1) was excavated in an area where the ground level slopes approximately 11° (UK1-1). A 4.95 m profile was exposed and divided into 10 lithological strata, 9 of which are attributed to the Pleistocene. Four horizons yielded archeological remains. Between 1993 and 1997, a second stage of research was carried out under the field direction of Postnov (Derevianko, Markin, *et al.*, 2001; Derevianko and Rybin, 2003). The new excavation (sector 2) is located 5 m east of the sector 1 limit (Slavinsky, 2007). It covers a surface of 250 m² at 7-10 m above the river level (UK1-2). A 6.5 m profile is exposed in an area where the ground level slopes approximately 13°. The stratigraphic profile is divided in 20 lithological strata, the majority of which are attributed to the Pleistocene. Ust-Karakol 2 (UK2) is located upslope at approximately 50 m from UK1-2 (Maloletko and Panichev, 1990). Zenin later connected UK1-2 and UK2 by digging a trench along the slope; however, the results of this excavation remain, up to now, unpublished. Although UK1-1 was reported as being circa 5 m east of UK1-2,

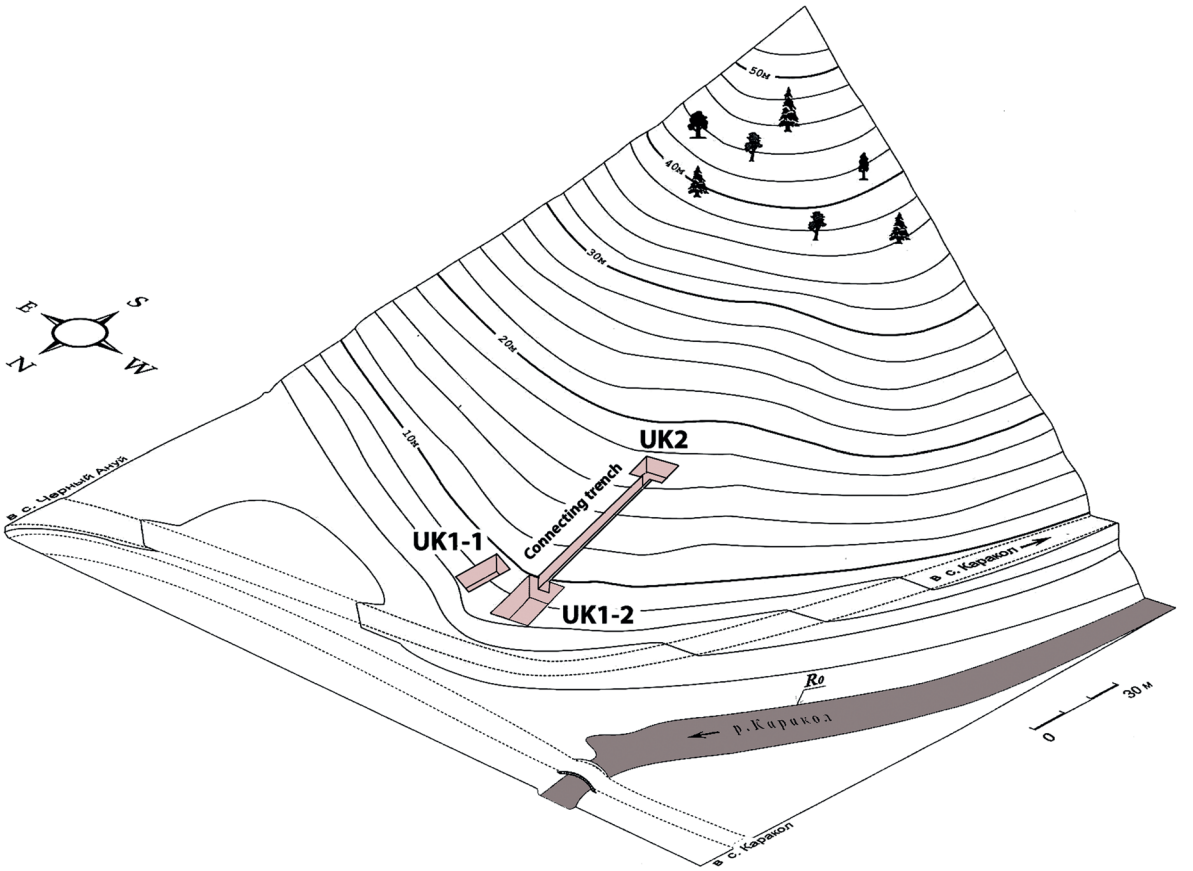


Figure 120: Ust-Karakol, general reconstruction of the excavation areas (modified after Derevianko *et al.*, 2003)

the two sectors were never connected. Based on published data, the sites are here approximately located on a general map (Figure 120).

3.8.3 STRATIGRAPHY

UK1-1

UK1-1 profile is subdivided into 10 lithostratigraphic strata (Derevianko *et al.*, 1987; Derevianko, Shimkin, *et al.*, 1998). Stratum 1 corresponds to the modern humus, Ceramic and bone fragments found in this stratum represent cultural level 1. Stratum 2 is made of light brown loam with isolated quartzite elements and limestone debris, shales and jasper. A few flakes and isolated bison and red deer remains are designated as cultural level 2. Stratum 3 contains medium size limestone blocks, pebbles and brown loam. Stratum 4 consists of silty clay sediments and contains traces of reworked humus beds. Stratum 5 is made of bedded yellowish brown loam, with small pebbles and gravels. Ferrous traces are rare and scarce. According to Derevianko and colleagues (1987), the lower part of stratum 5 contains cultural level 3. Stratum 6 contains isolated artifacts assigned to cultural level 4. The cracks are filled with sediments coming from stratum 5. Stratum 6 is composed of a gray homogenous loam and isolated limestone debris and shows the occurrence of horizontal, vertical and oblique frost cracks. Stratum 7 shows the occurrence of medium-sized limestone blocks and a dark gray loamy fill. Frost cracks are reported coming from the overlying stratum. Stratum 8 is made of homogenous dark-gray silty-loamy sediments,

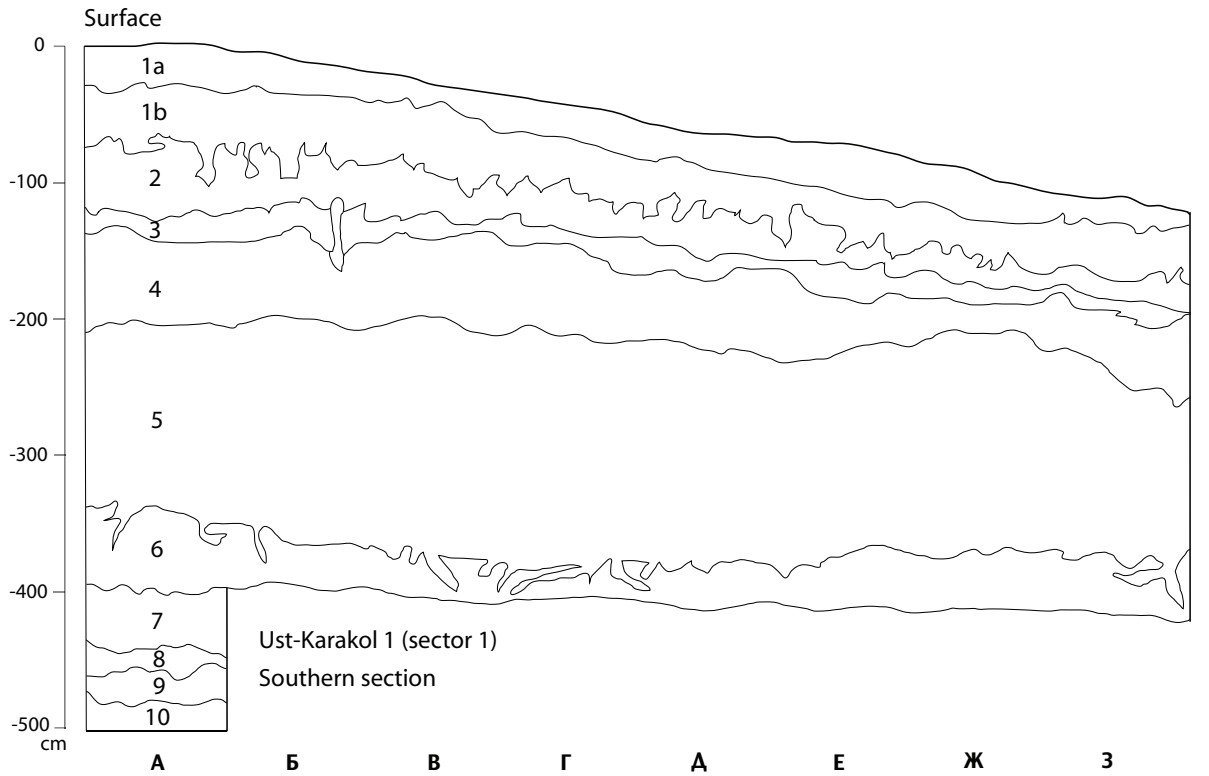


Figure 121: Ust-Karakol 1 sector 1, southern section, numbers indicate lithological strata (modified after Derevianko *et al.*, 1987)

bedded at the bottom with ferrous spots. Stratum 9 consists of gray clay with clear ferrous traces at the bottom, isolated pebbles of shale and sandstone. The lowermost stratum (10) is composed of small pebbles and boulders (sandstones and shales) with, at the top of the stratum, clay and sands. The richest human occupation is cultural level 3 from the lithological stratum 5, with an assemblage originally attributed to Early Upper Paleolithic (Derevianko *et al.*, 1987; Derevianko, Shimkin, *et al.*, 1998).

UK1-2

UK1-2 is divided in 20 lithostratigraphic strata, some of which are divided in sub-strata (Derevianko, Markin, *et al.*, 2001; Derevianko *et al.*, 2003). Stratum 1 represents the modern soil and stratum 4 is characterized by the presence of blocks and gravel. Strata 1-4 are composed of loose loess-like sediments with vertical cracks. Strata 5 and 8 are described as buried soils separated by gravels (stratum 7) and by a sandy-loam level containing evidence of soil formation. Strata 5-11 are described as loess and brown loam, containing traces of soil formation. According to Derevianko et al (2001), the deposition of stratum 11 is said to take place after a gap in the sedimentation process. Strata 12-17 includes layers of laminated red-brownish sandy loams. Laminations make the border between strata hard to follow. Stratum 18 is made of dark colored dense clayey silts containing rock debris. It is divided into two sub-strata and originates from the flood plain and from the hill side (rock). The underlying stratum 19 is divided into two sub-strata (19A and 19B). It consists of alluvial deposits and is made of sand and silt. Stratum 20 is composed of cobbles and pebbles cemented by a sandy filling. Although almost all strata have yielded archeological material, the richest assemblages are described in strata 8-11 (UP) and in strata 18-9 (MP). Strata 12-17 include small assemblages (MP) (Derevianko, Markin, *et al.*, 2001; Derevianko *et al.*, 2003).

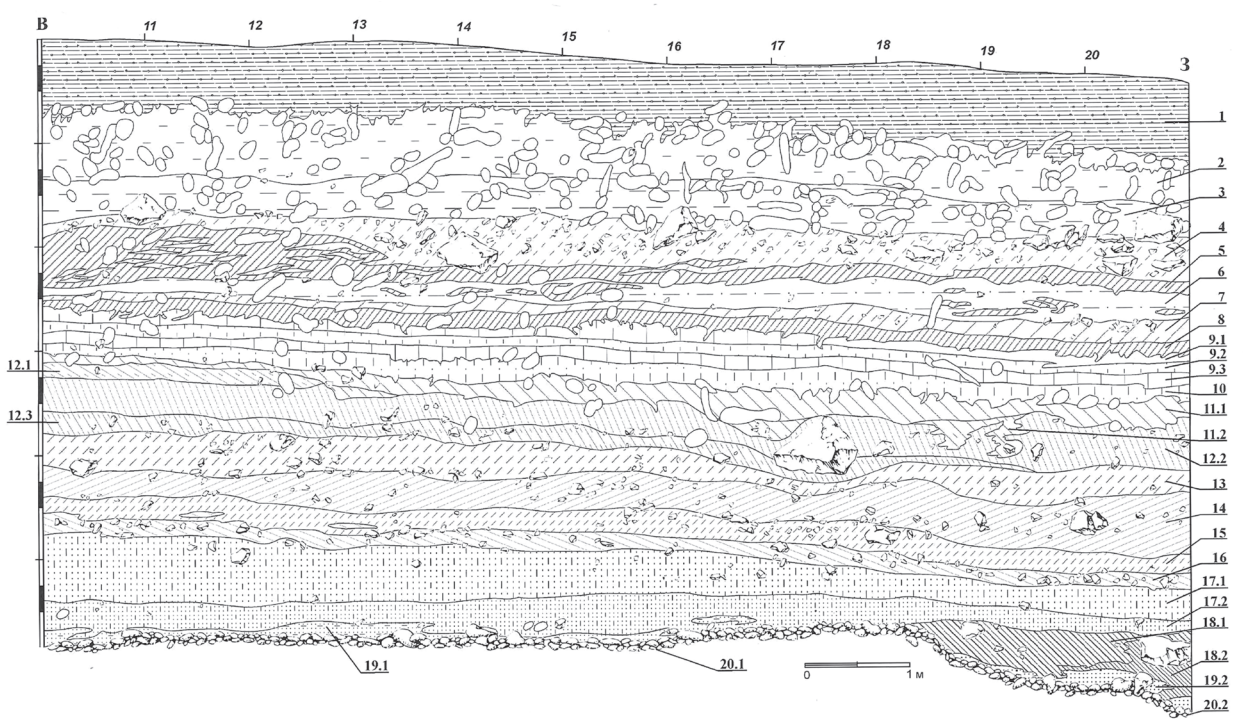


Figure 122: UK1-2, southern section (Derevianko *et al.*, 2003)

3.8.4 CHRONOLOGY

UK1-1

Two oval shaped hearths (0.7-0.8 m diameter) were identified in the lower part of stratum 5 (between -325 and -340 cm), associated with cultural level 3. Charcoal samples from two of combustion features gave conventional ages to 31, 410 ± 1,160 (SOAN-2515) and 29,900 ± 2,070 ^{14}C BP (IGAN-1077). A bison bone coming from stratum 2 was dated to 28,700 ± 850 ^{14}C BP (SOAN-2614) (Derevianko *et al.*, 1987; Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998; Derevianko, Shimkin, *et al.*, 1998). Only a few unidentified bone fragments are reported as associated with the hearths. Strata 1 to 6 have yielded palynological data. Stratum 5 and 6 indicate an open forest-steppe environment with an increase in moister in stratum 4. Strata 3-1 indicate a gradual decline of arborous species in favor of the grass species. Derevianko *et al.* (1990) attribute stratum 6 to the Zyrian period (OIS5a-d/4), stratum 5 to the Karginina interstadial (OIS3) and based on the occurrence of frost cracks, stratum 2 to the Lipovsko-Novoselovo (end of OIS3).

UK1-2

This excavation area has yielded radio-thermo luminescence (RTL) and radiocarbon dates (Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998). The RTL dates have yielded ages with large standard deviations, making their interpretation difficult.

Conventional radiocarbon dates indicate an age between 38 and 32.2 ka ^{14}C BP for stratum 10 and between 32 and 26 ka for stratum 5. Stratum 3 and 2 radiocarbon ages range between 32.7 and 28 ka (Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998; Derevianko and Rybin, 2003). The results are problematic, as they seem to show younger ages in stratum 5 than in strata 3 and 2. However, when considering the oldest dates from each level as more reliable, the majority of the dates overlap at one sigma.

Stratum	Sample	RTL	Lab number
9	burned sediment	50±12	RTL-660
18	alluvial sediment	90±18	RTL-658
18	alluvial sediment	100±20	RTL-659
19	alluvial sediment	133±33	RTL-661
20	alluvial sediment	207±41	RTL-662
20	alluvial sediment	210±42	RTL-640

Table 81: UK1-2, RTL dates

Stratum	Sample	Radiocarbon (^{14}C BP)	Lab number
2	Bone	31,430±1,180	IGAN-1077
2	Bone	28,700±850	SOAN-2614
3	Charcoal	31,345±1,315	SOAN-2869
3	Charcoal	31,410±1,160	SOAN-2515
5	Charcoal	26,305±280	SOAN-3261
5	Humates	26,920±310	SOAN-3356
5	Charcoal	27,020±435	SOAN-3356G
5	Charcoal	30,460±2,035	SOAN-3260
9	Charcoal	29,860±355	SOAN-3358
9	Charcoal	29,720±360	SOAN-3359
9	Charcoal	33,400±1,285	SOAN-3257
10	Charcoal	35,100±2,850	SOAN-3259

Table 82: UK1-2, radiocarbon dates

Geomagnetic analyses have been performed on a stratigraphic section, indicating 3 excursions: Lachamp (44-42 ka) in stratum 11, Mono (30-25 ka) in stratum 5, and Gothenburg (13-11 ka) in stratum 2 (Derevianko *et al.*, 2003). These results are in contradiction with the radiocarbon ages of stratum 2. Palynological analysis carried out by Malayeva indicates the occurrence of eight palynozones. These results are interpreted as reflecting alternating changes between two main floral complexes, namely a birch/pine-birch environment and taiga forest. The latter would indicate a cooler and more humid climate. On the long term, Malaeva interpreted these changes interpreted as a general cooling of the climate (Derevianko *et al.*, 2003).

About 107 identifiable bone remains have been collected throughout the whole Pleistocene sequence. This poor assemblage is unevenly distributed among the strata and does not allow any diachronic recon-

struction. *Bison priscus, Carpeolus pygargus, Poephagus mutus, Crocuta spelea, Cervus elaphus, Megaloceros giganteus, Procapra gutturosa, Capra siberica* and *Ovis ammon* are the main species identified. Some of these correspond to a forest (deer and red deer) or a mountain (Siberian goat) environment or to a steppe and meadow steppe environment (Mongolian gazelle) (Derevianko *et al.*, 2003; Vasiliev, 2003). About 27 species of small mammals have been identified (Agadjanian and Serdyuk, 2005). Long-tailed squirrels *(Spermophilus undulatus)* and zokors *(Myospalax myospalax)* are the most common, respectively, in strata 19 to 11 and 11 to 1. Forest species are more present in the lower part of the sequence. More generally, strata 19 to 13 are attributed to the Ermakovo period and strata 11 to 5 are attributed to the Karga interstadial period. The strata 4-2, although attributed to the Sartan period, have yielded radiocarbon estimations, indicating a Karginian age (OIS3) (Derevianko *et al.*, 2003; Agadjanian and Serdyuk, 2005).

One conventional radiocarbon date is reported from UK2. The 31,430 ± 1,180 ^{14}C BP (IGAN-1177) age is associated with a layer correlated with the stratum 5 at UK1-1 (Cherkinskii *et al.*, 1992).

3.8.5 TAPHONOMIC APPROACH

UK1-1

In a recent study, Slavinsky (2007) produced a series of refits from cultural level 3 from UK1-1. The results that he presented have strong implications regarding the integrity of the assemblage. Based on a planimetric reconstruction of the artifact distribution, Slavinsky proposes dividing stratum 5 into five sub-strata (Slavinsky, 2007). According to him, these strata correspond to five independent occupation horizons (OH), labeled from 5.1 to 5.5. Among these occupations, he distinguishes two main technological traditions. The first one groups OH5.1 to OH5.3, and the second groups OH5.4 and OH5.5. Based on a series of refits, he also argues that OH5.4 corresponds to a homogenous short term occupation. However, Slavinsky's planimetric model does not clearly rule out a possible influence of slope effects. Using the same data, ranges of altitude have been projected on a longitudinal section A14-3 and on the transversal southern section (A14-Z14). Artifacts are plotted arbitrarily in the middle of each square. Only a few data points have been discarded from the projection

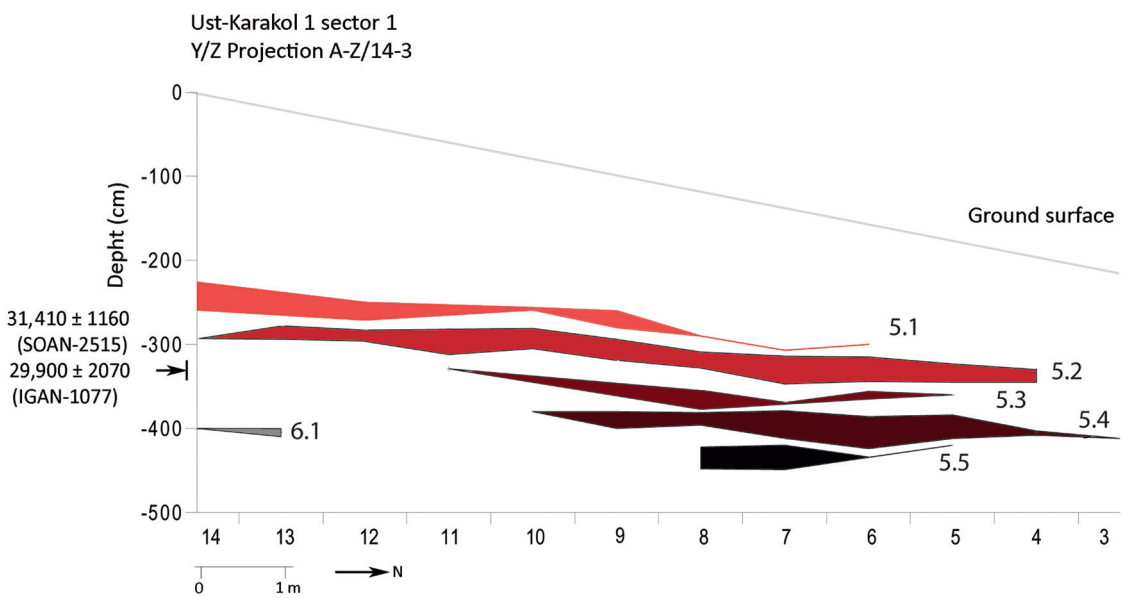


Figure 123: UK1-1, longitudinal projection of the piece-plotted artifacts based on their altitude range (data from Slavinsky, 2007)

as they had ambiguous labels. The longitudinal projection shows clearly that artifacts can be grouped in five different concentrations separated by sterile horizons ranging from circa 30cm down to a few cm in thickness. It is worth noting that none of the subunits are actually connected, although it could have been expected when projecting 8 m² on to a section. OH6.1 is reported as belonging to stratum 6 and appears here at the same altitude as OH5.4. This may imply that stratum 6 has a steeper slope then OH5.1-5.5, which appear sub-horizontal. The ground level is reconstructed using the inclination of 11° provided in the original publications (Derevianko *et al.*, 1987; Derevianko, Shimkin, *et al.*, 1998).

The transversal projection shows a similar pattern with OH5.1-5.5 clearly separated by sterile horizons. Once again, given that more than 11 m² are projected on a single profile, one would expect a certain overlap between OH. Only OH6.1 overlaps with OH5.4 due to its location higher in the slope. This reinforces the idea that stratum 5 includes individual assemblages that were grouped in the original publication under the label of 'cultural level 3'. All in all, Slavinsksi's subdivision model (Slavinsky, 2007) is validated by both transversal and longitudinal projections.

From a chronological point of view, Slavinsky argues that the dated hearth features are associated with OH5.2 as they are both reported between -324 cm and -336 cm (Slavinsky, 2007). The longitudinal projection indicates that the hearth features are either located in the interval between OH5.3 and OH5.2 or at the bottom of OH5.2. On the transversal section, the hearth features appear connected with the lowest part of the OH5.2; thereby, providing a minimal age for OH5.3-5.5.

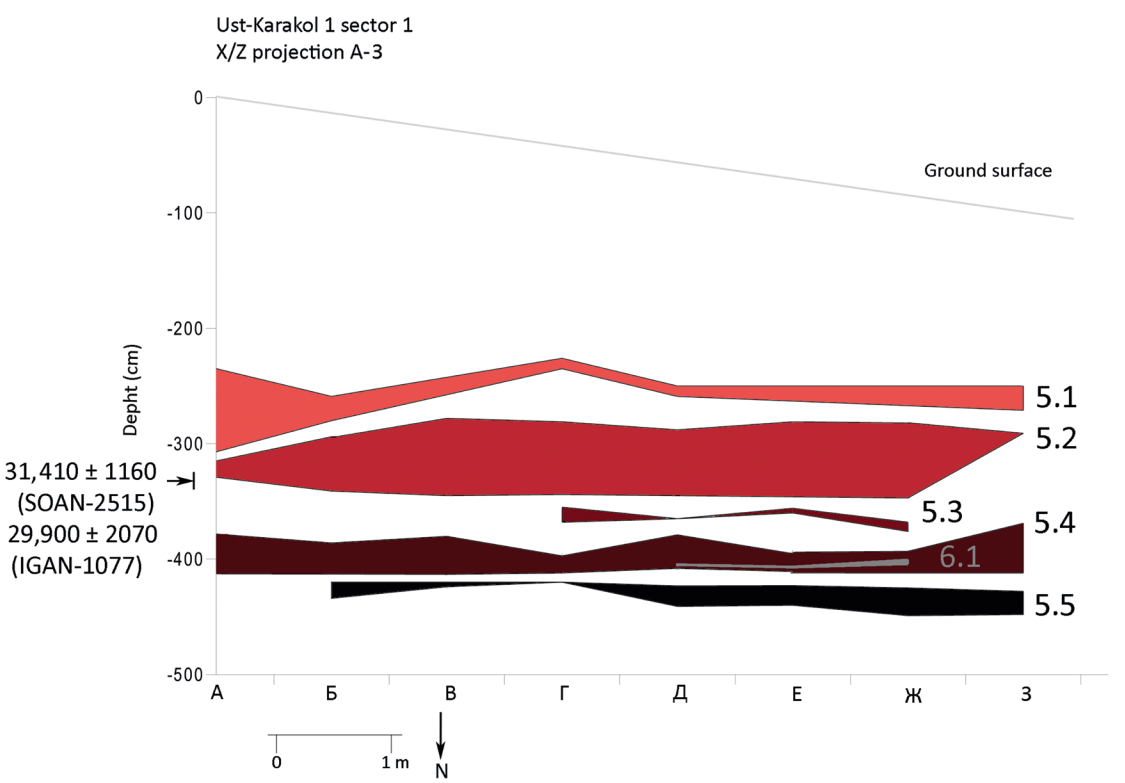


Figure 124: UK1-1, transversal projection of the piece-plotted artifacts based on their altitude range (data from Slavinsky, 2007)

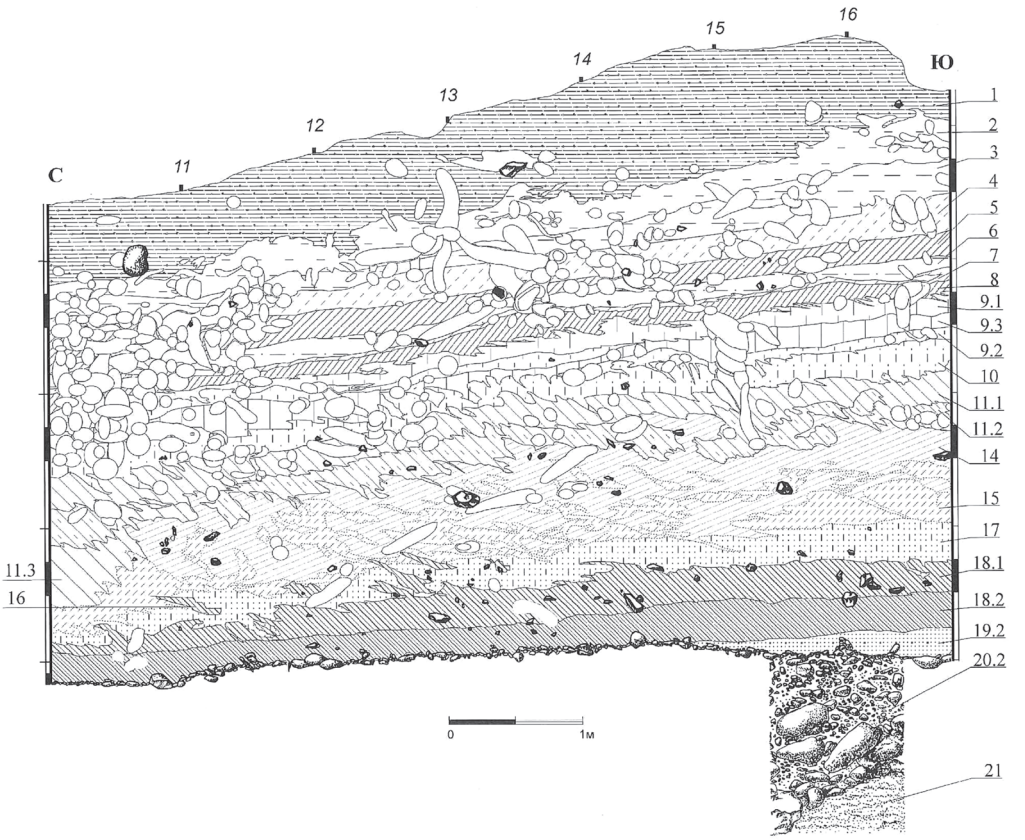


Figure 125: UK1-2, eastern section (after Derevianko *et al.*, 2003)

UK1-2

Up to now, no complete taphonomic analysis has been performed in UK1-2. However, some general comments can be formulated. As visible in the northern, southern and eastern sections, the excavated area shows a significant amount of bioturbation mainly affecting strata 2 to 14, but also more locally in the lower part of the sequence (strata 14 to 18) (Figure 125). In addition, frost cracks occur mainly between strata 9.3 and 16. These cracks are filled with sediments from the respective overlying strata. The bottom of the sequence seems relatively well preserved as stratum 18a has yielded at least one long refitted reduction sequence (Postnov, 1999) and a refit of a complete *Capra sibirica* distal foreleg (Derevianko *et al.*, 2003). Refits (Slavinsky, 2007) show movements of artifact between strata 9.1, 9.2 and 9.3, between 9.3, and 10 and between 10 and 11. In a few cases, a single sequence shows refits across several strata 9.2 to 11.1, 11b to 10 or 11.1 to 9.3. However, some long sequences are refitted within the same strata. These refits are mainly in stratum 9.3. Slavinsky notes that the Upper Paleolithic material from UK1-2 does not correspond to individual occupations, as opposed as UK1-1. He also mentions refits between strata 9-11 and 12-15 (Slavinsky, 2007). This may be linked with the facts that strata 12 and 13 are not identified on the whole site (Figure 122, Figure 125, Figure 126). Downslope, on the northern and on the eastern section, stratum 11 is directly in contact with stratum 14. Upslope, stratum 12 and 13 occur on the southern section. This likely indicates erosional processes usually affecting slope deposits. To summarize, the UK1-2 seems to show a good preservation of stratum 18 but show localized artifact movements between the middle and upper part of the sequence that are

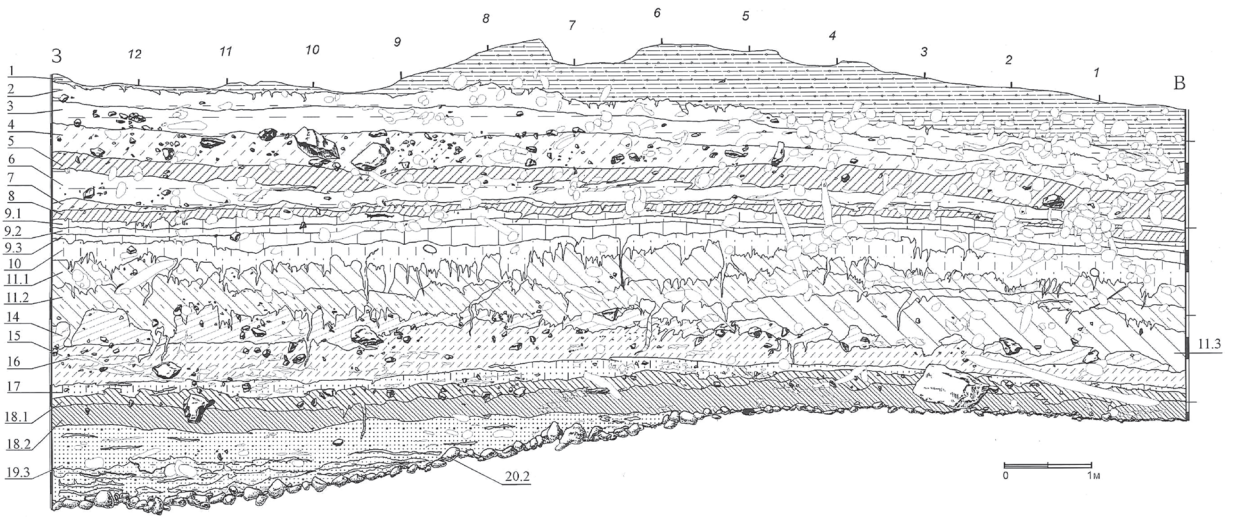


Figure 126: UK1-2, northern section

maybe due to the combine actions of slope erosion and rodent burrows.

Summary

As UK1-1 and UK1-2 trenches were not physically connected, the two sequences cannot be formaly correlated. Moreover, stratigraphic divisions are different from one trench to the other, although the two excavation areas are close to each other. The following table summarizes the available data to tentatively correlate the two in order to provide a comprehensive overview of the main chrono-cultural issues. The assemblages studied correspond to the earliest UP. Following the taphonomic assessment of UK1-1 cultural level 3, two variants of UP are recognized. OH5.1-5.3 are described here as EUP and the underlying assemblages OH5.4-5.5 are assigned to the IUP. These two variants are not differenciated at UK1-2 but are instead described as illustrating a transition from MP to UP. The interface between the MP and EUP assemblage is, however, not clear and includes erosion and slope processes as well as vertical movements of artifacts.

3.8.6 SAMPLE COMPOSITION

In this chapter, the material from UK1-1 OH5.4 and OH5.5 is described, focusing on the laminar technology. EUP assemblages from UK1-1 and UK1-2 are described in the next chapter. Initially, 657 lithic artifacts were reported as associated with cultural level 3 (Derevianko *et al.*, 1987; Derevianko, Shimkin, *et al.*, 1998). Slavinsky reported 318 artifacts for OH5.4 and 47 for OH5.5 (Slavinsky, 2007). OH5.4 has yielded 75 blades, 8 cores (including 2 fragments), 30 laminar flakes and 40 tools. For OH5.5, 6 cores, 22 blades, 2 laminar flakes and 18 tools are reported. However, this sample does not include a few pieces exhibited in the Akademia Gorodok museum (Novosibirsk, Russia).

Differences in the number of pieces between the present and the previous studies may be due to several factors. Some are due to ambiguities in terms of artifact labels and others are due to the fact that a part of the artifacts were not available at the moment of this study, as they were in the local museum. The sample studied does include the large majority of the material previously published, with the relevant remaining artifacts, including some from the museum, being discussed in the forthcoming chapters.

UK1-1				UK1-2			
Lithological stratum	**Cultural level**	**Cultural Attribution**	**Chronological attribution**	**Lithological stratum**	**Cultural level**	**Cultural Attribution**	**Chronological attribution**
1	1	?	Modern	1			Modern
2	2	?	OI2/3?	2	2-4	LUP	OIS2/3
				3			
				4			
				5	5	UP	
3	/			6	/	/	
4	/			7	/	/	
5	3 (OH5.1-5.3)	EUP	OIS3	8	11-8	EUP	OIS3
				9			
				10			
	3 (OH5.4-5.5)	IUP	OIS3/4?	11			
				12	12-17	MP?	OIS4
6	4	MP?		13			
7-10	/	/	?	14			
				15			
				16			
				17			
				18	18a-18b	MP	OIS5e(-d?)
				19	19	MP	
				20			

Table 83: Ust-Karakol 1, summary and comprehensive correlation of UK1-1 and UK1-2 sequences. Shaded rows represent assemblages studied

First observations on the lithic material from OH5.4 and OH5.5 by Slavinsky and the results of the present analysis indicate a high degree of similarity between OH5.4 and OH5.5. In order to obtain a statistically relevant sample, these two sub-levels are grouped in the following technological analysis under the label OH5.4-5.5. Petrographic data collected on the UK1-2 assemblage indicate that volcanic rocks, aleurolits and sandstones dominate, accounting for respectively 41%, 30% and 21.5 % of the archeological material. Volcanic rocks are found as pebbles along the Anuy ridge and in the Karakol and Muta River watersheds. These materials vary from dark grey to black. Aleurolits and sandstone being more com-

	N	*f*
Blade	58	64%
Bladelet	3	3%
Microblade	0	0%
Flake	1	1%
Core	9	10%
Tool	19	21%
	90	100%

Table 84: UK1-1, OH5.4-5.5, sample composition

mon in the Anuy and Karakol rivers, the data suggest an intentional selection of the volcanic rocks. Such a pattern is also observed in Denisova Cave and in Anuy II (Postnov *et al.*, 2000; Anoikin and Postnov, 2005).

3.9 LAMINAR TECHNOLOGY: OH5.4-5.5

3.9.1 BLANK ATTRIBUTES

Breakage

The distribution of both blades and bladelets indicates a majority of mesial and mesioproximal fragments (Table 85). Based on these observations, an MNI of 35 blades is calculated on a total sample of 62 laminar artifacts recorded.

Platform size and preparation

Based on observations from the MNI sample, OH5.4-5.5 blades show a majority of facetted platforms, followed by plain platforms and an insignificant occurrence of flat, dihedral platforms (Table 86).

Considering all platform types together, the mean thickness is 6.1 ± 3.5 mm and the mean width is 15.5 ± 9.6 mm.

Facetted platforms (Table 87) show a higher mean thickness and width than the MNI sample and than the plain platforms (Table 88). This difference is, however, not statistically significant. Dihedral plat-

	Total		Blade		Bladelet	
	N	*f*	N	*f*	N	*f*
Distal	0	0%	0	0%	0	0%
Mesiodistal	5	8%	4	7%	1	33%
Mesial	22	35%	20	34%	2	67%
Mesioproximal	16	26%	16	27%	0	0%
Proximal	8	13%	8	14%	0	0%
Complete	11	18%	11	19%	0	0%
	62	100%	59	100%	3	100%

Table 85: UK1-1, OH5.4-5.5, breakage

	N	*f*
Plain	11	31%
Facetted	20	57%
Dihedral Flat	3	9%
Undetermined	1	3%
	35	100%

Table 86: UK1-1, OH5.4-5.5, platform preparation

forms have a mean thickness of 5.8 ± 3.2 mm and a mean width of 14.2 ± 6.1 mm

Thin abrasion is almost absent (N=1), but some blanks for which a strong abrasion smoothed the external platform edge (N=5).

Blank size attributes

Length

As length is measured only on complete elements, the results presented are based on a smaller sample that includes only blades (Table 89). In spite of the small sample, the distribution of length measurements appears to be normally distributed (Shapiro-Wilk, W=0.91, p= .22).

	Total (blade)
Sample size	11
Mean (mm)	82.4
Standard deviation (mm)	22.1
Range (mm)	55.7 to 133.4

Table 89: UK1-1, OH5.4-5.5, blank length

Facetted platform	Total (blade)	
	Thickness	Width
Sample size	20	
Mean (mm)	7	18
Standard deviation (mm)	3.9	10.8
Range (mm)	1.4 to 13.6	4.8 to 52.4

Table 87: UK1-1, OH5.4-5.5, facetted platform size

Plain platform	Total (blade)	
	Thickness	Width
Sample size	11	
Mean (mm)	5.3	12.8
Standard deviation (mm)	2.4	6.3
Range (mm)	3 to 9.1	5.5 to 25.7

Table 88: UK1-1, OH5.4-5.5, plain platform size

Width	Total	Blade	Bladelet	Total MNI (Blade)
Sample size	62	59	3	35
Mean (mm)	27.3	28.2	9.4	30
Standard deviation (mm)	10.6	10.1	2	9.5
Range (mm)	7.5 to 52.1	12.7 to 52.1	7.5 to 11.5	14 to 52.1

Table 90: UK1-1, OH5.4-5.5, blank width

Width

The MNI mean width appears to be larger than for the total sample (Table 90) although the difference is not significant, meaning that there is no direct relationship between the width of the blank and the rate of breakage. The total sample (Shapiro-Wilk, W=0.96, p=<.05) and the MNI (Shapiro-Wilk, W=0.92, p=<.05) are not normally distributed. This is due to the combine effects of a positive skewness (0.52 for the total sample and 0.87 for the MNI) and to the presence of artifacts of more than 50 mm width, although the general distribution pattern is unimodal (Figure 127). The sample size may also play a role.

Thickness

The total sample (Shapiro-Wilk, W=0.94, p=<.05) and the MNI (Shapiro-Wilk, W=0.93, p=<.05) are not normally distributed (Table 91). This situation reflects the positive skewness of the distributions (0.91 for the total sample and 0.85 for the MNI) but also the occurrence of a second mode between 4 and 6 mm.

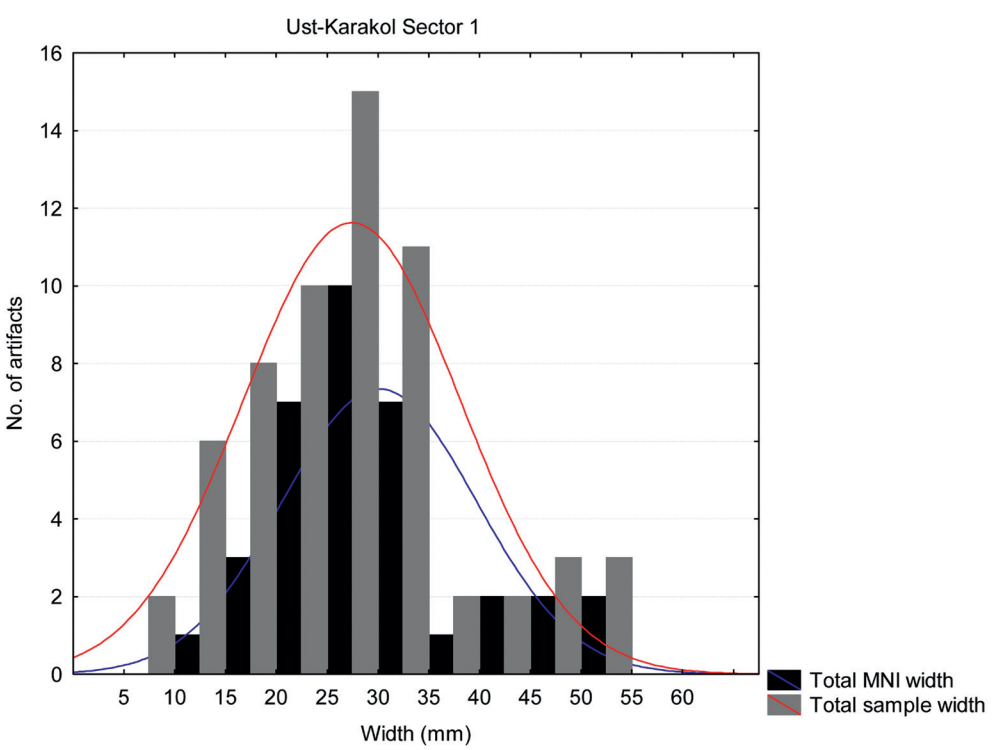


Figure 127: UK1-1, OH5.4-5.5, blank width distribution

	Total	Blade	Bladelet	Total MNI (Blade)
Sample size	62	59	3	35
Mean (mm)	8.9	9.2	3.2	10.3
Standard deviation (mm)	4.8	4.7	1.6	5
Range (mm)	1.7 to 24.3	2.1 to 24.3	1.7 to 5	3.4 to 24.3

Table 91: UK1-1, OH5.4-5.5, blank thickness

As was shown for the width, the mean thickness is larger for the MNI than for the total sample, but without showing significant differences. The thickness distribution may suggest that thinner blanks are more fragmented (Figure 128).

Dorsal scar pattern

Unidirectional and bidirectional scar patterns have similar frequencies in the total sample (χ^2 (1)= 0.314, p=.57) (Table 92). This suggests that the main reduction sequences are not strictly unidirectional or alternate bidirectional. The occurrence of crested and neo-crested blanks illustrates the initial reduction stages and the core management operations. The relatively large amount of undetermined patterns is mainly due to the frequent occurrence of concretion on the artifacts. When considering only the complete blanks, the sample size is sharply reduced and indicates a good presence of bidirectional blanks (N=5) and crested blanks (N=4) followed by unidirectional ones (N=2).

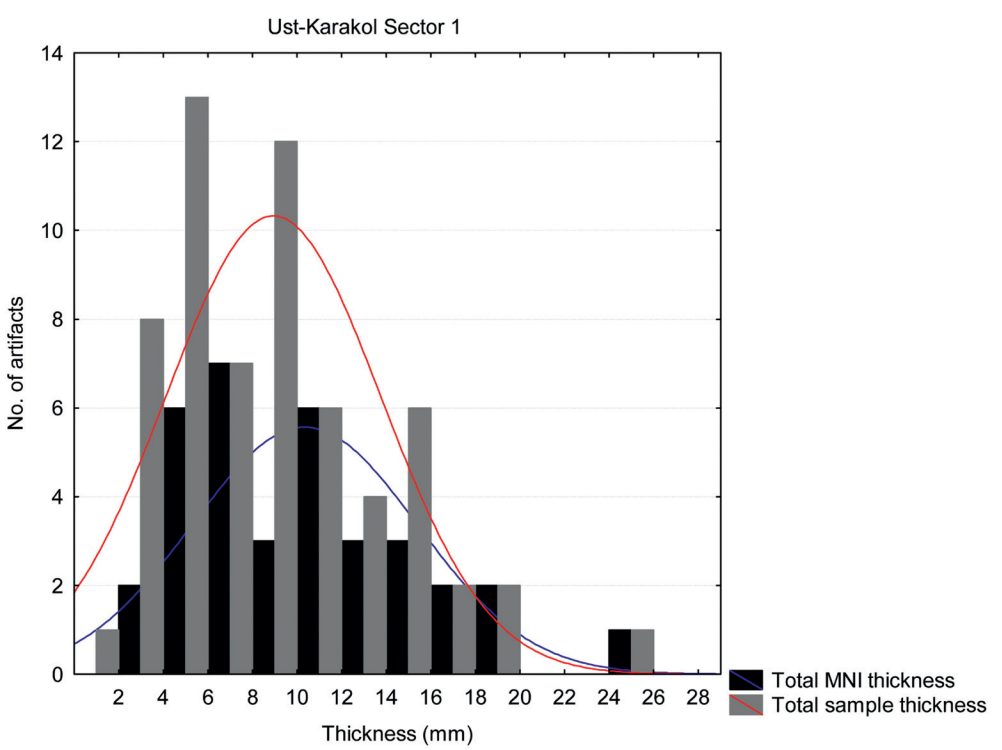


Figure 128: UK1-1, OH5.4-5.5, blank thickness distribution

	Total		Blade		Bladelet	
	N	*f*	N	*f*	N	*f*
Unidirectional	21	34%	20	34%	1	33%
Unidirectional and cortex	2	3%	2	3%	0	0%
Bidirectional	24	39%	23	39%	1	33%
Bidirectional and cortex	0	0%	0	0%	0	0%
Crest	4	6%	4	7%	0	0%
Second Crest	0	0%	0	0%	0	0%
Neo-crest	1	2%	1	2%	0	0%
Undetermined	10	16%	9	15%	1	33%
	62	100%	59	100%	3	100%

Table 92: UK1-1, OH5.4-5.5, dorsal scar pattern

Cross-section

Cross-sections appear to be mainly trapezoidal when considering the total sample (χ^2 (1)= 0.18, p=<.05) and the blade category (χ^2 (1)= 24.74, p=<.05)(Table 93). All bladelets have a triangular cross-section.

Profile

When considering the total sample, profiles appear to be mainly straight (χ^2 (2)= 22.31, p=<.05). Curved and slightly curved blanks occur with at equal frequencies, and the presence of twisted profiles is rare (Table 94).

	Total		Blade		Bladelet	
	N	*f*	N	*f*	N	*f*
Flat	1	2%	1	2%	0	0%
Rectangular	0	0%	0	0%	0	0%
Triangular	18	29%	15	25%	3	100%
Trapezoidal	42	68%	42	71%	0	0%
Polyhedral	1	2%	1	2%	0	0%
	62	100%	59	100%	3	100%

Table 93: UK1-1, OH5.4-5.5, blank cross-sections

	Total		Blade		Bladelet	
	N	*f*	N	*f*	N	*f*
Straight	33	53%	31	53%	2	67%
Slightly Curved	12	19%	12	20%	0	0%
Curved	12	19%	11	19%	1	33%
Twisted	4	6%	4	7%	0	0%
Undet	1	2%	1	2%	0	0%
	62	100%	59	100%	3	100%

Table 94: UK1-1, OH5.4-5.5, blank profiles

	Total MNI (blade)	
	N	*f*
Straight	17	49%
Slightly Curved	8	23%
Curved	7	20%
Twisted	2	6%
Undet	1	3%
	35	100%

Table 95: UK1-1, OH5.4-5.5, blank MNI profiles

These trends are similar when considering the MNI sample (χ^2 (2)= 8.18, p=<.05), indicating that breakage does not bias the values recorded on the total sample.

Orientation

When considering the total sample, most of the blanks are categorized as axial directly followed by the right and left-oriented blanks (Table 96). Differences between these categories are insignificant (χ^2 (2)= 0.83, p=.66).

	Total		Blade		Bladelet	
	N	*f*	N	*f*	N	*f*
Right	12	19%	12	20%	0	0%
Left	10	16%	10	17%	0	0%
None	14	23%	14	24%	0	0%
Undetermined	26	42%	23	39%	3	100%
	62	100%	59	100%	3	100%

Table 96: UK1-1, OH5.4-5.5, blank orientation

This observation is reinforced by the MNI (Table 97) where, except the undetermined artifacts, all categories show similar frequencies (χ^2 (2)= 0.63, p=.73).

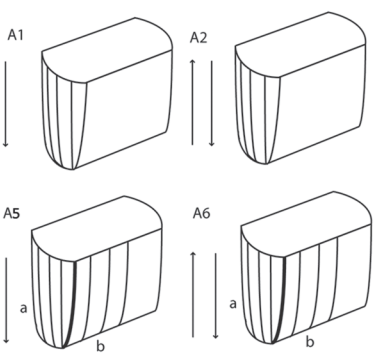
	N	*f*
Right	12	34%
Left	9	26%
None	11	31%
Undet	3	9%
	35	100%

Table 97: UK1-1, OH5.4-5.5, blank MNI orientation

3.9.2 CORES: REDUCTION PATTERNS AND SIZE ATTRIBUTES

Nine cores have been recognized in the OH5.4-5.5 sample (Figure 129). Six cores belong to Mode A as they are on block/slab blanks, and two of them are on blade blanks, and, therefore, are classified as Mode B. One is a flake core which is described but not included in the Mode classification.

Mode	*n*	%
A1	2	25%
A2	1	13%
A3		
A4		
A5	1	13%
A6	2	25%
A7		
A8		
A9		
A10		
A11		
A12		
B1		
B2		
B3		
B4		
B5	1	13%
B6		
B7	1	13%
	8	100%



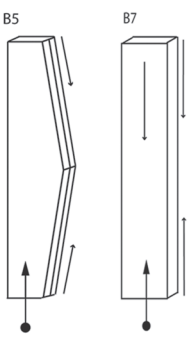


Figure 129: UK1-1, OH5.4-5.5, frequencies of cores per Mode

	Mode A		
	Mean	σ	N
Core length	35.7	22.3	6
Core width	45.2	18.7	6
Core thickness	91.5	35.1	6
Flaking surface length	91	35.5	6
Flaking surface width	44.7	20.8	6
Last removal length	67.6	5.5	5
Last removal width	27.2	15.9	5

Table 98: UK1-1, OH5.4-5.5, core size attributes

Size attributes

Only Mode A attributes are listed here, as the sample of Mode B cores is too small for the relevant statistics. The Mode B7 core is 21.0 mm long, 34.6 mm wide and 87.2 mm thick. The Mode B5 core is 32.3 mm long, 30.6 mm wide and 92.7 mm thick. The flaking surface is 91.8 mm long and 30.6 mm wide.

All measurements are recorded according to the system described in Chapter 2 which does not take into account the type of blank on which the core is produced. As a result, measurements are comparable, but in the case of Mode B cores, the thickness corresponds to the length of the blade blank, and the length of the core represents the thickness of the blade.

Striking platform preparation

Mode A cores show either a combination of a plain platform partially modified by faceting (N=4) or complete faceting (N=2). Mode B cores have plain platforms, one of them shows traces of a tablet removal.

Core descriptions

Mode A1 (N=2)

∗ YK-86-705-16

This core is produced on a block still covered by cortex (up to 70%)(Figure 130). With four surfaces displaying roughly equal width and a natural platform, the original block is a suitable shape for blade reduction with minimal preparation. It represents the early stages of a blade reduction process, with a first sub-cortical hinged blade removed from the corner between two surfaces followed by another one extending on one of the surfaces. The upper striking platform is prepared by the removal of two sub-cortical flakes and shows a series of unsuccessful attempts to remove a cortical side blade. These attempts, marked by the stepped morphology of the platform edge, have the effect of creating an oblique angle leading to a change of platform. An opposed platform is prepared by the removal of a large flake and a series of small hinged flakes illustrates the last attempts to remove a cortical blade, following the scar left by a previous removal.

∗ YK-86-673-1

This core is produced on a chert block that shows a series of removals detached from a platform prepared by the removal of a large flake (Figure 131).

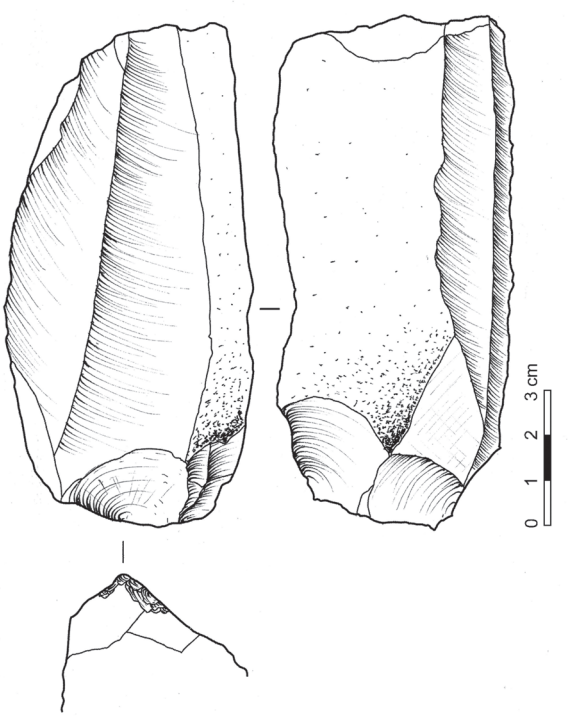


Figure 130: UK1-1, OH5.4-5.5, YK-86-705-16

The flaking surface is located on a narrow side of the nodule and displays negatives of two sub-cortical removals followed by a series of three hinged removals ending the reduction. A second opposed platform is shaped by the removal of a large flake, and although no blade was removed, a series of stepped small negatives testifies to a clear attempt to remove a thick blade from the intersection of the flaking surface and a cortical surface.

Mode A2 (N=1)

* YK-86-319-1

This core is made on an elongated cortical flake and shows two opposed platforms. A single removal is visible, detached from the upper platform and following a narrow edge of the blank.The second platform is prepared, but no removals were detached, probably due to a problem with the EPA.

Mode A6 (N=3)

* YK-86-678-1

This core is produced on a block/slab (Figure 133) and shows a main flaking surface on a broad side of the core, opposed to a cortical back. The reduction follows two opposed platforms, the upper one is prepared by the removal and faceting of the platform edge. The lower platform bear traces of a percussive event. A second flaking surface located on a narrow face illustrates attempts to remove a postero-lateral crested blade.

* YK-86-631-1

This core is produced on a block/slab with two separate flaking surfaces and two opposed platforms (Figure 134). Blade blanks are mainly detached from the broad flaking surface opposed to a cortical back. Two blades are detached from the upper platform (1, 2) and are followed by the detachment of a blank from the lower platform at the junction between the

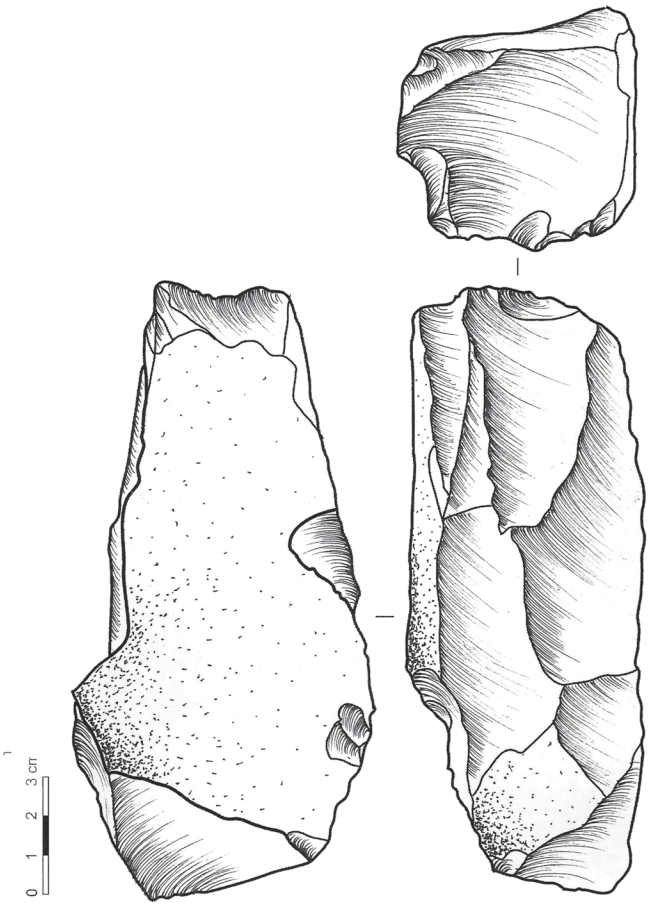


Figure 131: UK1-1, OH5.4-5.5, YK-86-673-1

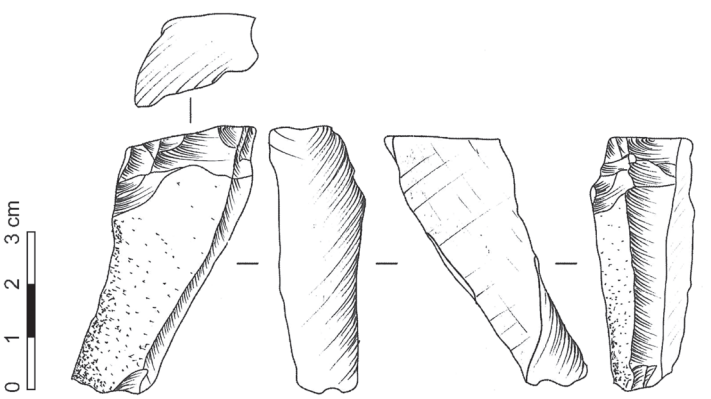


Figure 132: UK1-1, OH5.4-5.5. YK-86-319-1

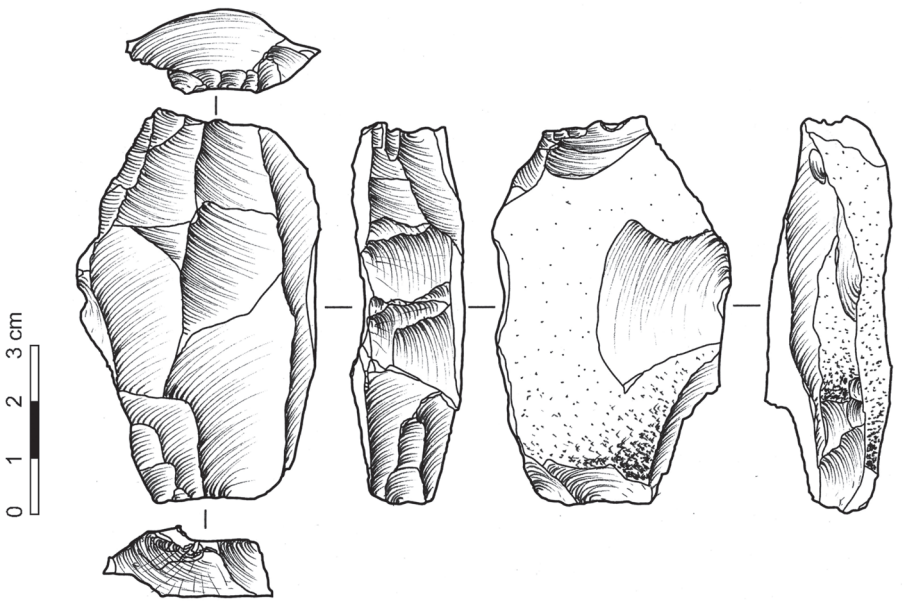


Figure 133: UK1-1, OH5.4-5.5, YK-86-678-1

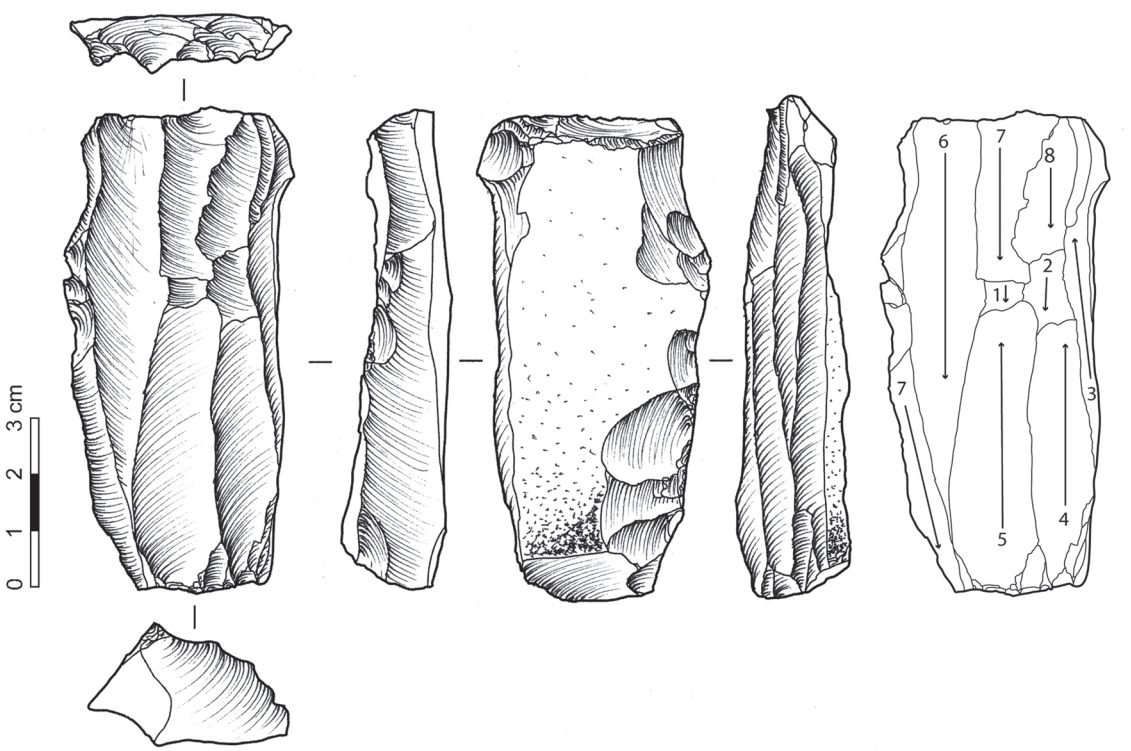


Figure 134: UK1-1, OH5.4-5.5, YK-86-631-1

broad and the narrow flaking surface (3). It is followed by the removal of a hinged blade from the upper and the lower platform, extending on the broad surface (4). Then, a hinged blade blank is struck from the lower platform, in the middle of the flaking surface (5). A platform switch occurs, with a first blade (6) followed by a blank removed from the corner of the flaking surface and two hinged fractures (7, 8).

The left corner of the flaking surface is then prepared as an antero-lateral crest by removing sub-cortical flakes from the back of the core. A single hinged removal represents the last attempt to resume the reduction sequence by creating a new flaking surface on the left narrow edge of the core. Judging by the number of removals visible on the right narrow edge, this seems to happen frequently in the course of the reduction.

The upper striking platform is rather thin and is prepared by faceting. The acute angle between the flaking surface and the striking platform is similar to an inverse truncation. The lower platform is plain and much thicker and is prepared by the removal of a sub-cortical flake and by a thin faceting still visible around the beginning of the next guiding ridge.

∗ YK-86-710-3

This core is produced on a block and has two distinct flaking surfaces (Figure 135). The main flaking surface is located on a broad face of the block and opposed to a semi-prepared and cortical back. The pattern of reduction is unidirectional. A first removal (1) is followed by an overshot (2) taking away the central part of the flaking surface. Removals are then detached from the left end of the broad flaking surface and from the perpendicular narrow flaking surface (3). The reduction ends with two hinged fractures (4, 5).

The striking platform is rather thin and is prepared by faceting, and a completely prepared platform is still visible on the left corner of the flaking surface and is posterior to removal 4.

Mode B7 (N=1)

∗ YK-86-721-11

This core is produced on a thick, bidirectional, asymmetric blade with a sub-triangular cross-section (Figure 136). It shows traces of a mesiodistal snapping event followed by two removals that prepare a strik-

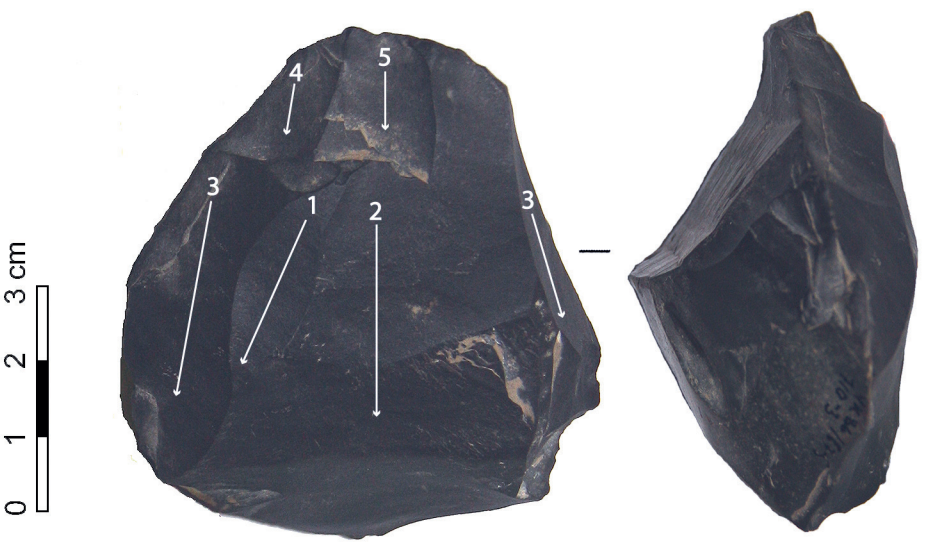


Figure 135: UK1-1, OH5.4-5.5, YK-86-710-3

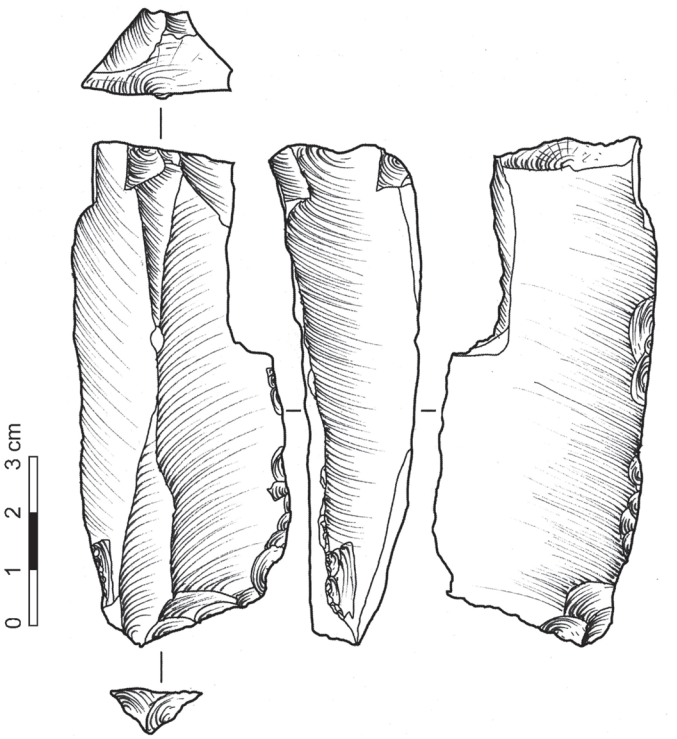


Figure 136: UK1-1, OH5.4-5.5, YK-86-721-11

ing surface. A hinged removal is detached along the right edge from a plain striking surface. More attempted removals are visible along the right edge, one using the ridge edge of the blank, the others trying to remove blanks from the central ridge.

The lower platform is a proximal truncation from which is struck a single removal following the central scar of the blank (Figure 137). Direct sporadic retouch is located along the right edge down to the proximal end. Inverse retouch is located along the left edge. This retouch may play the role of a crest.

Mode B5 (N=1)

* YK-86-619-6

This core is produced on a large bidirectional asymmetric blade which shows traces of snapping events at the lower end (Figure 138). The bidirectional reduction takes place along the right edge from two opposed platforms. The earliest phase of reduction (1) shows a removal detached from the lower platform which follows the left edge and covers the whole length of the flaking surface. Another early removal is located at the center of the flaking surface. The second phase is represented by a single removal detached from the upper platform (2). The following phase (3) includes removal from both platforms, the lower one displaying a deeply hinged negative. It is followed by a second hinged fracture (4) which ends the reduction from the lower platform. From the upper platforms, two removals including one hinged fracture (4), are followed by two hinged removals (5, 6). The upper platform is fragmented by the removal of a large flake and stepped negatives. The remaining part is elongated and shows traces of a tablet removal and lateral stepped removals. The lower platform is plain. Notable is the retouch located along the left edge that in this context is considered as a posterior crest.

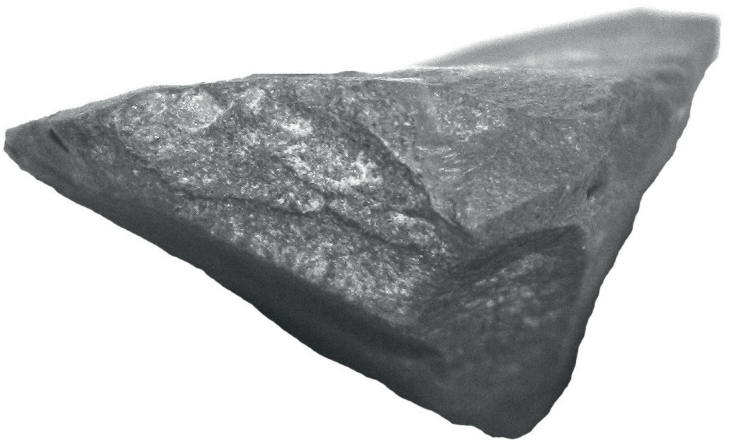


Figure 137: UK1-1, OH5.4-5.5, YK-86-721-11

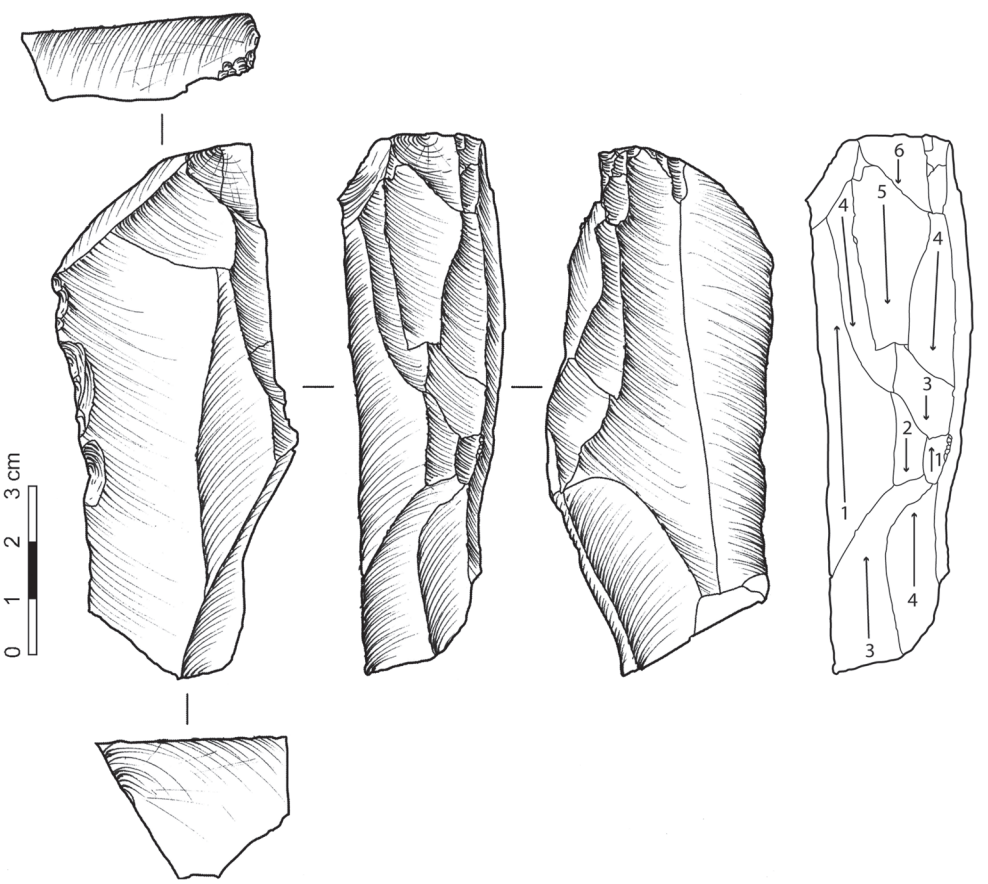


Figure 138: UK1-1, OH5.4-5.5, YK-86-619-6

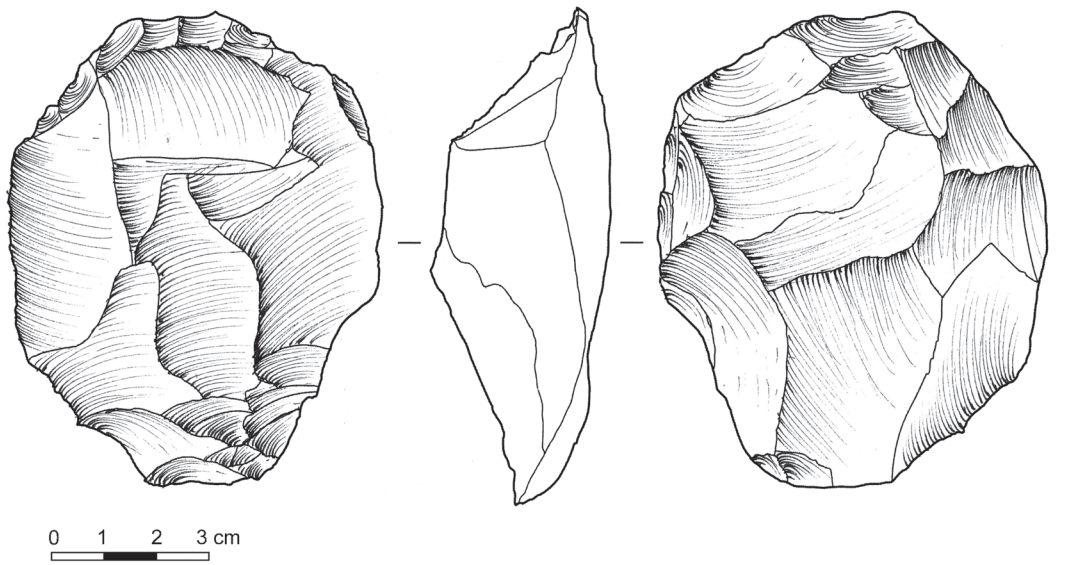


Figure 139: UK1-1, OH5.4-5.5, YK-86-625-1

Flake core (N=1)

∗ YK-86-625-1

A single Levallois flake core is associated with the sample. It shows a flat broad flaking surface opposed to a convex back shaped by radial flaking. The reduction seems to correspond to a bidirectional pattern, with blanks struck from two opposed platforms. This core show a strict surface treatment and no part of the narrow face has been used as flaking surface.

3.9.3 REDUCTION SEQUENCE RECONSTRUCTION

Following the result of the blank attribute analysis and the core descriptions, an analytical reconstruction of the individual reduction sequences is proposed in the following section.

Laminar blanks with parallel edges

Two main categories of blade can be recognized among the sample: parallel and convergent edge blanks. The first one is described as blades with parallel edges. These blades have a straight or slightly curved profile, show a roughly equal unidirectional and bidirectional patterning, and have a triangular or trapezoidal section. Some of these blades are relatively massive and the maximum length observed in the sample is 130 mm. Crested elements of various sizes testify of the initiation of the reduction, but also to core management in the course of the reduction (neocrest). Then the reduction starts by removing a blank that follows a natural edge, guiding the detachment of elongated blanks. Mode A core reduction starts from cortical blocks or nodules from which a striking platform is prepared by the removal of a large flake. Mode A1 cores are unidirectional, although they present clear traces of preparation of an opposed platform. The observed removal negatives indicate that the blanks produced are medium/large

blades with parallel edges. Mode A6 cores illustrate a more advanced stage of reduction. They clearly show the use of two flaking surfaces, the main one being located on a broad face of the nodule and the second one being located on a narrow face. The main pattern of reduction is bidirectional, using two opposed striking platform with short sequences of two-three unidirectional removals followed by a platform switch. As illustred on Figure 134, the removal of a blank from the intersection of the broad and the narrow face occurs frequently in the course of the reduction. This type of blank is generally thick (Figure 140) and is either guided by a previous scar or by the shaping of a postero-lateral or antero-lateral crest. As the use of the narrow flaking surface is embedded in the reduction of the broad surface, it is assumed that it plays a role in the management of the core, allowing a certain control on the convexity of the main flaking surface. This idea is reinforced by the fact that at the end of the core reduction, numerous attempts are made to remove such a thick blank to resume the reduction process. It seems that mostly one narrow face is used in combination with the broad face; however, the preparation of the second narrow face may occur in order to keep the reduction going.

Two of the thickest management blades (over 30 mm thick) have been subsequently transformed into Mode B cores. Core blanks are visibly snapped at both ends, snapped surface being prepared by flake removals. Another variant is the use of a truncation, which implies a preparation of the platform by facetting. Mode B cores show the use of a narrow face of the blade blank as a flaking surface. First removals then follow natural scars or edges, sometimes prepared as a crest by discontinuous retouch. The back of the core (core blank edge opposed to the flaking surface) is sometimes modified by retouch. The reduction is bidirectional, with two opposed platforms using the same flaking surface. The flaking surface is considered as a whole, as complete removals cover the entire length of the surface.

Mode B cores have a more constrained distribution of the flaking surface width than do Mode A cores. This is due to the fact that Mode B flaking surfaces are located only on the narrow edge of a blade,



Figure 140: UK1-1, OH5.4-5.5, YK-86/-378-1-633-2, refit of a thick side-blade with parallel edges

sometimes slightly extending on the broad face (B7). The maximal width of the flaking surface reflects the thickness of the blade blank. Mode A cores have a more variable flaking surface width, between 75 (early stages of reduction) and 40 mm (reduced blade cores). The single example of a narrow flaking surface core shows a Mode B core reduction strategy applied to a cortical flake and testifies to occasional production of narrow blanks.

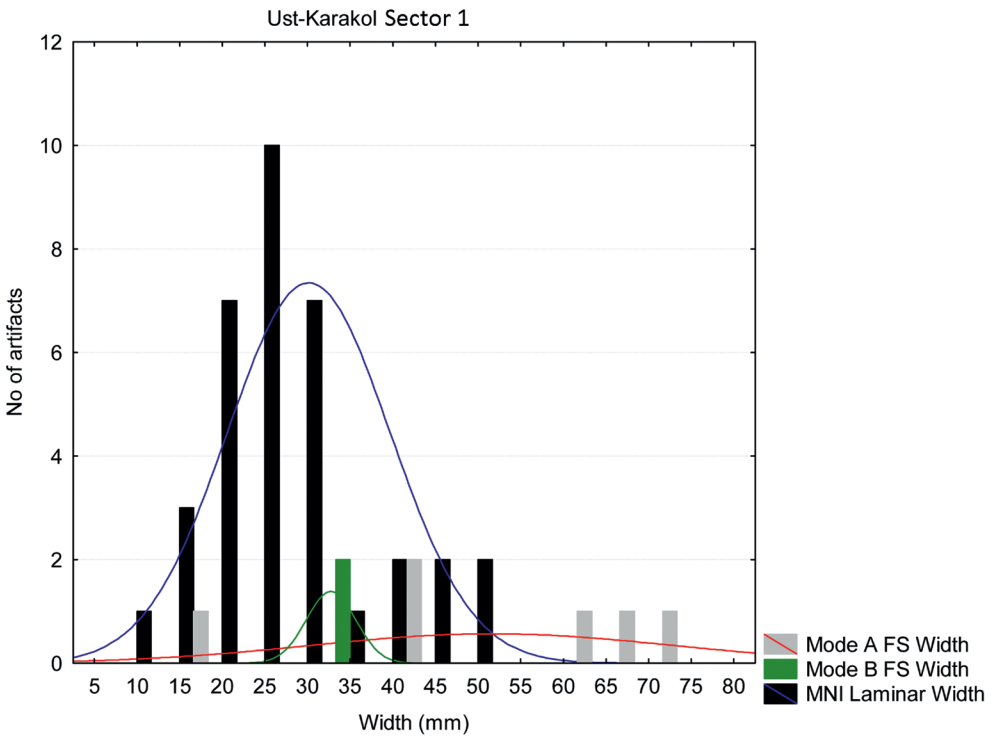


Figure 141: UK1-1, OH5.4-5.5, YK-86/-378-1-633-2, core flaking surface and MNI width distributions

The size of the blanks produced by Mode B cores overlaps with the blanks detached from Mode A cores during the advanced stages of reduction (Figure 141). However, some of them with a natural back (N=3) may testify to a detachment from the narrow face of a core. The widths range between 12 and 24 mm, and they all display a bidirectional dorsal patterning. The flaking surface length of Mode A and is comparable with the two Mode B cores, with a maximum length around 95 mm.

Convergent blanks

A second type of laminar blank showing convergent mesiodistal edges is attested to (N=4) (Figure 142, Figure 143). Two blanks are mesioproximal, one is proximal and one is a mesial fragment. One is bidirectional, two are unidirectional and one has an undetermined dorsal patterning. They all show trapezoidal sections and their profiles are curved or slightly curved. Their widths range between 24 and 56 mm, and they have a maximum thickness around 16 mm. This platform size does not differ from the variability observed on the overall blade sample, although it is notable that one of the two facetted platforms is *débordant* and represents the thickest recorded in the sample. The other facetted platform shows a partial faceting by marginal perpendicular flake removals.

It is assumed that these blanks are produced from a Mode A type of core, which displays a flaking surface wide enough and shows traces of three unidirectional sub-convergent removals or three bidirectional removals. Bidirectionality makes it easier to obtain pointed blanks from a broad surface whereas unidirectionality requires a convergence of the removals or a distal shaping of the core. Such a convergent orientation is unusual in the studied sample.



Figure 142: UK1-1, OH5.4-5.5, YK-86/D7-683-9, convergent blank with partial faceting platform preparation



Figure 143: UK1-1, OH5.4-5.5, YK-86/713-6, convergent blank

Platform preparation and percussion technique

No clear traces of abrasion have been observed in the sample, with the exception of a strong abrasion that smooths the external ridge of the platform (N=5). About 40% (N=14) of the MNI shows a macroscopic lip, and a single case of flaking on the bulb is observed combined with a lip. Lips occasionally occur in combination with extreme abrasion (N=4). Among the facetted platforms, some artifacts show only a partial faceting of the external edge and are flaked from a flat surface. All types of platforms show a mean thickness greater than 4 mm. Considering all these elements, the use of organic hammer seems unlikely. However, some features (extreme abrasion, lip, flaking of the bulb) may indicate the occasional use of a soft-stone hammer combined with a hard hammer.

Retouched tools

The main categories of retouched tools included here only tools on laminar elements. The three tools classified as others are one bifacial leaf-point on an undetermined blank, one sidescraper on slab and one sidescraper on laminar flake.

	N	*f* (among tools)	*f* (on total)
Retouched blade	15	83%	19%
Retouched bladelet	0	0%	0%
Retouched point	0	0%	0%
Endscraper	0	0%	0%
Other	3	17%	4%
	18	100%	23%

Table 99: UK1-1, OH5.4-5.5, composition of the retouched tool kit

The breakage pattern shows a majority of mesioproximal artifacts followed by mesial ones. Proximal and mesiodistal frequencies are low. The main differences between the unretouched and the retouched blanks is that mesioproximal fragments occur in a slightly higher frequency, and the mesial elements are less numerous. These variations are, however, not statistically significant.

	N	*f*
Distal	0	0%
Mesiodistal	2	11%
Mesial	4	22%
Mesioproximal	8	44%
Proximal	1	6%
Complete	3	17%
	18	100%

Table 100: UK1-1, OH5.4-5.5, tool breakage

The distribution of tool widths seems to indicate that, even after the retouch, tools are still wider than the overall blank population. This difference is statistically significant (Mann-Whitney, T=Ub=261, p=<.05). The single leaf-point on a blade has a width of 31 mm, which after retouch falls near the mean width of the blank production. The second leaf-point is 37 mm wide and falls near the mean width of the tools, and the sidescraper has a 41 mm width that roughly equals the mean width of the tools. Even when leaving out the two bifacial elements which are not on blade blanks, the difference between tool and blank width remains significant (Mann-Whitney, T=Ub=245, p=<.05).

The tool thickness distribution shows a similar picture, with a significant difference between tools and blanks (Mann-Whitney, T=Ub=250, p=<.05). The leaf-point on blade falls in the range of thickness of the blanks, with a thickness of 12 mm, the second leaf-point is 14.6 mm thick and falls in the mean thickness of the tool category, and the side-

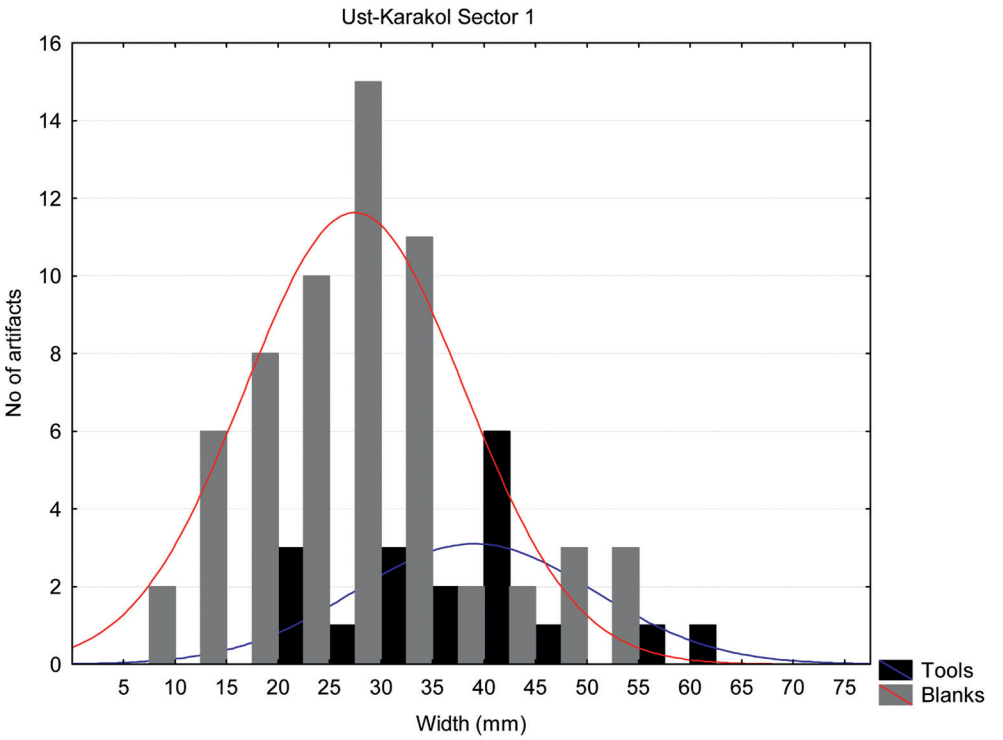


Figure 144: UK1-1, OH5.4-5.5, retouched tool and blank width distributions

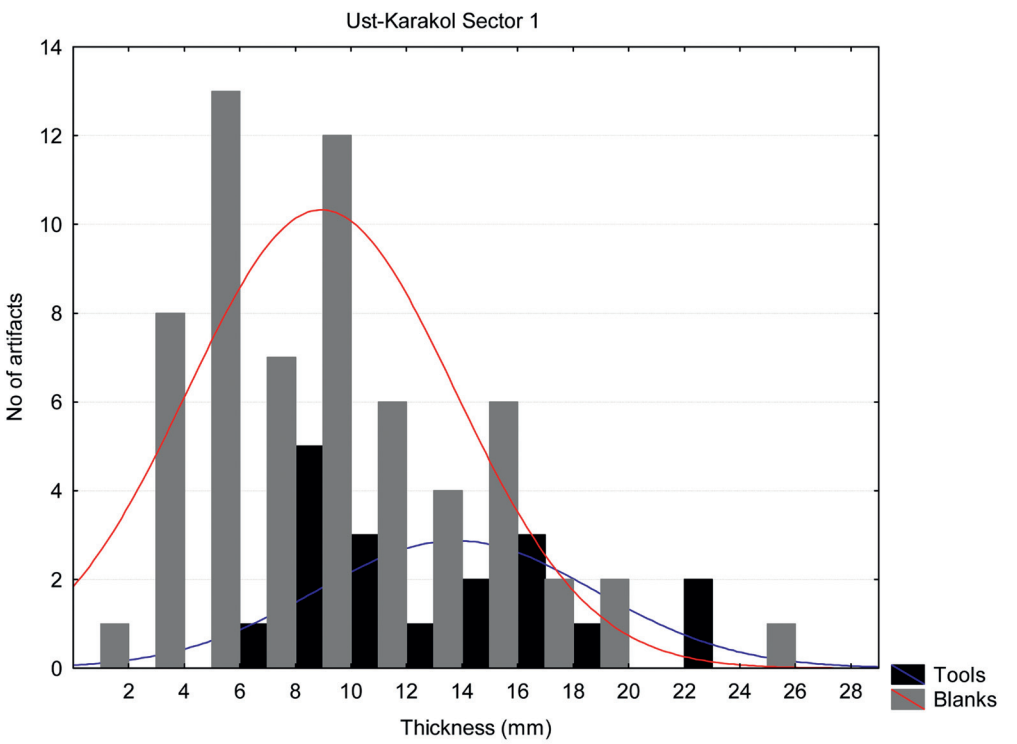


Figure 145: UK1-1, OH5.4-5.5, retouched tool and blank thickness distributions

scraper appears as one of the thickest tools with a thickness of 24 mm. When ignoring the leaf-points and the sidescraper which are not on blade blanks, the difference between the tool and the blank categories remains significant (Mann-Whitney, T=Ub=241, p=<.05), indicating that the tools tend to be thicker than the unretouched blanks.

Dorsal scar patterns indicate that most of the tool blanks are bidirectional and that a few crested elements are retouched. These results contrast with the observations made on the blank total sample; however, frequencies do not differ significantly. When comparing the tool patterning with the complete blanks, the results are in good agreement.

	N	*f*
Unidirectional	3	17%
Unidirectional and cortex	1	6%
Bidirectional	9	50%
Bidirectional and cortex	0	0%
Crest	0	0%
Second Crest	2	11%
Neo-crest	0	0%
Undet	3	17%
	18	100%

Table 101: UK1-1, OH5.4-5.5, tool dorsal pattern

Platform preparations are mainly undetermined partly due to the concretion covering some artifacts, and among the five observable cases the three different types of platforms occur. The mean platform thickness (N=5) is 4.8 ± 2.1 mm and the mean width is 14.4 ± 6.6 mm. The differences in platform thickness medians between the blanks and the tools appears not significant (Mann-Whitney, T=Ub=68, p=.43); however, the reduced sample of tool platforms makes the risk of type II error rather high.

	N	*f*
Plain	1	9%
Facetted	3	27%
Dihedral Flat	1	9%
Undetermined	6	55%
	11	100%

Table 102: UK1-1, OH5.4-5.5, tool platform preparation

The cross-sections are mostly trapezoidal (N=10), triangular (N=4) and polyhedral (N=4). The polyhedral category includes the leaf-points and the sidescraper. Tools are mainly axial (N=8) and undetermined (N=8) and generally display a straight profile (N=12).

Retouch is mainly direct, however, inverse retouch is well represented. Alternate retouch corresponds to a bifacial treatment, including two leaf-points and a sidescrpaer with bifacial retouch.

	N	*f*
Direct	9	50%
Inverse	6	33%
Alternate	3	17%
	18	100%

Table 103: UK1-1, OH5.4-5.5, tool retouch location (face)

Direct retouch is located on different parts of the blanks without any clear pattern is may be due to fragmentation and to a relatively reduced sample. Three main categories are observed, with a majority of mesial and continuous retouch (including two bilateral ones). For the inverse retouch, a clear pattern is observed with more retouch located on the proximal end of the blank. One leaf-point produced on a blade blank is included, as the two others artifacts

	Dorsal		Ventral	
	N	*f*	N	*f*
Distal	0	0%	0	0%
Mesial	3	27%	1	13%
Proximal	2	18%	5	63%
Combination	1	9%	0	0%
Continuous	3	27%	0	0%
Undetermined	2	18%	2	25%
	11	100%	8	100%

Table 104: UK1-1, OH5.4-5.5, tool retouch location (edge)

with bifacial treatment are included in the undetermined category.

From a morphological point of view, some of the tools need to be described in detail. In the sample considered, three tools show bifacial retouch.

One of the bifacial tools is a mesioproximal fragment produced on a thick blade blank (Figure 146). The dorsal face shows extensive flat retouch which mostly hinged in the thick proximal part. The ventral face shows continuous flat retouch along both edges, but the proximal part is less retouched. Typologically, it can be compared with a Jerzmanowice point, even if



Figure 146: UK1-1, OH5.4-5.5, YK-86/443-12, leaf-point on blade blank



Figure 147: UK1-1, OH5.4-5.5, YK-86/369-8, atypical leaf-point

the ventral retouch on the latter is usually located on the proximal end (Flas, 2008).

One bifacial element is likely produced on block/slab or a large flake. It shows bifacial, invasive, flat retouch. Although this artifact is classified based on its general morphology as a bifacial leaf-point (*e.g.* Freund, 1952; Koslowski, 1990; Flas, 2008), it is atypical as the preserved end is not pointed and the section is rather thick. It could also be typed as a biface. Another artifact (Figure 148) is produced on a thick slab and shows bifacial invasive retouches



Figure 148: UK1-1, OH5.4-5.5, YK-86/622-9, sidescraper

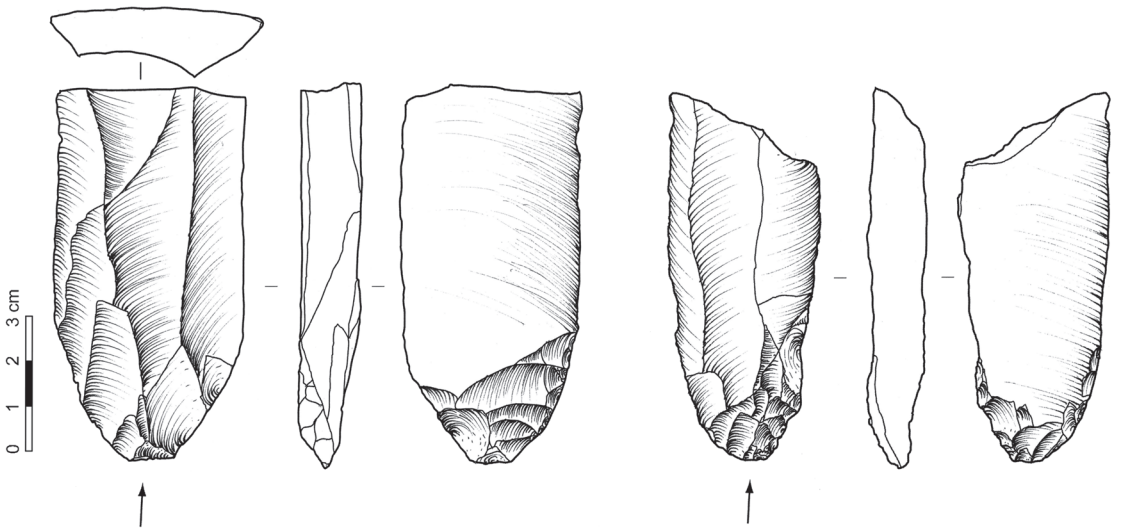


Figure 149: UK1-1, OH5.4-5.5, YK-86/B5-5-675-7 (left) and YK-86/392 (right), blades with basal thinning

along one edge, opposed to a natural back. This artifact is typed as a sidescraper.

In the sample, three blade fragments displaying proximal thinning have been identified (Figure 149). The blanks used are bidirectional blades with parallel edges bearing inverse flat retouch on their proximal end. One of them displays some direct proximal retouch similar to the Emireh point basal thinning (Garrod, 1955; Marks and Volkman, 1983; Volkman and Kaufman, 1983; Copeland, 2000). These tools can be typed as unifacial leaf points and are somewhat comparable with Jerzmanowice points, although the retouch is here not invasive (Flas, 2008).



Figure 150: UK1-1, OH5.4-5.5, YK-86/B7-719-12, large laminar flakes with inverse flat retouch

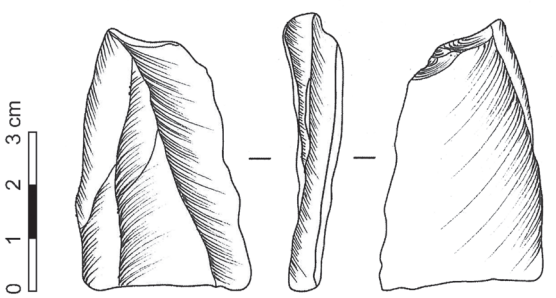


Figure 151: UK1-1, OH5.4-5.5, angle burin on oblique truncation

One of the tools is produced on a wide overshot laminar flake which bears some discontinuous direct retouch on the proximal end and along the left edge (Figure 150). The ventral side displays proximal scalar retouch and continuous and invasive flat retouch extending along the right edge. The left edge shows continuous retouch flat retouch. It can be typed as a bifacial sidescraper.

A tool is produced on proximal fragment of a bidirectional blade (Figure 151). It displays a truncation on its proximal end and a two lamellar removals slightly extending toward the ventral face. This tool can be typed as an angle burin on an oblique truncation. Some tertiary modifications of the burin edge can be observed and therefore can also be typed as a modified burin on a truncation (Demars and Laurent, 1992). Due to the reduced number of burin spall removals and to its general morphology, this burin cannot be typed as a Bassaler burin or classified as a core.

4 – The Ust-Karakol Upper Paleolithic variant

4.1 THE UST-KARAKOL AND ANUY SITES

In this chapter, assemblages attributed in the literature to the Ust-Karakol variant (see *e.g.* Derevianko and Shunkov, 2005) are described. These assemblages are mainly Ust-Karakol 1 sector 1 OH5.1-5.3 and sector 2 strata 11-8, Anuy II OH11 and OH12, and Anuy III stratum 12. Given that no specific taphonomic studies have been undertaken on this material, the present study focuses on artifacts that are recognized as typical of these assemblages and absent from the Kara-Bom variant. These are mainly bladelet and microblade cores. The main characteristics of the blade production are also described. Due to sample size and to taphonomic issues, the approach is here mainly qualitative, although some quantitative data are used to support some specific observations.

4.1.1 UK1-1 OH 5.1-5.3

UK1-1 has yielded assemblages that were previously attributed to the 'cultural level 3' of the lithological unit 5 (Derevianko *et al.*, 1987). Following the results of the taphonomic analysis presented in the previous chapter, cultural level 3 has been divided in five distinct Occupation Horizons (OH 5.1 to 5.5) on the basis of the artifact distribution (see also Slavinsky, 2007). OH5.1 to 5.3 have yielded small assemblages (N= circa 300). These three assemblages are similar to each other as they include a series of bladelet and microblade cores (Figure 152). The features observed on these pieces are in contrast with the material from OH5.4 and OH5.5.

As indicated by preforms and by the cortex on some of the pieces (Figure 152: 2, 4), bladelet and microblade core blanks are mainly small pebbles or slabs of metamorphic material. These pebbles are likely collected in the nearby Anuy river bed (Postnov *et al.*, 2000; Derevianko, Postnov, and Kulik, 2004; Anoikin and Postnov, 2005). Most of them are Mode A9 cores, with a flaking surface located on a narrow face and extending on the broad faces (semi-turning) with unidirectional scars. Some cores show a second flaking surface, roughly perpendicular to the other one and corresponding to Mode A8 type of cores (Figure 152: 3, 4). Striking platforms are cortical or reshaped by frontal, radial and sub-radial tablet removals with only rare traces of abrasion preserved on their external edges. These elements indicate that although the reduction sequence is likely oriented toward the production of microblades, starting from small pebbles, striking platform management and orientation changes lead to relatively exhausted cores.

The blade production is not well documented in these assemblages mainly due to the absence of cores. However, as indicated in previous reports, the assemblage lacks bladelet and microblades. The small size of the negatives on the cores suggests that these elements would be underrepresented in the assemblage unless sediments are screened with a 2 mm mesch.

4.1.2 UK1-2

The assemblage of UK1-2, strata 11-8 are subject to taphonomic issues and the integrity of the levels is questionable. If some of the unpublished refits come from a single level, others clearly indicate vertical movement between levels and admixture from the underlying levels (see Chapters 3 and 5). In this study, strata 11-8 are therefore considered together. In spite of these issues, UK1-2 strata 11-8 show specificities that are worth mentioning, as analogies can be found in the neighboring sites. A qualitative evaluation of the laminar technology is proposed

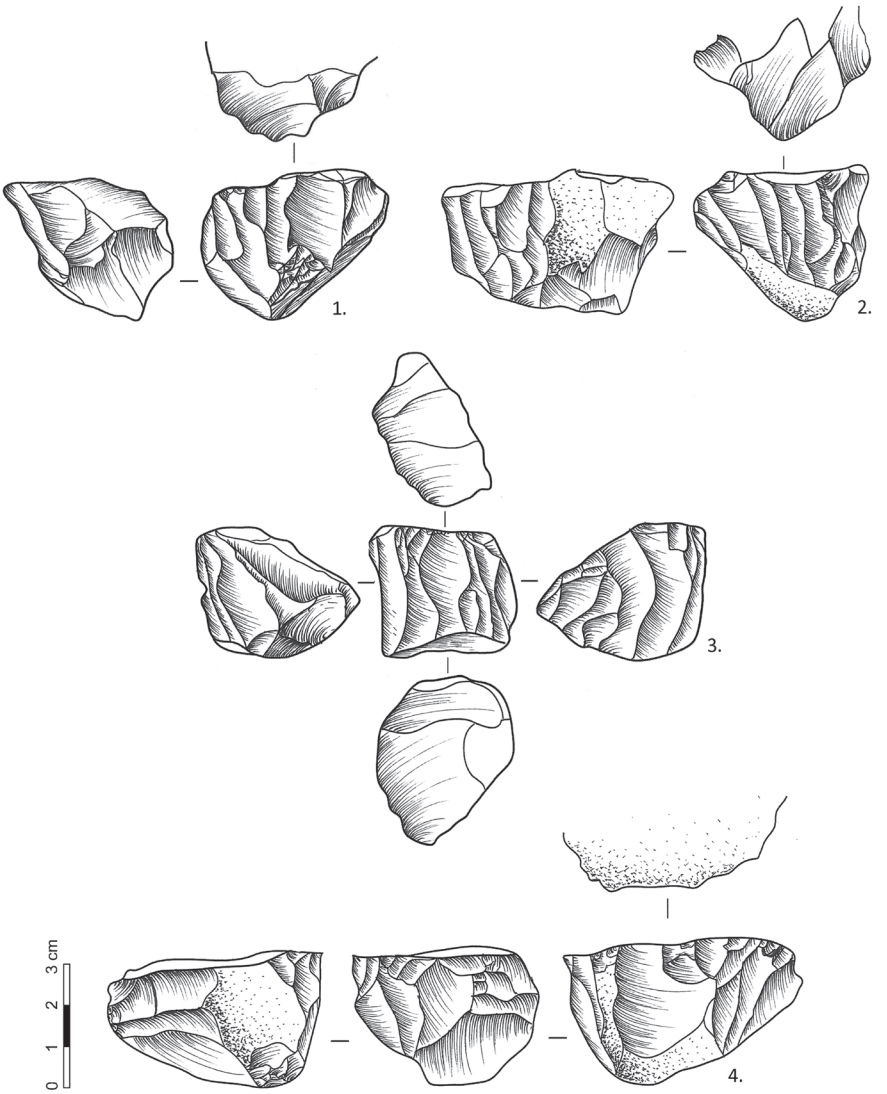


Figure 152: UK1-1, OH5.1-5.3, bladelet and microblade cores

here based on a sample of 195 blanks (105 blades, 67 bladelets, 7 microblades, 16 laminar flakes), 30 retouched blanks (25 blades and 5 bladelets) and 33 cores and preforms.

A series of bladelet and microblade cores is among the most diagnostic feature of this assemblage. Most of these cores are of Mode A type as they are produced on small blocks, slabs and pebbles of metamorphic rock. The main modes observed are Mode A1 (Figure 153: 1, 2, 8), A9 (Figure 153: 4) and A8 (Figure 153: 5-7). The reduction is mainly unidirectional following a frontal or a semi-turning path that starts from a narrow edge of the blank. Reduction is mainly convergent and takes place on a triangular flaking surface. Mode A8 shows orientation changes through the use of a separate flaking surface located on a narrow edge of the core. The negatives clearly indicate that those surfaces are used one after the other in a rather opportunistic fashion, according to suitable angles and convexities offered by the core morphology. Crests are used to initialize the reduc-

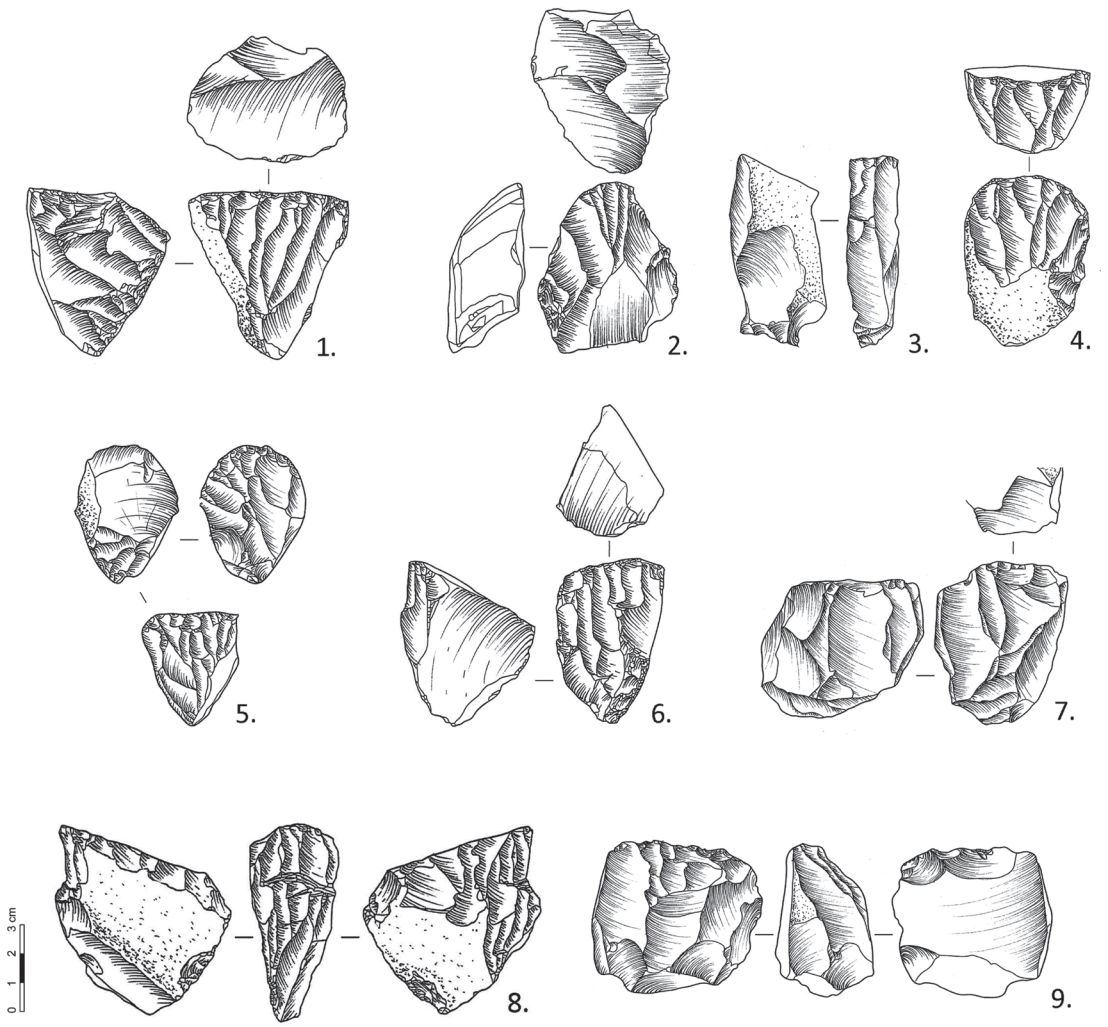


Figure 153: UK1-2, strata 11-8, bladelet and microblade cores (redrawn and modified after Derevianko *et al.*, 2003)

tion process (Figure 154: 12) and management operations are visible on the cores (tablet removals, distal crest) and are also documented by the occurrence of technical blanks. In cases of hinged factures, small blades are used for reshaping the flaking surface. Convexities are shaped by the removal of lateral flake at the corner between the flaking surface and the side of the core (Figure 154: 9, 11), or by the preparation of a crest at the back of the core. Bladelet overshots are occasionally used in order to keep the flaking surface triangular (Figure 153: 1). Striking platforms are cortical, plain or on natural surfaces and are sometimes reshaped by tablet removals. Some of the external edges of the striking platforms still bear traces of abrasion. The reduction of these cores is well documented in the assemblage, from the preform to the exhausted core. Beside this mainstream production, a single Mode A4 core (Figure 153: 9) and two examples of Mode B cores (Figure 153: 3) occurs in the sample. The Mode A4 core can be typed as a truncated-facetted piece. One Mode B cores is produced on a thick cortical blade and show unidirectional removal, and the second one is extremely reduced and produced on a jasper-like material.

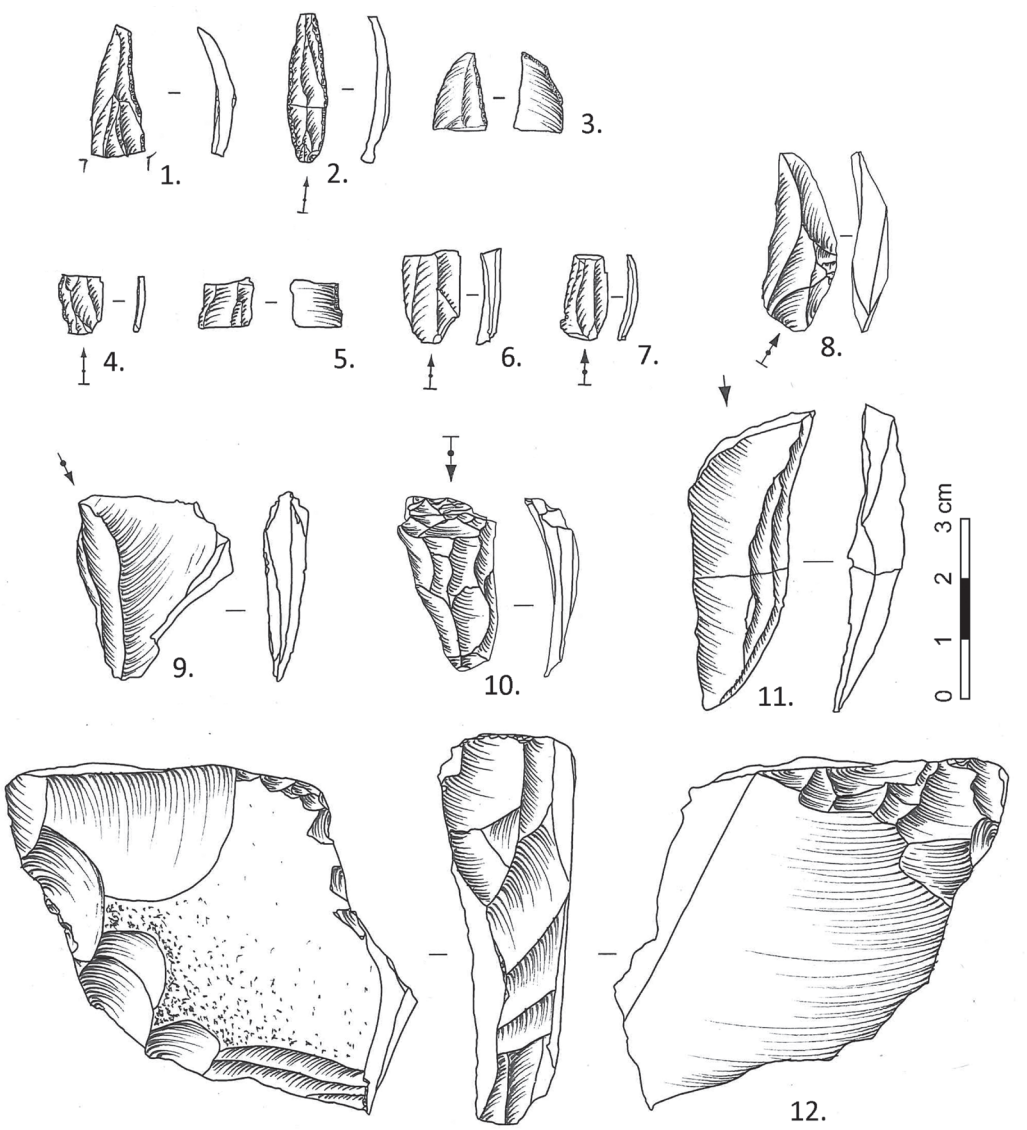


Figure 154: UK1-2, strata 11-8, retouched blanks (1-5), unretouched blanks (6-8), technical pieces (9-11) and core preform (12)

The bladelet and microblade blanks are generally highly fragmented (on a sample of 79, there are only 8 complete, 30 proximal, 15 mesioproximal, 19 mesial, 6 mesio distal and 1 distal). For the most part, the dorsal scar patterns on small segments could not be determined. All determined patterns are unidirectional (N=23). Blanks observed are relatively poorly standardized. The majority have a plain platform associated with a thin abrasion of the external ridge and with a lip (N=42). A few blanks have a punctiform platform (N=5). Profiles are mainly straight (N=41) or slightly curved (N=17) and sections are trapezoidal or triangular. Five of the blanks are retouched (Figure 154). A proximal and a mesiodistal fragment bear a direct, thin, continuous retouch respectively on the left and right edge. A mesial fragment shows inverse retouch on the left edge and can be typed as a fragment of Dufour bladelet, though classical Dufour bladelets usually bear inverse retouch along their right edge. A distal fragment of bladelet/blade

displays alternate, thin retouch. Although the shape of the complete blank is unknown, its section is unusually thick (3.6 mm). The most complete retouched bladelet is a pointed unidirectional blank, with a curved profile, bearing bilateral thin to semi-steep retouch. Although being rather small, this retouched piece is comparable to Font-Yves, Krems, El-wad or Arjeneh point types (*e.g.* Garrod, 1957; Hole and Flannery, 1967; Demars and Laurent, 1992).

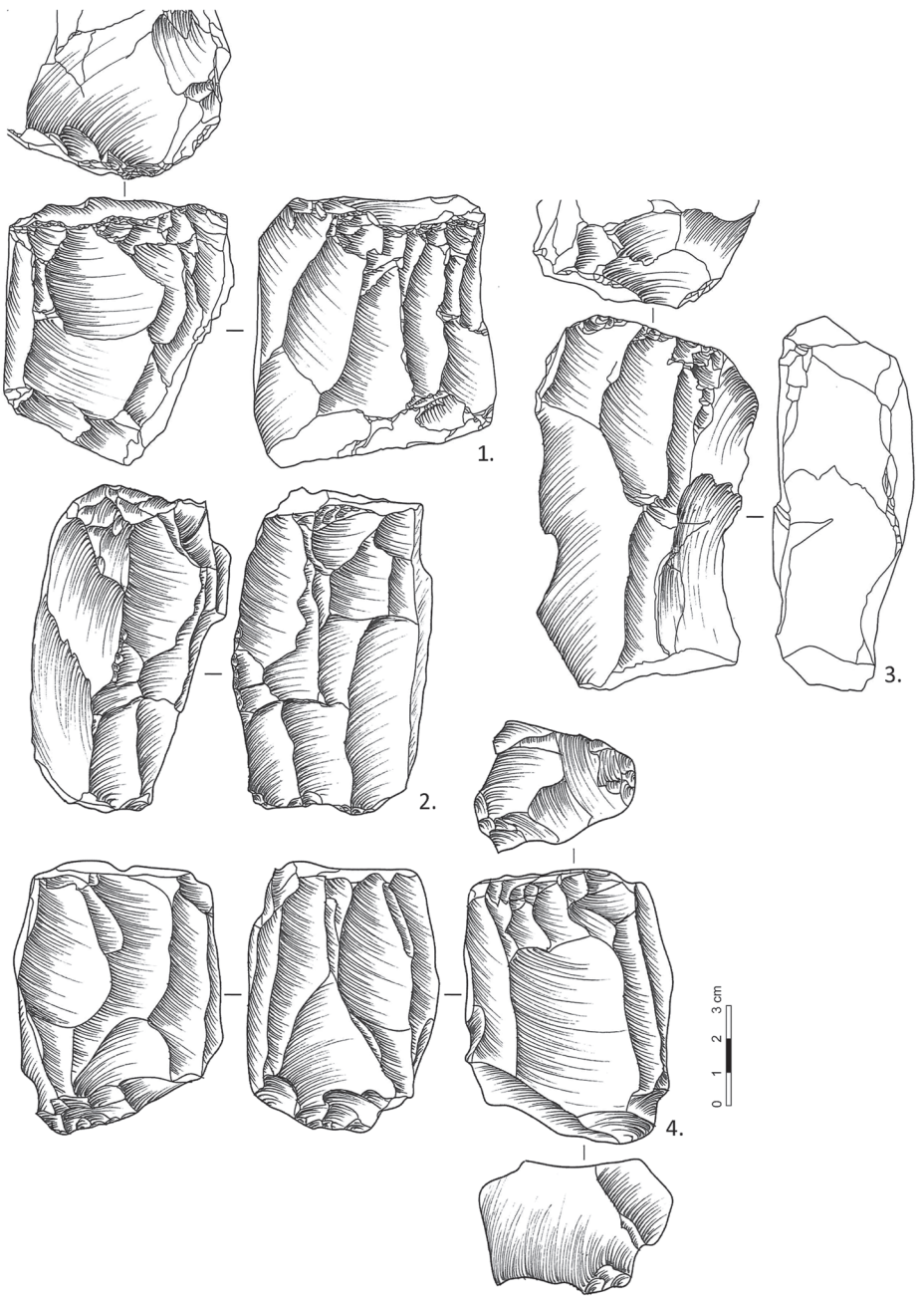


Figure 155: UK1-2, strata 11-8, blade cores (redrawn and modified after Derevianko *et al.*, 2003)

Some general observations can be proposed regarding the blade production. Blade cores are mainly produced on blocks of metamorphic material. They show a certain degree of morphological variability, and include Mode A3 (Figure 155: 1), A4 (Figure 155: 2, 3) and A10 (Figure 155: 4) core types. Some of the cores show a clear unidirectional patterning, even though they may display attempted platform switches at the end of the reduction. Some others show a clear bidirectional patterning with a reduction from two opposed platforms on a wide surface. Cores display frequent exploitation of a wide face, only occasionally extending on one or two lateral surfaces. This observation is, however, balanced by the cubic shape of some of the cores, indicating a rather advanced reduction process. Most of the blade cores show negatives of blanks with parallel edges, with one of them testifying of the production of convergent blanks (Figure 156). Striking platforms show frequent tablet removals and occasional abrasion of the external edge.

Blades are mostly fragmented (28 proximal, 22 mesioproximal, 25 mesial, 14 mesiodistal, 1 distal) with only 13 complete blanks among 104 artifacts. Except for 4 bidirectional and 17 undetermined, the dorsal patterning is mostly unidirectional, with 84 artifacts. 14 cortical blanks are identified, 4 blanks have less than 20% cortex, 4 blanks display 20 to 40% cortex and 6 have 40 to 60% cortex. Crested elements are present but poorly documented (N=3); however, side blades (N=9) show flaking surface management by using cortical edges (N=4) and natural crests. Platforms are mainly plain (N=45) but also facetted (N=12). Although it is not possible to determine with certitude the modes of percussion in use, diagnostic features (small size platforms, abrasion, lip) seem to mostly indicate the use of organic hammer. Other features (facetted and thick platforms, thick bulbs, scaled bulbs) in the assemblage, however, could also indicate the use of stone hammer. The use of hard hammer is definitely recognizable on some of the flakes and laminar flakes. From a more general point

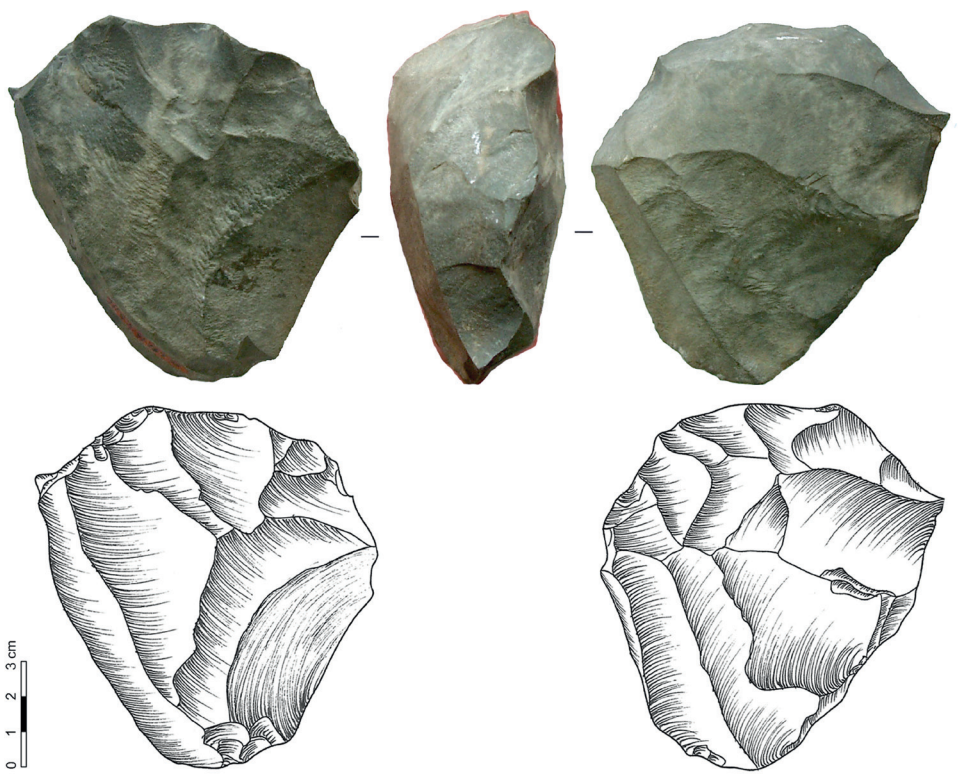


Figure 156: UK1-2, strata 11-8, blade core

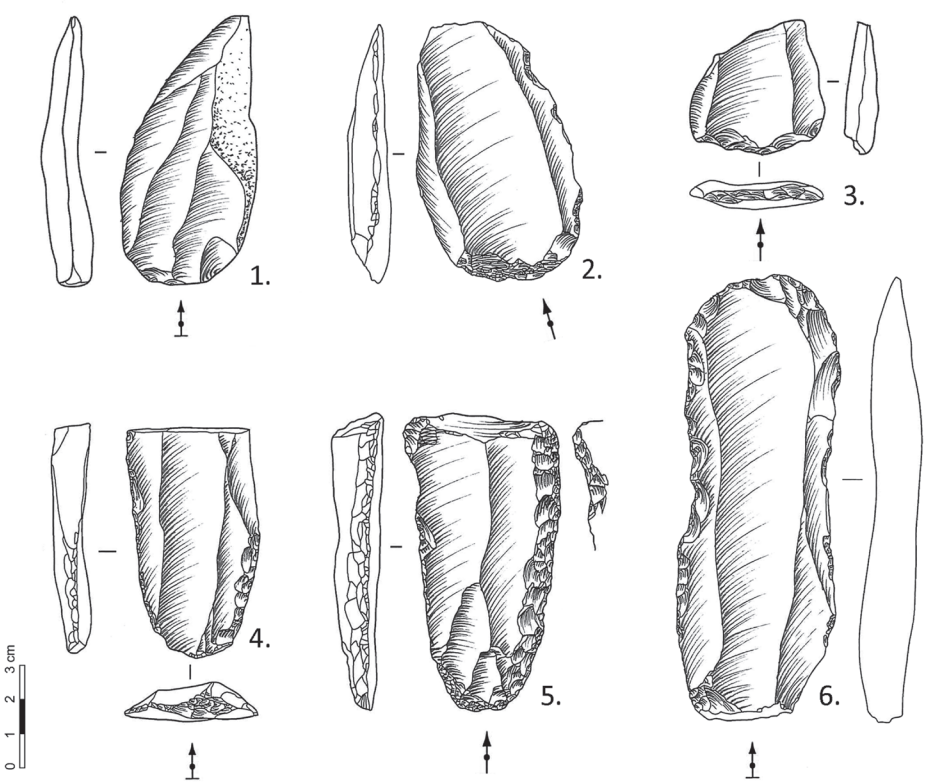


Figure 157: UK1-2, strata 11-8, convergent blanks (1-3), retouched blanks with parallel edges (4-6) (redrawn after Derevianko *et al.*, 2003)

of view, blades show mainly parallel edges, as convergent blanks are mainly flakes and laminar flakes (Figure 157: 1-3).

A few retouched blades are cortical (N=4). The rest of them show mainly unidirectional dorsal patterning (Figure 157: 46). Among the 25 retouched blanks, 8 endscrapers are identified, one of which is produced on a cortical crested blade showing some proximal burin removals. Notable is the occurrence of a fragment of a backed blade and a mesiodistal fragment of a bifacial piece likely produced on a blade blank. A fragment of leafpoint occurs in stratum 11 (Derevianko *et al.*, 2003, Fig. 154, num. 15). Most common types of retouch are thin and scaled, which are sometimes combined on the same piece. One artifact is typed here as a core-like tool as it shows lamellar removals on the distal end of a neocrested blade.

All in all, the UK1-2 assemblage is recognizable mainly in terms of bladelet and microblade production. The blade production is difficult to categorize given the taphonomic issues discussed above. It seems that different features coexist and some elements such as convergent blade cores and blanks, facetted platforms, bidirectional flat-faced cores, and occasional Mode B cores can be found in low frequency. This specific issue will be treated in the forthcoming Chapters.

4.1.3 ANUY II

Located along the right bank of the eponymous Anuy River, about 70 m downslope from Denisova Cave, the site of Anuy II was excavated starting from 1988. During the first campaign, excavations were carried out over a surface of 35 m² and revealed the presence of Paleolithic artifacts. Further excavations were

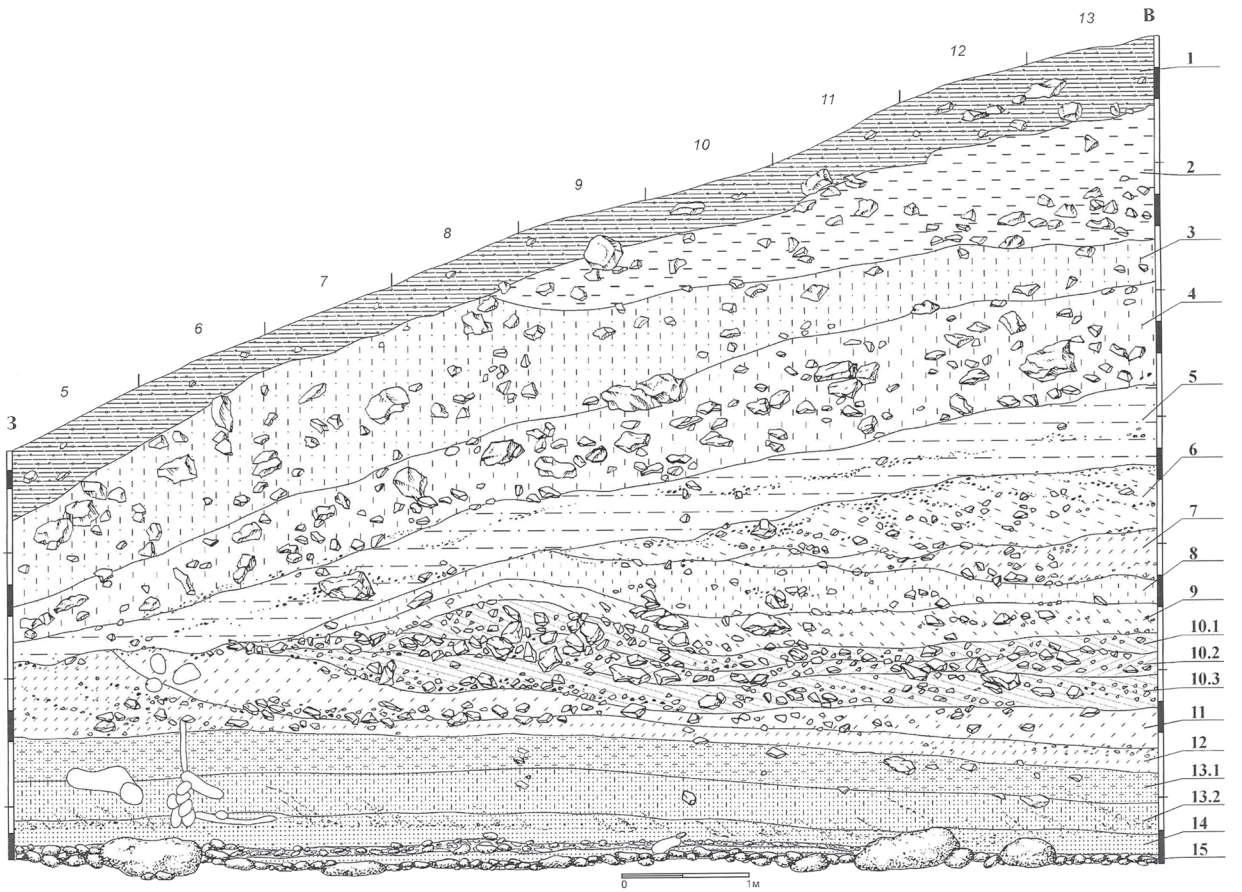


Figure 158: Anuy II, northern section (after Derevianko *et al.*, 2003)

conducted in 1990-1991, extending the excavated area to 79 m² (Derevianko, Markin, *et al.*, 2001). The 6.5 m stratigraphic section is divided into 15 lithostratigraphic units (Figure 158).

The bottom of the section (stratum 15) is composed of rounded river pebbles, rising about 3.5 m from the modern river surface and is covered by laminated alluvial sands (stratum 14). A thick layer of sandy-loam is then sub-divided in two sub-strata (13.2 and 13.1), respectively described as homogenous sandy-loam with thin gravels and as darker laminated sediments with traces of humus and charcoal. The middle part of the section (stratum 12-6) is characterized by a dark brown loam sediment matrix with the occurrence of laminated structures but containing coarse gravels and blocks. The geometry of the deposit indicates that the deposition of the stratum 11 affected deeply the underlying stratum 12, a mechanism of deposition that repeated with the stratum 10. The middle part of the section is truncated by the deposition of a thick and dense loam layer (stratum 5). The overlying strata are described as coarse gravels and blocks in a loam matrix (stratum 3 and 4), loess-like loam (stratum 2) and modern humic cover (stratum 1).

Archeological material is grouped by Occupation Horizons (OH) which are mainly located in the lower part of the section. The correlation between OH and lithostratigraphic strata is summarized in Table 105.

OH are said to be minimally 10 cm thick and separated by sterile horizons (Derevianko, Markin, *et al.*, 2001). Combustion features have been detected in

Stratum	OH
8	1
9	2
10.1	3
10.2	4
10.3	5
11 upper	6
11 lower	7
12	8
13.1 upper	9
13.1 lower	10
13.2 upper	11
13.2 lower	12

Table 105: Anuy II, correlation between lithostratigraphic strata and occupation horizons (OH)

various states of conservation. The most convincing features are ash lenses of circa 15 cm deep located in shallow depressions associated with OH12 (Derevianko *et al.*, 2003: Fig. 173). This evidence is interpreted as 'fire places' and has been use to infer the 'in situ' character of the layers (Derevianko *et al.*, 2003).

Conventional radiocarbon dates obtained from strata 13 to 10 and indicate ages ranging from 28 ka to 20.5 ka (Table 106) (Orlova, 1995; Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998).

Palynological studies conducted by Malaeva suggest a succession of two main alternating flora spectra (Malaeva, 1995; Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998; Derevianko, Markin, *et al.*, 2001; Derevianko *et al.*, 2003). The first is characterized by the dominance of birch pollen and pine-tree pollen and suggests a rather dry climate (strata 15-13; 9-7; 4-lower; 3). The second shows a dominance of dark coniferous taxa and is interpreted as reflecting damp conditions. This succession is observed throughout the whole sequence up to 1 m below the surface. Fauna are poorly preserved and only 9 specimens out of 560 have been attributed to a species. Fauna identified consist of a Bison sp. tooth fragment from stratum 13 and small mammals *(Asiscalops sp., Citellus sp., Microtinae gen., Myospalax sp)* similar to the current Altaic fauna were found in stratum 13 to 11. A shell fragment of *Bivalvia* is associated with stratum 13.

Stratum	Sample	Radiocarbon (^{14}C BP)	Lab number
10.1 (OH3)	Charcoal	21,280 ± 440	SOAN-3007
10.2 (OH4)	Charcoal	21,502 ± 584	IGAN-1431
11 (OH6)	Charcoal	21,502 ± 1,547	IGAN-1430
12 (OH8)	Charcoal	20,350 ± 290	SOAN-2863
12 (OH8)	Charcoal	22,610 ± 140	SOAN-2862
12 (OH8)	Charcoal	24,205 ± 420	SOAN-3006
13.1 (OH9)	Charcoal	27,125 ± 780	SOAN-2868
13.2 (OH12)	Charcoal	26,810 ± 290	SOAN-3005
13.2 (OH12)	Humates	27,930 ± 1,594	IGAN-1425

Table 106: Anuy II, chronological data

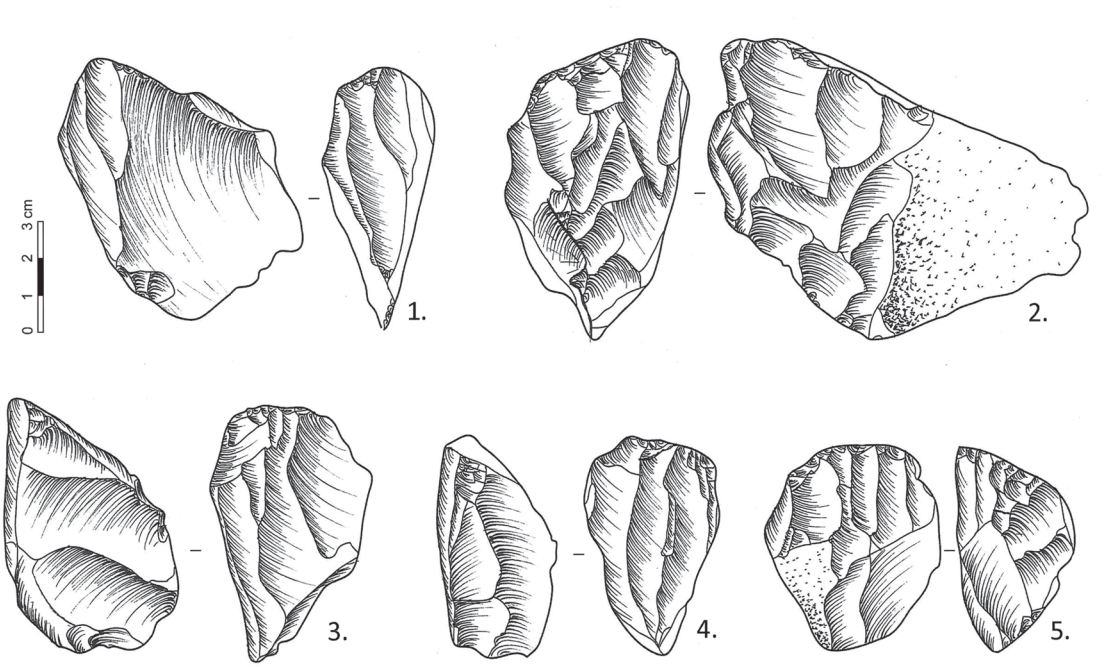


Figure 159: Anuy II, OH8 (3, 5), OH9 (4), OH10 (2), small blade/bladelet cores (redrawn after Derevianko *et al.*, 2003)

99 % of the 15000 artifacts from Anuy II are associated with OH6-12. Based on their typo-technological similarities, the OHs are considered by authors as belonging to a single techno-complex (Derevianko, Markin, *et al.*, 2001). The raw material is mainly collected in the nearby Anuy river bed and shows a majority of metamorphic rocks (Postnov *et al.*, 2000; Derevianko, Postnov, and Kulik, 2004; Anoikin and Postnov, 2005). The main characters of the laminar reduction sequences are summarized below.

The production of small blade, bladelet and microblade blanks is attested to mainly by the occurrence of a series of cores and by a few retouched blanks.

Among the bladelet cores, Mode A1 (Figure 159: 1-4), A3 (Figure 159: 5) and A8 (Figure 159) are the most common. Mode A1 show a flaking surface located on a narrow edge of a thick flake with unidirectional convergent removals. The flaking surface maintains a triangular shape by the production of a crest (Figure 159: 2), by keeping a convergent orientation to the removals (Figure 159: 1), or by the removal of lateral laminar flakes from the striking platform or from an inverse provisionary platform (Figure 159: 4; see also Derevianko *et al.*, 2003, Fig. 178). Some of these cores display a crested back which illustrates a management of the flaking surface convexities (Figure 159: 3). Striking platforms are plain, and their external edges show the remains of a thin abrasion. The general morphology of these cores is prismatic and testifies of a genuine volumetric laminar reduction. Mode A3 have a flaking surface located on a broad face and bear unidirectional removal negatives. These cores also show traces of abrasion on the external edge of the striking platform. Although their general morphology is comparable to thick endscrapers carinated endscrapers (Demars and Laurent, 1992), genuine Mode A3 cores are rare. More common is the Mode A8 type core that shows a minimum of two reduction phases (Figure 160). It combines Mode A1 and A3 as it displays two separate flaking surfaces, located on the broad and the narrow face. It is usually not easy to distinguish the chronology of the two faces and removals from the broad face can also play a role in the management of convexities and flaking surface shape.

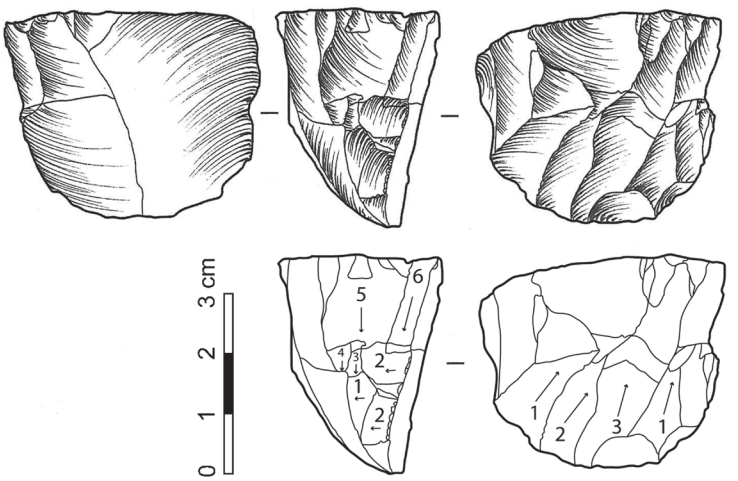


Figure 160: Anuy II, OH8, bladelet/microblade core

In addition, two atypical Mode B cores are reported. The first one is produced on a neocrested spall and shows a single hinged removal (Derevianko *et al.*, 2003: Fig.178, num.1). Its atypical character is inferred from its small size and from the absence of a clear laminar removal. The second is produced on a thin spall that shows two cortical faces (Figure 161). The blank is, therefore, not directly linked with a continuous blade reduction and is closer to a Mode A2 type.

Beside the production of small laminar elements, the production of larger blade blanks is attested to by the occurrence of blanks, retouched blades and blade cores. While the general pattern of reduction seems unidirectional and parallel, bidirectional cores occur occasionally among the set. Bidirectional cores are of two kinds, some of which are semi-turning and others are on a flat surface (Figure 162).

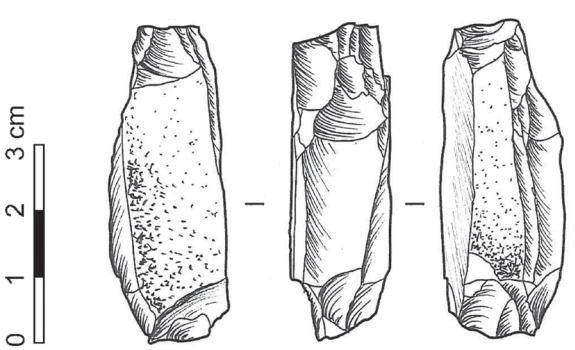


Figure 161: Anuy II, atypical Mode B core (OH12)

Circa 1500 blade blanks were uncovered in the lower part of the Anuy II sequence. The platforms are mainly plain, although a infrequent occurrence of facetted platforms can be observed (see also Derevianko, Markin, *et al.*, 2001). Although no quantitative data could be recorded on this material, observations on the dorsal patterning of the retouched blades seem to indicate that a majority of unidirectional blanks were selected. Among the retouched blades, endscrapers are frequent. This type of tool is also associated with flake and cortical flake blanks. Some of the endscrapers can be categorized as core-like tools as their general morphology is comparable to carinated and nosed endscrapers, but they bear microblade removals of a highly reduced size (Figure 163; Derevianko *et al.*, 2003: Fig. 182).

Some retouched blades also show burin spalls removal. The main types are burin on truncation (Figure 164: left) and burin on retouched blades. They are typed as tools due to the reduced numbers of removals observed and to the morphology of the spalls. Notable is a blade fragment displaying bifacial retouch.

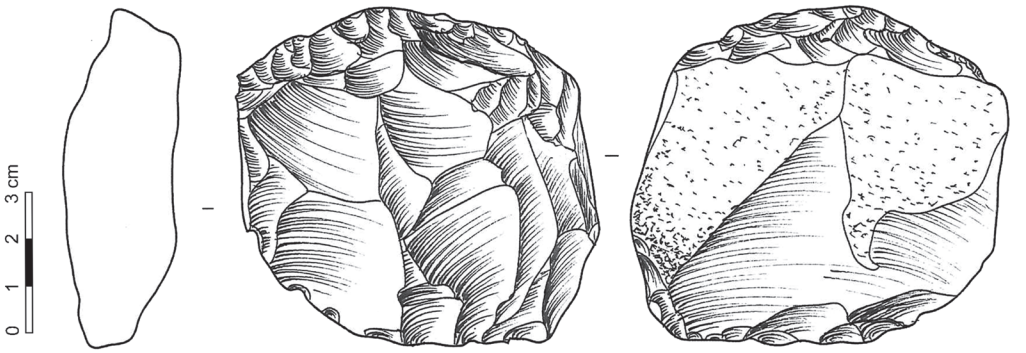


Figure 162: Anuy II, bidirectional core, (OH12), (redrawn after Derevianko *et al.*, 2003)

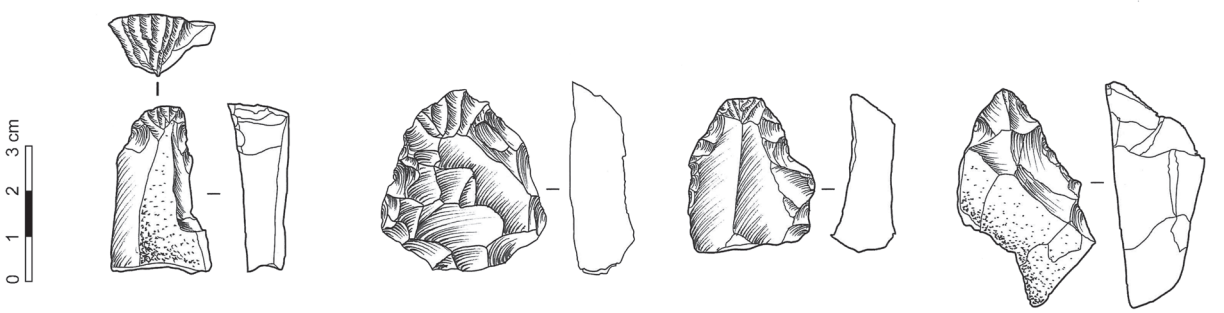


Figure 163: Anuy II, endscrapers (OH11)

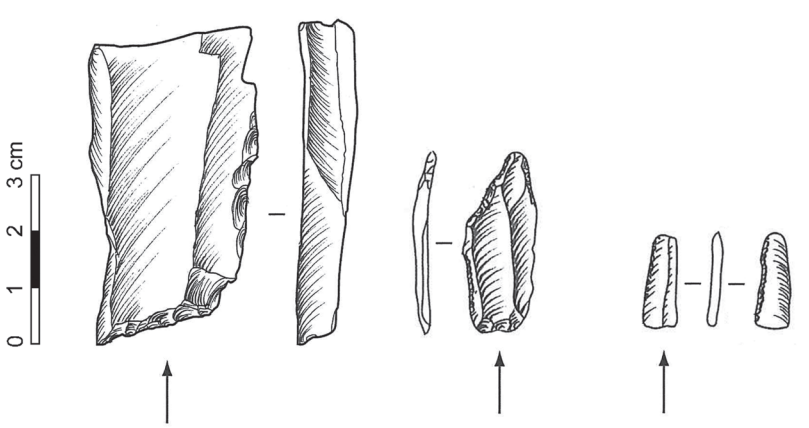


Figure 164: Anuy II, left, burin (OH12); middle, pointed bladelet (OH9); right, Dufour bladelet (OH10)

Given the good representation of bladelet and microblade cores, a relatively small number of blanks have been discovered (N=136). Among these blanks, just a few were retouched (N=19), among which is a single Dufour bladelet (Figure 164: right) bearing alternate retouch and a series of pointed bladelets displaying a distal truncation by semi-abrupt and abrupt retouch and some occasional proximal and mesial retouch (Figure 164: middle).

4.1.4 ANUY III

The Anuy III site is located on the left bank of the Anuy River, about 1.3 km downstream from its confluence with the Karakol (N 51°23'35'', E 84°40'49'') (Derevianko, Shunkov, *et al.*, 2000). A six meters thick profile has been divided into 21 lithological strata (Figure 165) (Derevianko, Shunkov, *et al.*, 2000). The lowermost stratum corresponds to a bedrock made of alluvial pebbles (stratum 21) followed by greenish sandy-loam (stratum 20), a thick laminated loam matrix (stratum 19) and a by a light-brown loam with oxide and manganese stains (stratum 18). The middle part of the section (strata 17-13) corresponds to laminated loam of various colors, and the upper part of the profile shows a succession of loam sediments (strata 12-4), followed by a loess like fine grained with some traces of laminated sediments at the bottom (stratum 3-2).

About 1500 small mammal remains have been uncovered throughout the entire section. Changes in the composition of the spectra have been used to define three main climatic units (Agadjanian and Shunkov, 1999). The lower part of the profile (strata 18-13) has yielded a relatively poor assemblage that indicates cool and rather humid conditions *(Asioscalops sp., Myospalax myospalax, Clethrionomys sp., Lagurus sp., Stenocranius gregalis, Microtus oeconomus, Spermophilus undulates)*. The lack of burrowing animals is interpreted as reflecting a strong frost penetration during the winter time. The middle part of the profile (strata 12-5) seems to correspond to a climatic improvement as shown by the increase of mole and zokor remains, the presence of vole, forest vole and pika. The upper part of the sequence (strata 4-2) suggests a humid but rather cold climate. The changes in small mammal populations also suggest fluctuations within these three main periods. From a chronological point of view, the Anuy III section has yielded a single RTL date, 54 ± 14 ka (RTL-962) coming from stratum 12. Further chronological attributions are inferred by researchers (see *e.g.* Derevianko and Shunkov, 2002) based on an interpretative correlation of the lithostratigraphy with the sequence of Ust-Karakol 1 sector 2. An attribution to Erma-

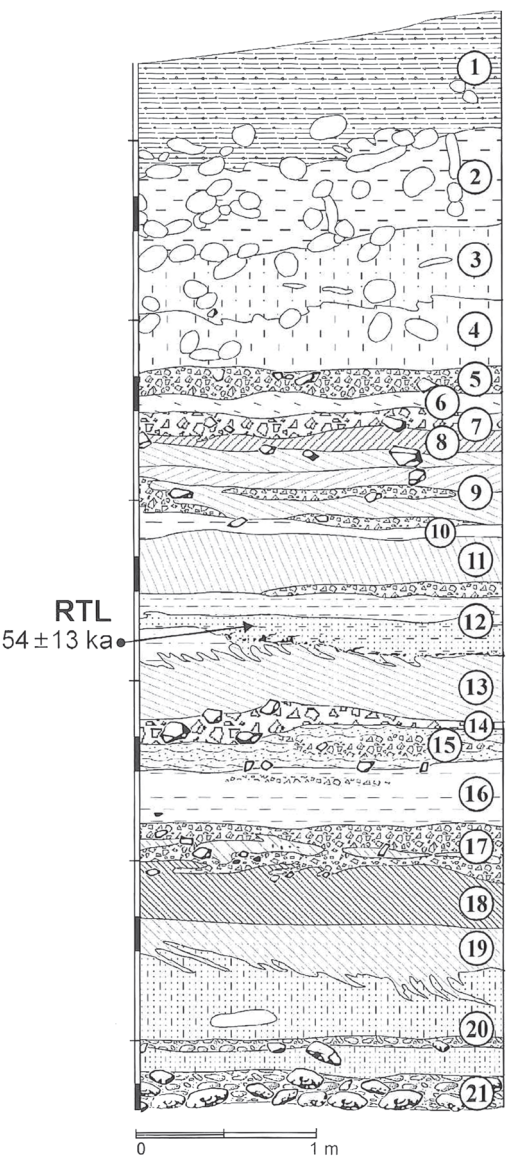


Figure 165: Anuy III, stratigraphic column with RTL sample location (after Derevianko and Shunkov, 2002)

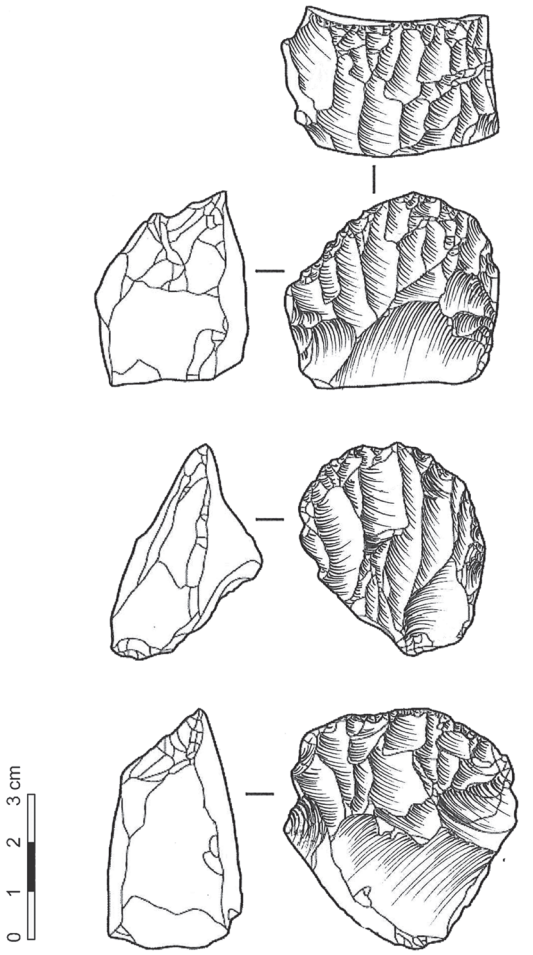


Figure 166: Anuy III, stratum 12, microblade cores (redrawn and modified after Derevianko *et al.*, 2003)

kovo (OIS 5-4) for strata 18-13 is proposed with and an approximate age between 100-90 ka for stratum 18. Strata 12-10 are estimated between 50-29 ka and strata 8-4 are attributed to the end of the Karginian stage or beginning of the Sartan (OIS3-2). Strata 3 and 2 are attributed to the Sartan. This correlation remains hypothetical and is not supported by radiometric data.

Archeological material uncovered in strata 18, 16, 15 and 13 have been attributed to the regional Middle Paleolithic and the archeological material from strata 12, 11, 9, 4, 3 and 2 to the Upper Paleolithic (Derevianko, Shunkov, *et al.*, 2000). A relatively small collection of artifacts has been found within stratum 12 (N=59, including 4 cores and 23 retouched tools). This assemblage, however, includes diagnostic elements such as bladelet and microblade cores (N=4) and a series of retouched bladelet and microblades (N=7). As for the nearby site of Ust-Karakol 1, the raw material is mainly local. It consists of pebbles of metamorphic but also sedimentary rocks, collected along the Anuy river bed (Kulik and Shunkov, 2000). Bladelet and microblade cores include mainly Mode A3 (N=3) and Mode A6 (N=1). Mode A3 cores (Figure 166) display a flaking surface on a broad face of a pebble blank, and have semi-turning unidirectional removals. Striking platforms are plain and their external edges show clear traces of a thin abrasion. Although having a prismatic morphology, some of

these artifacts fall into the definition of carinated endscrapers (Demars and Laurent, 1992).

The Mode A6 core is a small blade core on a block (cortical back) with two separated flaking surfaces (Figure 167). The main one is located on a broad face and bears removal negatives that show two opposed platforms. The second flaking surface is located on a narrow face and bears unidirectional removals. The upper striking platform is reshaped by laterally removed tablets, as the reshaping of the lower platform is frontal. The reduced size of this core seems to indicate a production of small blanks at the end of the reduction.

A series of small blanks is associated with this assemblage. In total, 4 bladelets and 9 microblades, including 7 retouched microblades, are attributed to stratum 12 (Figure 168). Most of them are fragmented, with 1 proximal, 7 mesioproximal, 3 mesial and 1 mesiodistal fragment. A single artifact is complete. Preserved platforms are all plain. Except for one of the unretouched bladelet blanks, all platforms are less than 1mm thick (Mean=0.7 ± 0.1 mm). The width of the retouched artifacts is clearly lower than 6 mm (Mean=3.3 ± 0.7 mm) and unretouched artifacts are between 5 and 6 mm in width (Mean=6 ± 1 mm). The thickness of retouched artifacts (Mean=1.4 ± 0.2 mm) also differs from the unretouched blank (Mean=1.8 ± 0.5 mm).

The complete microblade is unretouched and is 17.2 mm long. All dorsal scar patterns are unidirectional. Profiles of retouched artifacts are straight (N=4), slightly curved (N=1) or curved (N=2). Profiles of unretouched blanks are curved (N=3), slightly curved (N=1) and straight (N=1), with one being undetermined. All cross sections are trapezoidal except one triangular. Retouch is only direct and mainly continuous, with equal proportions on the left edge (N=3) and the right edge (N=3). One mesioproximal fragment has retouch located on the left proximal end. The type of retouch include steep (N=2), semi-steep (N=2), and combinations between semi-steep and thin (N=1) and semi-steep and steep (N=1). Typologically, two of the microblades are backed pieces (Demars and Laurent, 1992). The blade production of stratum 12 is poorly documented (N=9) and is not discussed here.

To summarize, EUP assemblages are mainly characterized by a production of bladelets and microblades independent from the larger blade production. Blades are mainly detached from volumetric unidirectional

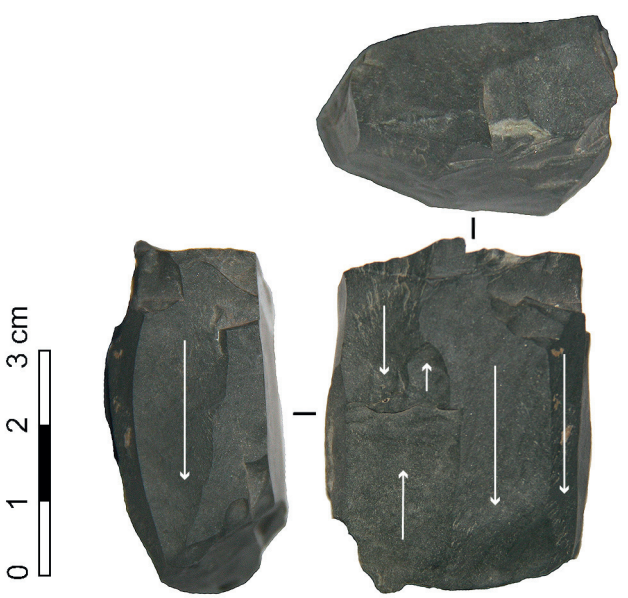


Figure 167: Anuy III, stratum 12, small bidirectional core

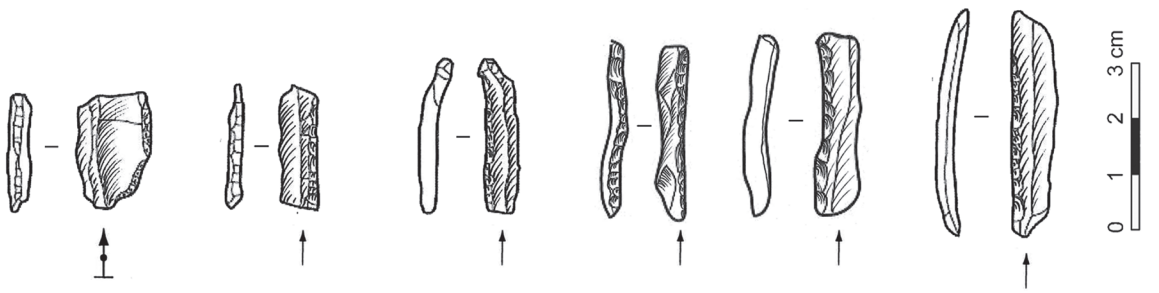


Figure 168: Anuy III, stratum 12, retouched blade and microblades (redrawn and modified after Derevianko *et al.*, 2003)

cores and testify to the use of soft hammer. In the following chapters, the results of the present analysis are compared with the published material and a comparative synthesis is proposed.

5 – Comparing the research background and the new results

In the Chapters 3 and 4, the reconstruction of the reduction sequences is organized from the detailed to the broader interpretation (for the methodology, see also Chapter 2). This chapter integrates the result of this analysis in the larger framework of the published material. Generally speaking, the results are in good agreement with previous studies of this material as they suggest the existence of two distinct technological systems corresponding to the early phases of the Upper Paleolithic of Gorny-Altai. However, some interpretations of the data set may differ and result in alternative reconstructions of the reduction sequences.

5.1 THE KARA-BOM ASSEMBLAGES

5.1.1 MIDDLE PALEOLITHIC HORIZON 1 (MPH1)

In the published report of the initial excavation at Kara-Bom, Okladnikov mentions that the maximum depth reached in square Z12 is -411 cm below datum (Okladnikov, 1983). According to the results of the second phase of excavation (1987-1993), this altitude would correspond to the top of MPH1 (Derevianko, Petrin, *et al.*, 1998). Down slope (line 14 to 17, squares B-N), the test pit reached a maximum depth of -630 cm. This implies that, in this area, the first test pit would have easily reached the MPH2. MPH1/2 would then be connected with Okladnikov's layer 4 and 5. According to Nikolayev's report, this area is disturbed by water circulation (Derevianko, Petrin, *et al.*, 1998). It is, therefore, difficult to link the Middle Paleolithic assemblage coming from Okladnikov's test pit with the material uncovered during the second phase of excavations.

As mentioned earlier (see Chapter 3), the nature of the assemblage and the sample size make attempts at general constructions rather problematic. Therefore, MPH1 is usually considered together with MPH2 (*e.g.* Rybin, 2004). The material from MPH1 is described by Derevianko *et al.* (Derevianko, Shimkin, *et al.*, 1998) as richer in burins than the lower level, with the occurrence of a few small blades. The figure illustrating the material is, however, wrongly attributed to the Upper Mousterian layer (Derevianko, Shimkin, *et al.*, 1998, Fig. 75) and corresponds instead to the lower one, as illustrated in the monograph (Derevianko, Shimkin, *et al.*, 1998, Fig. 32). A part of the assemblage collected by Petrin during the 1990 campaign is described by Goebel as Kara-Bom Middle Paleolithic 'component 1' (Goebel, 1994). This sample is relatively small (N=54) and judging by the illustrated material, likely corresponds to MPH2. In the original monograph, the assemblage is described as combining a production of flakes on Levallois-like flat-faced cores with the occurrence of blades (Derevianko, Petrin, *et al.*, 1998). Tools are on flake and blade blanks, including some Levallois blades. The most common retouched tools are flakes with irregular retouch and notched tools, and the most common unretouched tools are Levallois points. A single burin is mentioned in the type list. In a more recent study, Shunkov (2005) insists on the importance of Levallois technology in the Kara-Bom assemblage and on the lack of Mousterian features in the toolkit. According to him, the latter is characterized by a rather narrow typological spectrum, with mainly tools on blade blanks and unretouched Levallois points. These features are considered typical of the Kara-Bom variant of the Altai Middle Paleolithic. The reduction sequence is described as a succession of three main stages. Reduction mainly follows a recurrent unipolar strategy switching from parallel to convergent reduction pattern, and then switching back to parallel (Derevianko, Petrin, and

Rybin, 2000). Rybin (2004) placed more emphasis on the Levallois features in MPH1. He also insists on the unidirectional character of blank production. He regards MPH1 and MPH2 assemblages as very similar and as non-facetted, due to a 'moderately high' index of faceting.

As observed in all archeological levels at Kara-Bom, the raw material mainly consists of metamorphic rocks of a local origin, either coming from the Altairy River or from its vicinity. The size of the blocks or pebbles collected remains unknown. In contrast to the subsequent OH6 and OH5 assemblages, no fragments of massive blades are associated with the sample. Given the absence of cores, blade production is mainly documented by the data collected on blanks and on retouched blades. The occurrence of technological elements, such as a small neo-crested blade and a small blade with a burin spall morphology, indicate that, at least occasionally, blade reduction takes place either at the intersection of two flaking surfaces or on narrow flaking surface. Two core-like tools have been described. Both are similar to Mode B cores (one of them produced on a side blade). Their atypical morphology suggests, but does not clearly illustrate, a production of small laminar blanks associated with MPH1.

As noted by Rybin (2004), a majority of the dorsal removals on blanks are unidirectional. However, relatively large blades with parallel edges and bidirectional scar patterns are present among the blanks and among the retouched blades. In fact, the MPH1 frequency of unidirectional dorsal patterning is similar to assemblages such as OH6 and OH5. The main differences are the low frequency of bidirectional blanks and the relatively high frequency of undetermined patterning. By contrast, retouched tools on blades are mainly bidirectional. One of the main factors influencing how dorsal patterning is assessed is the high rate of breakage (96% of the blade blanks are fragments), as some bidirectional blanks fragments can appear unidirectional (Bar-Yosef and Van Peer, 2009). In other words, the small sample size, the high frequency of undetermined elements and the rate of breakage could partly explain differences in dorsal scar patterns between MPH1 and the overlying assemblages.

The Levallois character of the MPH1 assemblage is mainly expressed by the occurrence of flake cores, unretouched Levallois points, and retouched or unretouched Levallois flakes. The dorsal scar patterns observed on the points vary with examples of unidirectional cortical to bidirectional and sub-radial patterning. One flake core can be placed in a Levallois recurrent strategy with a sub-triangular flaking surface that may have been oriented toward the production of convergent blanks. The second one falls within a sub-radial strategy though it shows a short sequence of unidirectional convergent removals. The switch from parallel to convergent and then back to parallel flaking proposed by Derevianko *et al.* (Derevianko, Petrin, and Rybin, 2000) would imply that blades and convergent flake blanks are produced from the same nodules and that the shape of the blank is related to one of these alternating steps. This pattern could not be observed on the MPH1 assemblage. The flake cores, in their last stage of reduction, do not exhibit clear traces of parallel or laminar reduction and bear no traces of lateral reduction. Blades have mainly parallel edges and bear previous laminar removals on their dorsal face. Combined with the use of crests, the latter observation suggests a parallel coexistence between a Levallois flake technology and a sub-volumetric blade reduction. In the absence of long refit sequences or of clear reduction patterns, the blade and the flake production are considered here as independent sequences.

Platforms are both plain and facetted and no significant differences could be observed among laminar and flake blanks. No clear diagnostic could be proposed regarding the mode of percussion, although hard hammer use is assumed for the flake production.

Regarding the retouched toolkit, retouched blades and notches are the most common. Among the retouched blades, pointed blade fragments indicate a possible axial use for some of the tools. Although tools on flake blanks are not the focus of this study, some taphonomic features suggest that tool types such as notches should be interpreted carefully. The MPH1 assemblage includes a small number of finds with a significant vertical distribution (Derevianko, Petrin, *et al.*, 1998). In addition to differences in

patina, there is evidence for a certain degree of mechanical reworking. In this situation, edge damage may have artificially increased the number of notches, although it is noted that clear intentional notches are present, including one on a Levallois flake blank. Typical Mousterian features, such as sidescrapers, are absent.

To summarize, the present results on the MPH1 assemblage are consistent with previous studies (Derevianko, Petrin, *et al.*, 1998; Derevianko, Shimkin, *et al.*, 1998; Derevianko, Petrin, and Rybin, 2000; Derevianko and Postnov, 2004; Rybin, 2004; Shunkov, 2005) as they illustrate the coexistence of a Levallois component, mainly expressed in the flake technology, with a rather high blade frequency. It is suggested that the MPH1 assemblage displays a Levallois recurrent flake technology alongside a subvolumetric blade production. Reduction continuity between the two types of blanks cannot be demonstrated. This analysis could not confirm the unidirectional reduction pattern as a typical feature of this assemblage. Based on the studied sample, it appears that both bidirectional and unidirectional blanks coexist. Unidirectional reduction seems to dominate the assemblage; however, this may reflect a bias due to the small sample size, to the high frequency of undetermined patterns and to a high rate of fragmentation. Furthermore, the retouched laminar tool kit is mostly bidirectional. The non-facetted character of MPH1 could not be confirmed as facetted and plain platform frequencies are not significantly different.

5.1.2 OH6 AND OH5

Assemblages from OH6 and OH5 are often considered together as they show chronological and techno-typological similarities (*e.g.* Goebel *et al.*, 1993; Goebel, 1994; Derevianko, Petrin, *et al.*, 1998; Derevianko, Petrin, and Rybin, 2000). Originally considered as Mousterian by Okladnikov (1983), these assemblages have been described as illustrating a local transition from Middle to Upper Paleolithic, from a technological and typological point of view (Derevianko, Petrin, *et al.*, 1999; Derevianko and Volkov, 2004; Rybin, 2004; Derevianko and Shunkov, 2005; Derevianko, 2011a). Derevianko and colleagues (Derevianko, Petrin, and Rybin, 2000), describe a recurrent Levallois blade technology with a parallel bidirectional pattern starting from the early stages of reduction. The flaking surface is generally located on a broad surface. Following the exhaustion of the flaking surface, cores are then reduced from a narrow face, producing series of blanks classified as narrow blades and microblades (Derevianko and Rybin, 2003). Derevianko and Volkov (2004) note a rather low frequency of Levallois cores offset by a high frequency of narrow-face cores. As opposite frequencies are described for the MPH1 and MPH2, they interpret the switch to the narrow face as a consequence of the reduction process. They argue that by transforming the shape of the core, the exhaustion of the broad face facilitated a reduction from the narrow face. More generally speaking, the change in the location of the main flaking surface, from the broad side toward the narrow one, would then represent a transition from a surface to a prismatic conception of blank production. A similar reduction pattern is said to be observed on a single core producing convergent blanks and points.

Heavily reduced cores, massive *débordant* flakes and lateral spalls are then modified into multifaceted burins (Derevianko, Petrin, and Rybin, 2000; Derevianko and Rybin, 2003). Some of them are considered as a type of core specific to Kara-Bom, with a flaking surface on the narrow face. Polyhedral burins are seen as the result of a continuous reduction of the large blade cores, their morphology being related to an advanced stage of exhaustion (Petrin and Chevalkov, 1992; Derevianko, Markin, *et al.*, 2001). The occurrence of wedge-shaped cores is also mentioned with a production of microblades from narrow-face cores (Derevianko, Petrin, and Rybin, 2000).

Compared to MPH2 and MPH1, OH6 and OH5 are said to be characterized by a significant increase in blade production with blades outnumbering flakes. Some of the blades are long and massive and, as opposed to the unidirectional reduction system from MPH2 and MPH1, OH6 and OH5 illustrate a switch to bidirectionality. Levallois points are mentioned in both OH6 and OH5 assemblages with rather laminar proportions, more elongated and thinner than in

Mousterian assemblages (Derevianko, Petrin, and Rybin, 2000).

Blank platforms are described as presenting a combination of facetted, dihedral, plain and 'microplatforms'. These platform types occur in roughly similar frequencies, except for the more dihedral ones which are more unusual (Derevianko, Markin, *et al.*, 2001). According to Derevianko and colleagues (Derevianko *et al.*, 2002; Derevianko and Volkov, 2004), Kara-Bom is said to illustrate the origin of pressure flaking, mainly through the production of blades by 'force-pressure flaking' (Volkov and Giria, 1990; Volkov, 1999). Specific studies on blank secondary treatments described the retouch as mainly scaled and sub-parallel and mention the occurrence of retouch by pressure flaking (Derevianko, Shunkov, Kolobova, and Petrin, 2005). Endscrapers, burins, points, notches and denticulates are the main types of tools listed together with an infrequent occurrence of specific tools such as 'sickle-like' (Goebel *et al.*, 1993) or trimmed blades (Derevianko, Petrin, *et al.*, 1998; Rybin, 2000). Notches are said to be less intensively retouched in OH6 and OH5 than in MPH1 and MPH2.

The OH6-OH3 material coming from 1990 and 1991 campaign is described by Goebel and colleagues (Goebel *et al.*, 1993; Goebel, 1994) as Early Upper Paleolithic or Kara-Bom 'component II' and is grouped into a single sample. Most of this material could not be included in the present sample. Flat-faced cores, sub-prismatic cores and a flake core are reported with a majority of single face, uni- and bi-directional cores. The majority of the tool blanks is unidirectional, and the platforms are mostly facetted. Goebel also notes the occurrence of crested blanks. Among the specific tools, endscrapers and points on elongated unidirectional and bidirectional massive blades are recognized. Burins on massive thick blades occur, as well as notched tools on flakes and a single biface (Goebel, 1994: Fig. 7.12; Goebel, 2004: Fig. 12.2, num. 11).

The results of the quantitative and qualitative analysis presented in Chapters 3 and 4 are consistent with most of the previously published observations. From a taphonomic point of view, minor vertical movements between OH4-OH5 and OH5-OH6 are detected downslope and no vertical movements could be observed between MPH1 and OH6. The assemblage from Okladnikov's test pit could not be correlated with the subsequent excavations and, therefore, was not included in the quantitative analysis. Nevertheless, it is clear from the original publication that most of the material from OH6 and OH5 is somehow included in Okladnikov's layers 2 and 3.

As shown in Chapter 3, OH6 and OH5 are technologically similar and the main characters of these assemblages can be summarized together.

The raw material is almost identical to that found in MPH1 and consists mainly of fine-grained metamorphic rocks. The production of massive and long blades is characterized by a reduction sequence mainly from cores with two separated flaking surfaces and two opposed platforms (Mode A6). The initial phase of reduction is not well documented. It is assumed that opportunistic or shaped crests can occur along one of the edges of the nodule, although some lateral preparation on the cores could possibly indicate an occasional use of central crests. In spite of a small sample size and of a relatively high degree of core exhaustion, it could be observed through the reduction sequence reconstruction that, in most cases, reduction ends with blade removals from a single narrow face. However, some negatives visible on the narrow face precede further removals on the broad face, and, thus, indicate several switches between flaking surfaces in the course of the reduction. The reduction proceeds by short unidirectional or bidirectional sequences of 3-4 removals followed by the detachment of a thicker blade from the intersection of the two surfaces. This process reshapes the flattened, broad, flaking surface by creating a new convexity. The repeated use of such a method is reflected by the high frequency of *débordant*, naturally backed, naturally crested, crested and neo-crested blades of various sizes. Cores analyzed are assumed to be heavily reduced, as none of them correspond to the numerous massive blades in of the sample.

In Figure 169, the 'Technical blank' category groups all crested, naturally backed and *débordant* blanks. Only blade blanks are represented with a cut-off at

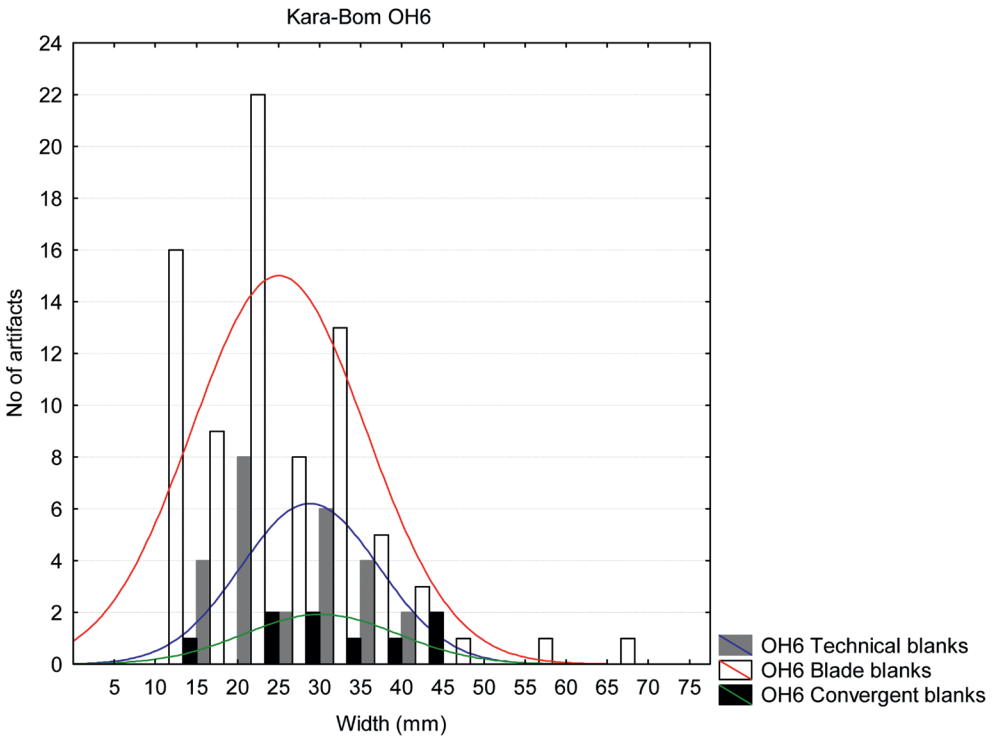


Figure 169: Kara-Bom, OH6. Comparison between the widths of technical blanks, blade blanks with parallel edges, and convergent blanks

12 mm width. All categories have a similar width distribution. The first mode corresponds to blanks of 20-25 mm width. The second mode observed in the blade blank category, spanning from 12 and 15 mm, is related to a distinct reduction sequence. Assuming that large/medium blades illustrate a single reduction process, the histogram suggests that technical and convergent blanks are detached throughout the whole blade core reduction.

The core reduction takes place on two surfaces following a sub-volumetric approach, extending from a broad face to a narrow face (Figure 170). The detachment of blanks from the narrow face, and from the intersection between the two surfaces, provides a form of control on the convexity of the broad face. The sample studied suggests that only one of the narrow faces is flaked, giving the core an asymmetric section. Pelegrin (1995) describes a similar reduction method in layer 8 from Roc-de-Combe that is defined by Boëda as a mixed system *(gestion mixte)*, combining a volumetric approach that turn into a surface reduction (Boëda, 1990) (Figure 170). It differs from the definition of Levallois (Boëda, 1995) as it does not represent a surface conception *sensu strictu*.

In the case of Kara-Bom OH6 and OH5, both convergent and parallel blanks are detached from the broad face of the core. Bidirectional reduction offers the possibility to obtain convergent blanks without

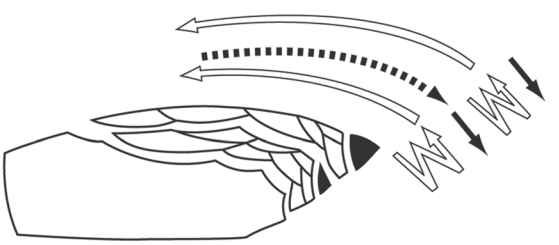


Figure 170: Reduction system of Roc-de-Combe layer 8 type (after Boëda, 1990). Black elements are associated with the initial flaking and the management of convexities

necessarily having a triangular flaking surface or a strictly convergent reduction system on a broad surface. It also facilitates the production of blanks with straight profiles (Pelegrin, 1995). This observation is consistent with the dorsal scar patterning observed on convergent blanks that usually display negatives of divergent opposed removals on their distal end. Some of the chronological reconstructions show successions of 3-4 removals (similar to a Levallois point production) that may illustrate such a process.

As noted by Derevianko and colleagues (Derevianko, Markin, *et al.*, 2001), a single core displays a convergent last removal. Prior to the removal of a pointed blank similar to a first order Levallois point *(pointe de premier ordre)* (Bordes, 1980) a blade was struck from an opposed platform, giving a subtriangular shape to the flaking surface. This bidirectional scar does not appear on the dorsal face of the refitted last removal. This suggests that, even on complete blanks, the bidirectional reduction system may be underrepresented in the dorsal scar patterning (cf. Bar-Yosef and Van Peer, 2009). On this core, the flaking surface is located on the broad face, but several hinged removals are visible at the intersection one of the narrow face.

A few published cores were not included in the quantitative analysis as they were missing from the collection at the time of the sampling (*e.g.* Derevianko, Petrin, *et al.*, 1998: Fig. 34 num. 2). Some of them have been analysed afterward (*e.g.* Derevianko, Petrin, *et al.*, 1998: Fig. 34 num. 3)(Figure 171).

It is noted that some of the cores have a narrower flaking surface that could be characterized as semi-turning and volumetric. These cores could be seen as representing an independent reduction sequence exclusively oriented toward a production of blanks with parallel edges following a bidirectional or unidirectional reduction path. They could also be part of the sub-prismatic reduction sequence stopped during a stage of flaking from the narrow face. Therefore, the presence of such type of core does not contradict the propose reconstruction.

It is clear that the cores observed lack convergent negatives, but this does not necessarily imply that the production of convergent blanks corresponds to a specific step in the reduction sequence. The variability observed in blank shape and size is similar to other type of blanks. As shown in Figure 169, the width distribution is statistically similar to technical blanks and regular blade blanks ($F(2, 111) = 2.115$, $p = .13$). Parallel blades and convergent blades are not always easy to distinguish and the categories sometimes overlap (Figure 172).

Beside large blade production, these assemblages can be characterized by the presence of specific reduction sequences oriented toward the production of small blade/bladelets. The Mode B category group-

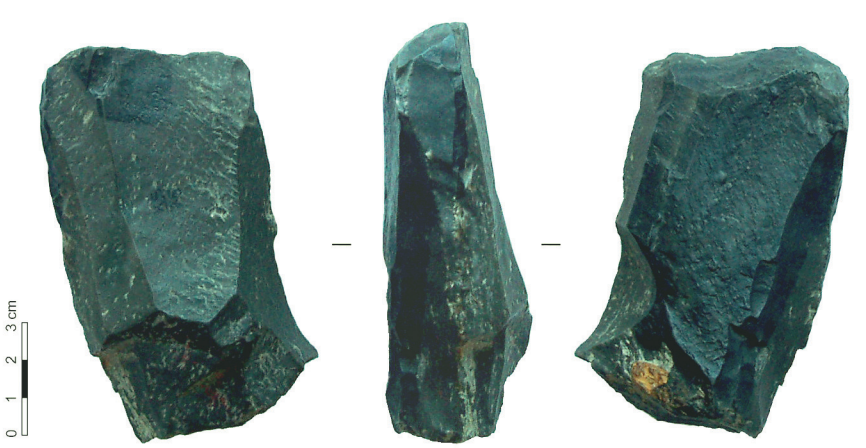


Figure 171: Kara-Bom, OH6, blade core



Figure 172: Kara-Bom, OH6. Blade with sub-convergent edges, detached from the lateral end of a flaking surface. Note the crest scar and the débordant platform along the left edge.

ing all cores on blade blanks is the most represented in OH5 (80%) and OH6 (74%) of the core sample. The core blanks are selected among the thickest blades, or blade fragments, of the assemblage (with a minimum of circa 10 mm thickness) (Zwyns *et al.*, 2011). These thick blades are mainly *débordant*, naturally backed or crested. According to the impact points visible on some of their sections, it is inferred that blades are occasionally snapped by direct percussion. Fragments are then turned into cores using the edge of the blank as a flaking surface. The reduction starts from the thickest end, either using a natural or a retouched edge as a crest, and proceeds by short unidirectional sequences followed by switches to an opposed platform. Platforms are sometimes prepared by faceting and reshaped by the removal of small core tablets. The morphological variability that covers Mode B1 to B7 is interpreted as reflecting different steps of reduction. B1 and B5-7 are the most numerous. The blanks produced range from small blades down to bladelet size pieces (<12 mm width). Their morphology varies according to their position on the flaking surface and the number of guiding scars they follow. As most of the flaking surfaces are rather narrow, burin spall and *débordant* elements are quite numerous. Some of Mode B5-7 cores, although sometimes reported as polyhedral burins (*e.g.* Derevianko, Petrin, and Rybin, 2000), were also explicitly considered here as cores (Petrin and Chevalkov, 1992; Goebel, 1994; Derevianko, Petrin, *et al.*, 1998; Derevianko and Rybin, 2003; Zwyns *et al.*, 2011).

Besides the Mode B cores, a infrequent occurrence of Mode A cores is associated with small blank production. One example is produced on a slab and shows a semi-turning bidirectional reduction from a flak-

ing surface located on a narrow side. Basically, the reduction pattern is rather similar to a Mode B core except that the flaking surface extends slightly on to the broad side. Some examples of truncated-facetted pieces are technologically analogous to large blade cores as they follow the same reduction sequence, with the alternate use of two flaking surfaces. The fact that Mode B cores are produced on blade or laminar flakes and that truncated-facetted pieces are produced on flakes does not support the idea of continuous reduction, as previously suggested (Petrin and Chevalkov, 1992; Derevianko, Nikolayev, and Petrin, 1993). The production of small laminar blanks is only indirectly related to the production of large blanks as Mode B core blanks are recycled technical blanks. The *débordant* and crested blanks then play a double role: management pieces for large blade production and core blanks for another reduction sequence.

Regarding the blank platforms, a coexistence of facetted and plain platforms is observed with a more limited occurrence of dihedral platforms. Although frequencies are not exactly the same, the general results are consistent with some of the previously published analyses (Derevianko, Markin, *et al.*, 2001). Differences with Goebel's (1994) platform frequencies are likely due to differences in the sampling method. Goebel considers OH6-OH3 as a whole and records technological attributes exclusively on the toolkit. In the present study, it is noted that some of the facetted platforms can be classified into two distinct groups: a classical faceting, covering the whole platform surface, and a partial faceting (Figure 173, Figure 174) located on the external edge of the platform. The latter type of preparation is roughly similar to what Nehorochev defines as a 'striking platform reduction' (Nehoroshev, 1999).

In addition, some facetted platforms appear to be *débordant* on one side. Those blanks vary in length and width from the long blades to the short, broad and pointed laminar flakes. This reinforces the idea of an interaction between the broad and narrow flaking surfaces during the whole reduction process.

No thin abrasion is observed on the external edge of the blanks or of the cores. However, some of the

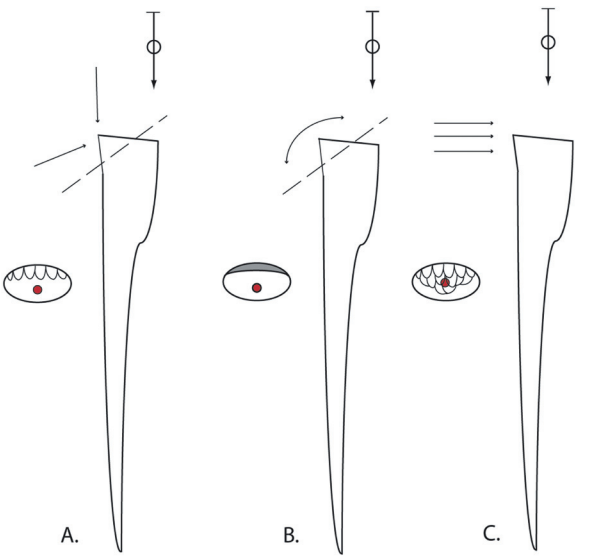


Figure 173: Platform preparation types. Partial facet-ing; B. Extreme abrasion; C. Faceting

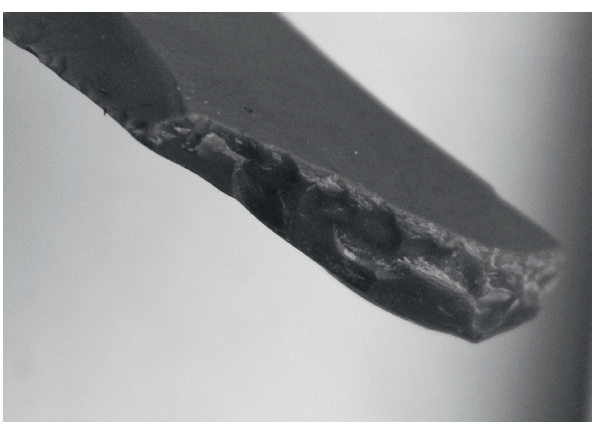


Figure 174: Débordant facetted platform (blade illustrated in Figure 172)

blanks bear traces of a strong abrasion smoothing the external edges. Lips, cones of percussion and flaking on the bulb occasionally occur and, generally speaking, the mean platform thickness is higher than 4 mm. The lack of thin abrasion and the platform thickness tend to rule out the use of organic hammers. Considered as a whole, the described features rather indicate a direct percussion with a stone hammer. The lips, the flaking on the bulb and the strong abrasion could indicate the use of a soft stone hammer. The typical features of soft stone hammer, how-

ever, overlap with the organic and the hard hammer (Roussel *et al.*, 2009), and it is, therefore, not possible to determine at what frequency it is used. Following the definition of Tixier (1984), no evidence for pressure flaking is observed in the studied sample. Instead, the irregularity of the removals, the relative thickness of the blanks and of the platforms, and the core morphology suggest a use of direct percussion.

The tool kit included in the studied sample mainly consists of retouched blades. The main types of retouch observed are scalar, semi-steep and thin retouch. Systematic retouch by pressure flaking could not be observed. The identification of such a technique (usually described in the context of a bifacial technology or for the retouched projectile points) is, however, beyond the scope of this analysis. Recent studies (*e.g.* Pelegrin, 2004; Mourre *et al.*, 2010) underline the need for an experimental protocol in order to isolate typical features. These results should be compared with the archeological material using an attribute analysis. In the present case, the retouch does not appear to differ from direct percussion, and it is assumed that pressure flaking was not the main retouch technique. The tool kit consists of blades with retouch located mainly around the distal and proximal ends. Some of these blades are pointed and others, with a more rounded distal end, can be typed as endscrapers. A refit has turned two blade fragments, that Derevianko and colleagues (Derevianko, Petrin, *et al.*, 1998) typed independently as an endscraper and a retouched blade, into a massive 'sickle-like blade'. This specific type of blade occurs so far exclusively in OH5. A single trimmed blade is associated with OH6 in the original monograph (Derevianko, Petrin, *et al.*, 1998). The proximal part of the blank displays inverse retouch and the proximal edges show direct marginal retouch. The distal end is pointed by a bilateral semi-steep and steep retouch. This artifact was missing from the collection at the time of the study; it is clearly associated with OH6.

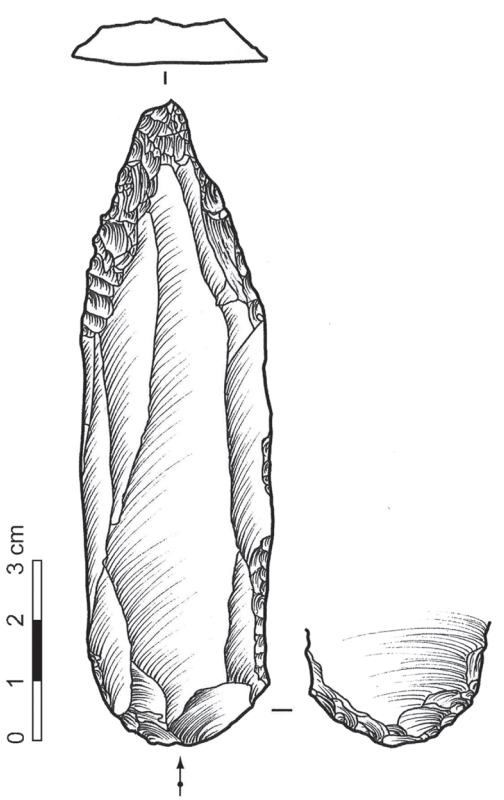


Figure 175: Kara-Bom, OH6, pointed blade with proximal thinning (redrawn after Derevianko, Petrin, *et al.*, 1998)

Generally speaking, small blade/bladelet blanks are rarely retouched. The few elements observed are either on irregular blanks and present a steep or semi-steep retouch or they are on regular blanks with a very thin retouch. The latter category includes a Dufour bladelet.

In his first report, Okladnikov (1983) mentioned the discovery of a biface but without mentioning in which layer it was discovered. Goebel first reported 2 bifaces associated with component II (OH6-OH3) (Goebel *et al.*, 1993) but, shortly after, he mentioned a single one (Goebel, 1994). Derevianko and Shunkov attribute a single biface from Kara-Bom (2002) to an unclear provenience that is likely a re-deposited Middle Paleolithic assemblage. In fact, it appears that Okladnikov, Derevianko and Shunkov, but also Goebel mentioned the same artifact, namely a complete biface made of dark grey metamorphic rock with porphyric inclusions. In his dissertation, Goebel deals with a sample of component II from the 1990-91 excavation and does not include this piece but instead includes and draws a biface with a missing distal part (see also Goebel, 2004). Thus, this artifact can be broadly associated with OH6-OH3.

A set of ornaments and pigments has been uncovered from a small depression at the bottom of the OH6. It was filled with more than 88 g. of goethite concretions and powder. A long flat pebble of greenish and white striped raw material (Figure 176 : 4) was found within the reddish pigments (Derevianko and Rybin, 2003). In addition, one perforated ungulate tooth and one piece of unidentified mammal bone were found in the same spot (Figure 176 : 1, 3). These elements were discovered during the 1991 excavation in the vicinity of the I-K/8-9 fireplace. At less than 1 meter away from the cluster of these objects, a BC and three spalls were refitted. One spall was found on a schist slab. The burin and one of the spalls were found at similar depth. A fragment of ungulate bone showing a bi-conique perforation was found outside of the pigment concentration (Figure 176 : 2). One of the surfaces of this object displays parallel incisions. It was found in direct association with the BC refit (Derevianko and Rybin, 2003) (Figure 176 : 5). As the BCs clearly belong to OH5 and OH6, there is no convincing evidence supporting the idea that this ornament piece is an intrusive element from OH4 or elsewhere (*contra* Zilhao, 2007). In this context, the rest of the ornaments are likely to be connected with either OH5 or OH6. Given the few refitted artifacts between OH4 and OH5, however, this issue cannot be addressed properly.

To summarize, OH6 and OH5 include a systematic and organized laminar technology. The large blade reduction sequence is not representative of Levallois. Previous studies did interpret the reduction as mainly located on the broad face of the cores, a switch to the narrow facilitated by the exhaustion of

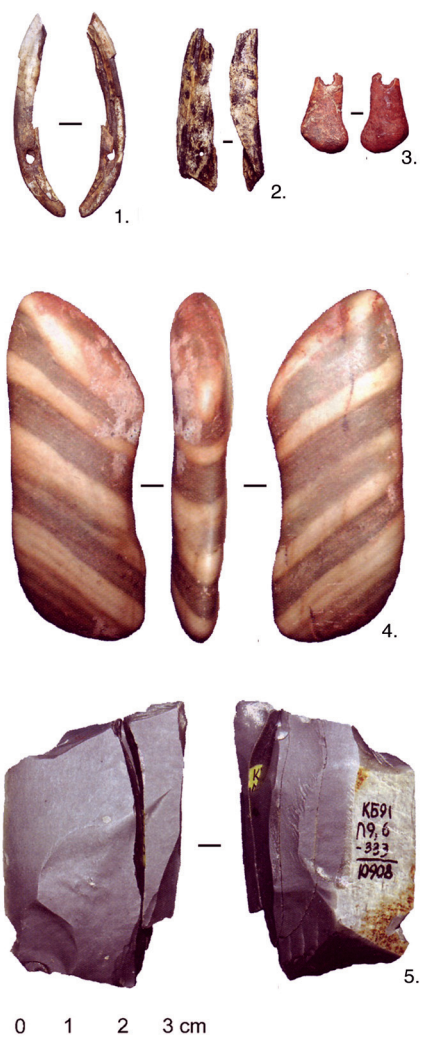


Figure 176: Kara-Bom, ornament (1-3), pebble (4), BC refits (5) (after Derevianko and Rybin, 2003)

the core that ended the reduction process (Derevianko and Volkov, 2004). The two faces were then considered as independent, representing clear-cut steps in the reduction (Derevianko, Markin, *et al.*, 2001; Rybin, 2004). Instead, it appears that a 'back-and-forward' interaction between the broad and the narrow face of the core indicates a sub-volumetric conception of the core. In this view, the use of a narrow face is not a consequence of the exhaustion of the core but rather a necessary condition to proceed. The management of the convexities is achieved by the removal of naturally backed and crested elements all along the reduction process as shown by the frequent occurrence of neo-crest, varying in size. The reduction from the broad flaking surface, some of the lateral preparations, the faceting and the morphology of some of the blanks suggest a Levallois background for this technology. A few cores, by their shape, testify to a semi-turning progression. It is still not clear if they illustrate other stages of exhaustion of a sub-prismatic core reduction or an independent reduction system.

Two arbitrary categories of blank have been defined that sometimes overlap: blanks with parallel edges and convergent blanks. They are both generated by the same reduction process using alternatively two opposed platforms but also short unidirectional sequences. The morphology of the convergent blanks, ranging from pointed blades to short laminar flakes, suggests that they are produced during various stages of reduction rather than corresponding to a specific step in the process.

A second reduction sequence is included in the general technical scheme. The thickest technical blanks from the large blade production are transformed into cores following a systematic process. Blades are snapped and reduced along one of their narrow edges from one or two opposed platforms. This reduction, including the use retouch edges as partial crest, corresponds to a volumetric conception of the core. The blanks produced range from the small blades to the bladelet size, mostly with a triangular section. As for the large blades, the use of two opposed platforms allows a production of elongated convergent blanks with a straight profile. Rare truncated-facetted pieces and a single semi-turning core illustrate other facets of the technological variability associated with OH6 and OH5. This technology is seen as specific and not the result of the intense reduction of a larger core.

5.1.3 OH4

As previously noted, OH4 yielded a relatively small sample with, upslope, a stratigraphic position clearly distinct from the underlying assemblages. Downslope, the situation is more problematic due to the proximity between the various layers which are separated in some places by only a few centimeters of sterile sediments. The main concentration of lithic material, burned bones and charcoal is located around squares Z-I/8 (Derevianko, Petrin, *et al.*, 1998). Assemblages from Okladnikov's early excavations cannot be directly correlated with the subsequent stratigraphic divisions but it is reasonable to assume that the majority of artifacts from OH4 are to be found among the finds from layer 1 (Okladnikov, 1983). The raw material is similar to the one described in the underlying assemblages. Assemblages OH4 to OH1 are usually described as a whole as belonging to a local Upper Paleolithic tradition. The original publications mention a flat-face core described as showing a parallel flaking pattern with a lateral crest and associated with OH4, two unclear narrow-face cores on massive blade blanks, and a preform of Levallois core (Derevianko, Petrin, *et al.*, 1998; Derevianko, Markin, *et al.*, 2001). OH4-OH1 flakes have mainly plain platforms, with a rare occurrence of facetted and dihedral preparations. Blades are said to be elongated and to show a majority of plain and microplatforms, followed by facetted and dihedral. The increase in bidirectional and crested blanks noted, together with a decrease of unidirectional convergent and parallel flaking, is interpreted as reflecting a transition toward a non-Levallois technology (Derevianko, Markin, *et al.*, 2001).

Additional data regarding OH4 blade technology are provided by refits (Slavinsky and Rybin, 2007) (Figure 177). A fragmentary sequence illustrates an initial stage of reduction with the detachment of two cortical flakes on the distal part of the nodule followed by the shaping and detachment of a poste-

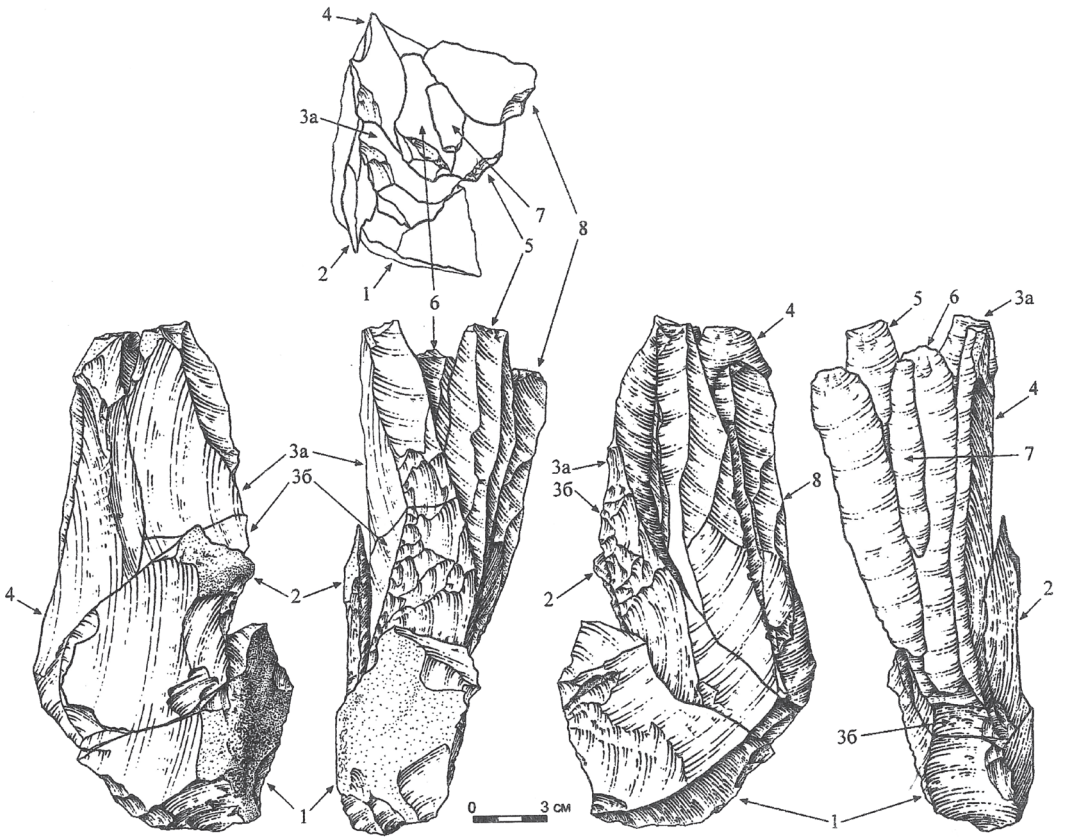


Figure 177: Kara-Bom, OH4 (+OH5 and Okladnikov testpit). Refit of laminar reduction sequence (after Slavinsky and Rybin, 2007)

rior crest (detached by two removals) and of a massive laminar flake. Then, four unidirectional blades with parallel edges are detached. Slavinsky and Rybin (2007) mention that these artifacts were located downslope and this refit includes 2-3 artifacts from OH5 and from Okladnikov's collection.

The retouched toolkit is said to show a slight increase of blade blanks, a minor frequency of retouched flakes and the absence of Levallois points. Tools display mainly a combination of direct semi-abrupt and scalar retouch. Sidescrapers occasionally occur but with a rather high morphological variability (Derevianko, Petrin, and Rybin, 2000). Notches and notch-denticulate tools are the most represented, representing circa 28% of the toolkit. A single scraper on blade and four retouched points are mentioned (Derevianko, Petrin, *et al.*, 1998).

The additional refits provided by the present study confirm that some occasional mixing between OH5 and OH4 may occur in the lower part of the slope. It is, however, unclear if they reflect post-depositional processes (such as slope erosion) or labeling issues. In the studied sample, a single core could be analyzed. It is a small blade/bladelet core on a *débordant* flake that resembles a blade core tablet. The flaking surface is located on a narrow edge and bears bidirectional reduction negatives coming from two opposed platforms. The flat-face core mentioned in the original monograph (Derevianko, Petrin, *et al.*, 1998) could not be observed. Judging by its thickness, it appears more of an overshot blade blank than a core. Nevertheless, it bears clear bidirectional negatives from two opposed, facetted platforms. The narrow-face cores on thick blades have been considered as blades, as it is not clear if the removals vis-



Figure 178: Kara-Bom, Okladnikov workshop layer 1/2, intial stages of blade reduction

ible on their edges were detached before the blank itself. The occurrence of cortical second crests confirms that initial flaking takes place at the site. In addition, it is worth mentioning a prepared block from the Okladnikov's collection and attributed to one of the two first layers meaning, therefore, likely either OH4 or OH5. It illustrates the initial steps of a blade reduction with negatives of antero-lateral crested blades and at the back of the block, an undetached posterior crest.

Bidirectional removals widely dominate the sample. This observation is consistent with some of the previous analyses (*e.g.* Derevianko, Markin, *et al.*, 2001) but does not match with what is observed on some of the refits (Slavinsky and Rybin, 2007). Thus, this raises questions regarding the representative character of this specific sequence when considering the assemblage as a whole. Although showing some contacts with OH5, the majority of artifacts are, however, associated to OH4. This example of unidirectional reduction may illustrate a facet of the

assemblage variability. Blanks have mainly parallel edges and some are relatively massive.

A single Levallois point with a plain platform is associated with the sample (Derevianko, Petrin, *et al.*, 1998: Fig. 46, num.5). The occurrence of small blanks with natural backs and the only core observed suggest a production of small blanks from narrow-edge cores. Notable is the presence of a refitted, very narrow and long burin spall.

Plain platforms are more numerous than facetted ones, although this difference is not statistically significant. Dihedral platforms are rare, and the platform average thickness is larger than 4 mm with no thin abrasion visible on the external edge. Only one blank displays a strong smoothing of the edge. These features suggest that mainly stone hammers were used, with a possible use of soft-stone hammer.

The majority of the tools analyzed are classified as retouched blades. Some blanks are convergent, but only two artifacts are classified as retouched points. A blade has a continuous retouch ending with a distal truncation along the right edge and single endscraper is noted. Thin marginal retouch is the most common, alone, or combined with a steep or semi-steep retouch. No clear selection among the blanks could be observed.

To summarize, the assemblage from OH4 is difficult to characterize given its reduced sample size and due to a lack of identifiable cores. Initial phases of reduction occur at the site, with the removal of anterior or antero-lateral crests and possibly the shaping of posterior crests. The blade reduction is mainly bidirectional although some unidirectional sequences are illustrated by refits. The assemblage shows a combination of reduction from narrow-face and flat-faced cores testifying to both surface and volumetric core treatments. Due to the lack of analyzed cores, the relationship between these two approaches remains unclear. Mode B cores are absent from the stratified sample, but a production of small laminar element is attested to by the presence of a Mode A narrow-face core and by the presence of naturally backed blanks. The idea that this assemblage represents a transition toward a non-Levallois technology (Derevianko, Markin, *et al.*, 2001) is hard to test. Indeed, Levallois points are rare but still occur in this small sample. The illustrated blade reduction sequence seems to start from the intersection between two surfaces and to expand toward the broad face, and the blade overshot mentioned in the monograph as a core (Derevianko, Petrin, *et al.*, 1998) illustrates a reduction from two opposed platforms. Combined with the crested and side-blades, this suggest a sub-volumetric or volumetric core reduction. These technological features are similar to those observed in OH5 and OH6, but in the absence of blade cores, they cannot be linked with each-other. The most striking difference is the absence of convincing Mode B cores even though thick blade blanks are present.

5.2 UST-KARAKOL 1 SECTOR 1 (UK1-1)

As described earlier, the Ust-Karakol site is divided in three locations, Ust-Karakol 1 sector 1, Ust-Karakol 1 sector 2 and Ust-Karakol 2. Material from Ust-Karakol 1 sector 1 and 2 is presented here independently.

Originally, the material from UK1-1 cultural level 3 was described as a single assemblage by Derevianko and colleagues (Derevianko *et al.*, 1987). They describe it as a blade assemblage including massive blanks that are considered characteristic of the beginning of UP in Siberia. The cores illustrate parallel flaking on a single flaking surface from one or two striking platforms. They mention the rare occurrence of bifacial cores and several radial cores. One exhausted bifacial core is described as transformed into a side scraper (Derevianko, Shimkin, *et al.*, 1998). Some cores are described as possible preforms for wedge-shaped cores. Although displaying a radial preparation, they show a transfer of the flaking surface toward the ‘butt’ of the preform (Derevianko, Shimkin, *et al.*, 1998). Genuine wedge-shaped cores are absent and the authors note the lack of microblades. A large blade, of about 262 mm long, 42 mm wide and 20 mm thick stands out a as the largest retouched tool in the assemblage (Figure 179). The blank is curved, with a bidirectional dorsal pattern and bears continuous semi-steep and scalar retouch along the right edge and a mesiodistal discontinuous

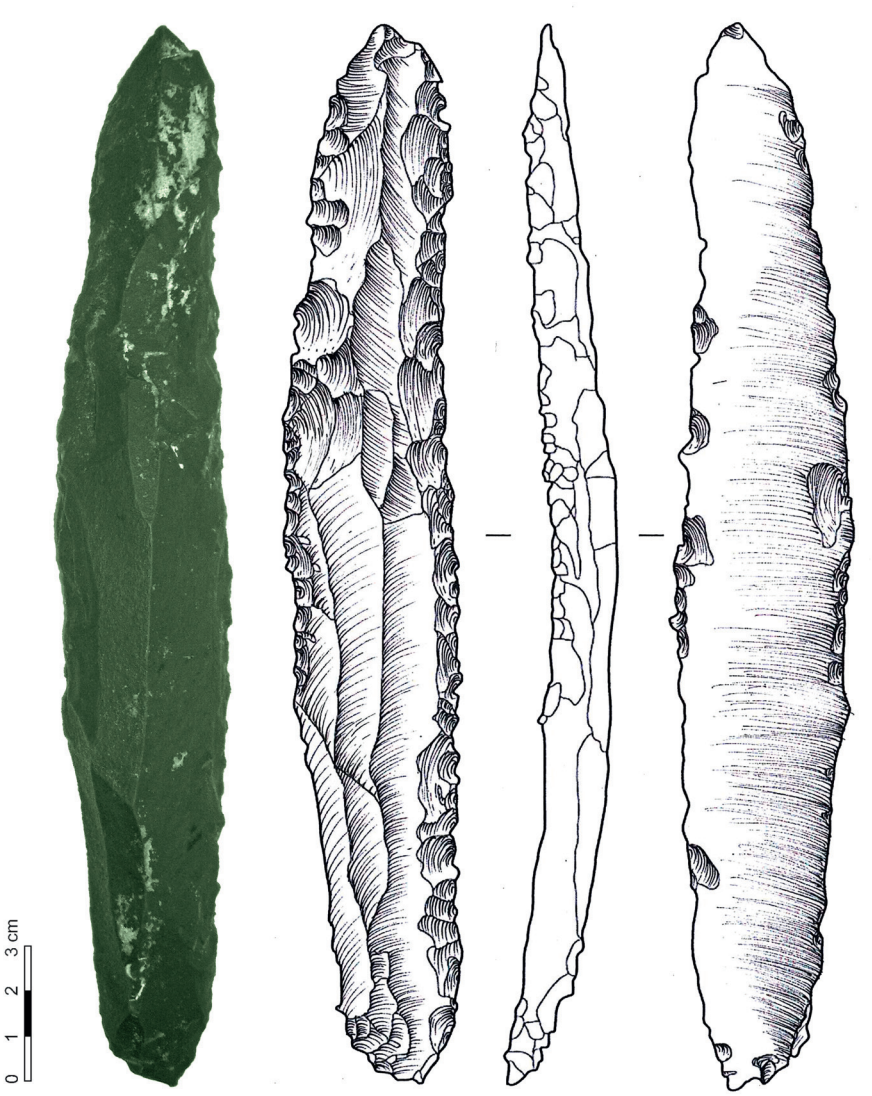


Figure 179: UK1-1, cultural level III (OH5.4-5.5?), massive retouched blade (redrawn after Derevianko, Shimkin, *et al.*, 1998)

retouch along the left edge. The platform and part of the bulb are missing. Depending on the authors, this artifact is typed either as a retouched blade similar to a 'dagger' (Derevianko, Shimkin, *et al.*, 1998) or as a 'double straight side scraper' (Goebel, 1994).

Among the tools listed, side scrapers are said to be the most numerous (Goebel, 1994; Derevianko, Shimkin, *et al.*, 1998). They are produced on blade and flake blanks with longitudinal, transversal or inverse steep, semi-steep and scalar retouch. Points are either atypical Levallois, with bilateral retouch, or are more amorphous. Some of these points are on massive laminar flakes and bear irregular scalar retouch. A series of retouched blades with ventrally flaked proximal ends is reported by Derevianko and colleagues (Derevianko, Shimkin, *et al.*, 1998) and also reported as 'unilaterally retouched bimarginal blades' by Goebel (1994). One of these blades is refitted on another fragment with a direct mesio-distal retouch along the right edge and a direct distal retouch on the left edge (Slavinsky, 2007) (Figure

180). The direct retouch is semi-steep and steep. The inverse retouch is a bit more invasive and extends along the right edge. The presence of bifacial tools is considered as rather atypical for the Altai (Derevianko, Shimkin, *et al.*, 1998). One is made on a massive long flake with a plano-convex cross-section and another one is leaf-shaped. Retouched blades are generally not numerous and include denticulate tool types. Some of the irregular retouch likely results from tool-use. Endscrapers are unstandardized, show bifacial treatment, and have lamellar retouch on their distal end. Burins are reported as rather amorphous and mainly produced on blades.

From a general point of view, the first categorizations of the UK1-1 layer 3 assemblages underline the coexistence of Mousterian and Upper Paleolithic forms, with uni- and bidirectional blade reduction, Levallois and discoid cores. This assemblage, for the first time, clearly illustrates the association of bifacial tools and blades with proximal thinning. The occurrence of some 'preforms' are interpreted as representing a possible initial stage in the production of wedge-shaped cores which subsequently occur all across Northeast Asia (Derevianko *et al.*, 1987; Derevianko, Shimkin, *et al.*, 1998). The primary reduction system is oriented mainly toward blades and Goebel (1994) notes that the cores are mainly flat-faced and subprismatic with a rare occurrence of Levallois elements. He characterizes the tool blanks as mainly unidirectional parallel with smooth (plain) platforms and an external edge prepared by trimming.

More recently, based on projections of the piece-plotted artifacts, Slavinsky (2007) proposed subdividing cultural level 3 into several assemblages designated as OH5.1 to OH5.5. He suggests the existence of two different traditions. The first tradition is represented by OH5.4 and OH5.5 and shows similarities with the material from Ust-Karakol 1 sector 2 (UK1-2) strata 11 to 8. According to some of his refits, UK1-2 strata 11 to 8 'do not represent a single habitation horizon' and show some similarities with strata 15/12 (Slavinsky, 2007). The second tradition, although not described in detail, is considered as distinct. A small series of refits from the OH5.4 indicate that the material is practically undisturbed and represents a single short-term occupation. Bifacial elements, blades with proximal inverse retouch, and most of the blade production belong to OH5.4 and OH5.5.

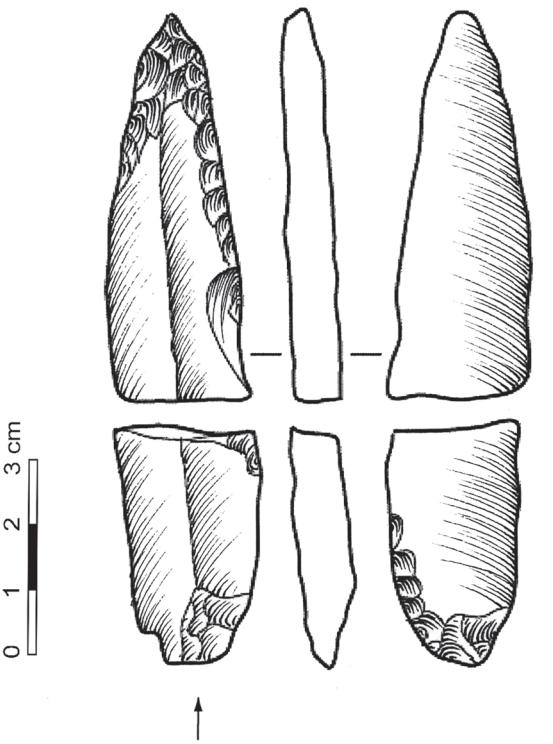


Figure 180: UK1-1, OH5.4-5.5, refit of pointed blade with proximal thinning (redrawn after Slavinsky, 2007)

In the present study, Slavinsky's views on the cultural level 3 are tested using vertical projections of the same spatial dataset. The results are in agreement with his suggestion to divide the cultural level 3 into five sub-units. Thus, assemblages were studied here independently in order to test Slavinsky' second suggestion regarding the existence of two distinct techno-cultural units. The results are presented with OH5.1, 5.2 and 5.3 grouped into one sample, and OH5.4 and OH5.5 grouped into another.

5.2.1 OH5.4-5.5

Although the assemblage was sometimes described as produced mostly on chert (*e.g.* Goebel, 1994),

the material appears to be metamorphic, some with porphyria inclusions. Large blade reduction is documented by two main types of cores on blocks or on large flakes: cores with a main flaking surface located on a narrow face (Mode A1 and A2) and cores with two separated flaking surfaces (A6 and A7). Both show uni- and bidirectional reduction systems. The largest blocks are Mode A1 cores with a single flaking surface located on the narrow face and showing some unidirectional negatives. These cores show a significant amount of cortical or natural surfaces and represent an initial stage of reduction. Mode A2 is represented by an atypical small size cortical flake, with two platforms and a single removal. The idea that strict unidirectional removals correspond to the early stages of reduction is reinforced by the absence of bidirectional cortical blanks. The Mode A6 and A7 illustrate an advanced stage of reduction and some of them appear rather exhausted. They show a bidirectional reduction on a broad face from two opposed platforms but also a second flaking surface on a narrow face. Reconstruction of the reduction stages shows that, at least occasionally, the two flaking surfaces interact. Blanks are detached from the broad face, extending to the narrow face and going back to the broad face. Other examples show attempts to remove a crested blade from the narrow face at the end of the reduction. One example appears unidirectional, but the median part of its flaking surface has been removed by an overshot. The second narrow face, opposed to the flaking surface, is sometimes prepared as a posterior crest. Thus, the core morphology illustrates a volumetric or sub-volumetric approach consistent with the occurrence of specific technical blanks such as crested, neo-crested, *débordant* and naturally backed blades. These blanks are removed from the intersection between two surfaces and range from 50 to 100 mm long and 25 to 40 mm wide. This, together with the sequences of removals observed on the cores, may indicate that lateral management of convexities happens during several stages of core reduction. Thus, it is assumed that reduction starts with unidirectional removals, using naturally shaped crests, then extends to the broad face of the core and proceeds by bidirectional removals from two opposed platforms. The convexities are managed by removing a thick crested or *débordant* blade from the intersection of the broad and narrow face. Then, reduction continues on the broad flaking surface. The narrow flaking surface visible on the core corresponds to the last attempts to resume the process before the reduction ends. Most of the cores show the use of a single narrow face, but in one case small hinged negatives and the shaping of an anterior crest could indicate that a second narrow face was tested for similar purposes. In sum, the large blade production is based an interdependence between surfaces and indicates a sub-volumetric conception of the core morphology. The presence of a radial Levallois core is also noted.

Blanks are classified as convergent or parallel according to the orientation of their edges. Convergent blanks, although not numerous, show a high degree of variability in terms of size and shape. Some examples are massive and elongated, others are relatively small. Both bidirectional and unidirectional dorsal scar patterns are observed and the direction of removal does not seem to be correlated with the size of the blank. It is assumed, therefore, that bidirectional reduction is adopted rather early in the reduction process. These observations partly contradict Goebel (1994) who, although noting the coexistence of uni- and bidirectional scars, retained unidirectional as clearly dominant. Some of the blanks are typologically Levallois points. Most of the blanks with parallel edges are fragmented; however, some of them appear remarkably massive. Both unidirectional and bidirectional dorsal scar patterns coexist in roughly equal proportions and the occurrence of massive blade fragments with bidirectional patterns seems to confirm a rather early use of two opposed platforms in the course of the reduction.

Two cores on thick blades occur in the sample and are classified as Mode B5 and Mode B7. From their asymmetrical section and from their thickness, it appears that the core blanks are *débordant* blades struck from a large blade core. The Mode B5 core shows a rather intense reduction along the left edge that proceeds from two opposed platforms. Some discontinuous retouch could be seen as a posterior crest, although its technological relevance remains unclear. Striking platforms are plain with a marginal faceting. The Mode B7 core is made on a thick asymmetric blade with a proximal truncation. It shows

several opportunistic attempts to initiate a reduction process using the available natural edges. Some of the removals extending on the broad face of the core blank are posterior to the truncation. In this context, and following a technological approach, the alternate retouch along the edges could be seen as a posterior crest. These cores produce small laminar blanks and some of which may be naturally backed.

The platforms are facetted and plain, with the notable occurrence of partial faceting. The proportions reported here are significantly different from those collected by Goebel (1994) based on the retouched toolkit. For the most part, the external edge bears no evidence of thin abrasion, but a few blanks show a strong abrasion combined with a lip. Trimming (Goebel, 1994) is not counted here as platform preparation as its role in the blank removals is not clearly defined. The mean of platform thickness is higher than 4 mm. Considered as a whole; these features indicate the use of hard hammer percussion with a possible use of soft stone hammer.

Among the distinctive features of the retouched toolkit are blades with proximal inverse retouch. The examples included in the sample are all mesio-proximal fragments and represent one of the most recognizable typological components of the retouched toolkit. The refitted point, although it could not be included in the studied sample, is of great importance as it indicates that these blades were likely pointed. The massive blade mentioned earlier could not be included in the studied sample as its provenience could not be assessed. It is not clear if it this artifact is associated with OH5.4-5.5, but the dorsal scar pattern and the massive aspect of the blade are consistent with such an attribution. As described below, technological features of OH5.1-5.3 are different (unidirectional reduction, absence of blade cores, quasi-absence of blades) and do not match with the production of such blanks. Bifacial elements are also part of the retouched toolkit. They show a high degree of variability in shape and in technology. One is typed here as a Keilmesser and is produced on a slab. The two others can be typed as bifacial leaf-points, one of which is on an unknown blank and the other on a blade blank. The largest biface is not included in the studied sample but is clearly associated with OH5.4-5.5.

5.2.2 OH5.1-5.3

The remaining part of the material attributed to OH5 is mainly characterized by a series of microblade cores. They are produced on small river pebbles and oriented exclusively toward the production of very small blanks. These pieces have been previously interpreted as wedge-shaped core preforms (Derevianko *et al.*, 1987; Derevianko, Shimkin, *et al.*, 1998) due to the extension of the cortex visible on some of them which may indicate a rather low degree of reduction. Others show at least two distinct flaking surfaces related to orientation changes in the course of reduction. This could indicate a more intense exploitation of the cores or an opportunistic exploitation of the shape of the nodule. The reduction is volumetric and semi-turning, unidirectional, and with lateral preparations. The bifacial preparation and the 'counterstrike' mentioned by Derevianko (1998) probably correspond to a combination of lateral preparation and tablet removals. More generally, and as suggested previously, these cores share some similarities with wedge-shaped cores (Derevianko 1998) or prismatic cores (Goebel, 1994) based on their volumetric form and the fact that their flaking surfaces are primarily located on a narrow face. Typologically, some of them are close to carinated endscrapers cores (Demars and Laurent, 1992).

Derevianko and colleagues (Derevianko, Shimkin, *et al.*, 1998) also notes that, in this assemblage, the actual microblades are lacking. One would expect to find the spalls detached from these cores; however, their small size would have required a systematic screening of the sediment with a 2 mm mesh. No precise mention regarding the screening procedure could be found, and the lack of screening may partly explain the absence of such artifact class. Although in the European record such a technology is usually assumed to be linked with the use of an organic hammer, the absence of abrasion does not allow any clear identification of the percussion technique.

The blade production is rather poorly represented in the assemblage, but the blades observed show unidirectional dorsal patterning and a curved profile. A pronounced oblique angle combined with the general morphology observed on blank overshots indicates, at least occasionally, the occurrence of a volumetric core reduction. Platforms are small (< 4mm thick) and bear a pronounced lip. A few examples display thin abrasion on their external platform edge.

To summarize, the main characters previously noted on the UK1-1 assemblage when treated as a whole also occur in the results of this analysis (Derevianko *et al.*, 1987; Goebel, 1994; Derevianko, Shimkin, *et al.*, 1998). The main differences are expressed in the blank analysis with regard to the dorsal patterning and the platform preparation. These differences are possibly due to the fact that the assemblages studied are different; Goebel considered OH5.1/5.5 as a whole and recorded technological attributes exclusively on the retouched toolkit. Moreover, some methodological differences concerning the definition of attributes (faceting, trimming) could result in the observed differences. The present analysis finds its best match with the Slavinsky's study (2007) both in terms of the taphonomy and technology. First, the taphonomic reassessment of the assemblage underlines the necessity of recognizing five archeological occupations within cultural level 3. Second, the technological approach suggests the existence of two distinct technological traditions belonging respectively to OH5.1-5.3 and to OH5.4-5.5. The first is characterized by a microblade component, as illustrated by a series of small prismatic and sub-prismatic unidirectional cores on small-size pebble blanks. These cores show an opportunistic volumetric approach oriented toward a frontal and semi-turning reduction from a narrow face. Orientation changes are frequently observed and likely correspond to an adaptive strategy that uses available angles and convexities offered by a small size blank to a strict volumetric reduction. These cores have been identified in previous studies and were considered either as wedge-shape cores preforms (Derevianko, Shimkin, *et al.*, 1998) or as sub-prismatic cores (Goebel, 1994). The few blades available indicate a fully developed volumetric technology. By contrast, OH5.4-5.5 shows a production from massive down to medium-size blades, convergent or parallel, and by a sub-volumetric, bidirectional reduction sequence. The cores illustrate an interaction between two surfaces and the repeated use of crested and *débordant* blades. The bidirectional reduction includes short unidirectional sequences. In addition, some of the thickest technical blades are turned into cores for the production of small blades/bladelets. The most notable retouched tools belong to the OH5.4-5.5 assemblage. These confirm the coexistence of various bifacial tools and points on blades with basal thinning as suggested by Derevianko (1998). Some specific technological features such as partial faceting and *débordant* platforms are noted. As reported by previous authors (Goebel, 1994; Derevianko, Shimkin, *et al.*, 1998), the Levallois component is poorly expressed and consists mainly in the occurrence of Levallois points among the convergent blanks and of a Levallois radial core. Other type of tools, such has naturally backed knives, awls, angle burins and notches are mentioned. Notable too is the mention of foliated bifaces (Derevianko *et al.*, 2003).

5.3 UST-KARAKOL 1 SECTOR 2 (UK1-2)

Derevianko and Volkov (2004) described the blade technology in UK1-2 as the gradual development of two main trends (Figure 181). Trend 1 is a deeply rooted process that illustrates in five stages a continuous transition from the earliest level of occupation (stratum 18) to the Upper Paleolithic (stratum 9). It is described as a shift from a preferential Levallois flake production with radial preparations to a blade production with preparations occurring only on the distal end of the flaking surface. Until stage 3, the sub-radial opposed removals visible on the distal part of the flaking surface are interpreted as distal preparations. Starting from stage 4, an additional striking platform appears, but it is considered by Derevianko and Volkov (2004) as strictly devoted to rejuvenation. The final stage shows a narrowing of the flaking surface.

The second trend is described in 4 stages as a gradual transfer of the core flaking surface from the broad face to the narrow face. This trend has a less deep time depth as it develops only from strata 11 to 9. Trend 2 does not include the use of an auxiliary plat-

form. The shift from flake production on the broad face of the core (stratum 11) to the narrow face (stratum 9) is proposed to be mainly driven by the exhaustion of the core. The exploitation of the narrow face is then considered as a technological response allowing a longer reduction by switching flaking surfaces. The trend 2 is described by Derevianko and Volkov (2004) as a rather basic technological system mainly adapted to raw material nodules of tabular shape and producing poorly standardized elongated flakes. The shift of flaking surface is considered as an evolutionary development, representing a possible origin of microblade production (Derevianko and Volkov, 2004). Furthermore, the same authors say that these methods are associated with a generalized use of pressure flaking.

Recently, taphonomic issues have been raised regarding the material from UK1-2. Refitted artifacts show vertical movement between strata 15/12 to strata 8/11 (Slavinsky, 2007). This situation is particularly problematic as strata 15/12 assemblages are attributed to the MP of Levallois-Mousterian tradition. When looking at the published UP material (*e.g.* Derevianko *et al.*, 2003), it clearly appears that the majority of Levallois elements occur between strata

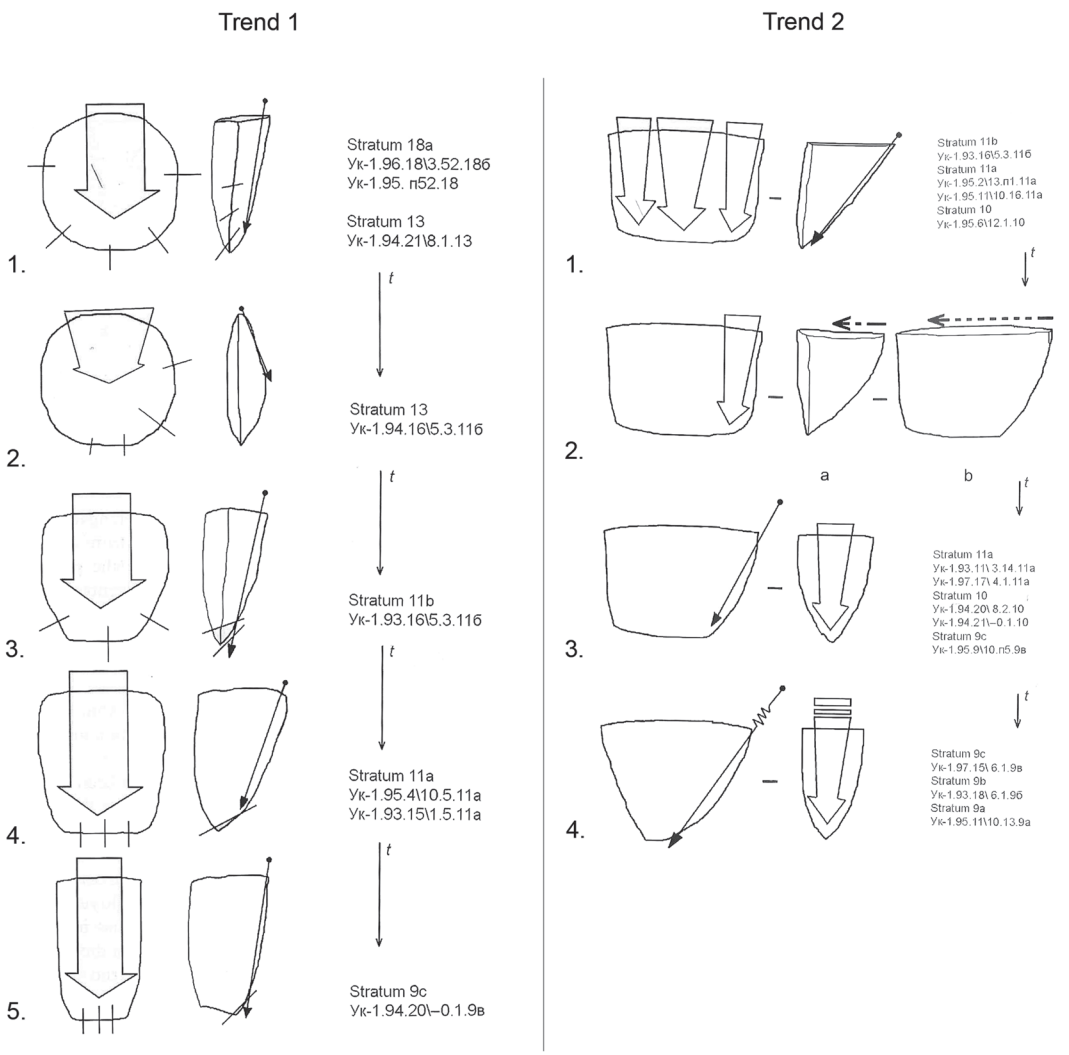


Figure 181: UK1-2, Evolutionary trends of the Ust-Karakol laminar production as proposed by Derevianko and Volkov (2004)

11 and 10. Furthermore, the majority of the microblade cores are concentrated in strata 10 and 9, although they occur sporadically within strata 11 and 10. Although this situation has been interpreted as illustrating a transitional process, vertical movement of artifacts could play a in creating these assemblages. For these reasons, the assemblages from UK1-2 are treated here as a whole and mainly qualitatively.

The technological features of blade reduction in strata 11 to 8 display an association between uni- and bidirectional cores. One blade core displays two striking platforms and clear hinged removals up to the middle part of the flaking surface. Although described by Derevianko and Volkov (2004) as showing an auxiliary opposed platform, this specific case illustrates a convincing bidirectional reduction. Indeed, on some of the cores the removals are rather short or fragmentary, which could indicate the dominance of one striking platform over the other. This strategy could facilitate the production of blades with a straight profile and a series of short blade removals. At least a third of the complete blanks and byproducts show opposed negatives on the distal part of their dorsal face (Pelegrin, 1995). The dorsal patterning seems, however, mostly unidirectional, and the few bidirectional blanks in the assemblage are mainly fragments of all kinds. Generally speaking, the discrepancies between the cores and the blank dorsal patterning could be explained by the high rate of fragmentation and undetermined dorsal patterns. Moreover, cores seem reduced following rather long unidirectional sequences before a platform switch and, therefore, produce mainly unidirectional blanks. As suggested by Derevianko and Volkov, (2004), opposed removals may also represent management of the flaking surface distal convexities.

Beside the blade production, artifacts linked with a production of microblade blanks are among the most representative of this assemblage. This includes a series of cores, unretouched blanks, technical pieces and a few retouched artifacts. In other words, most of the elements of the reduction sequence are identified. Core blanks are mainly on slabs, small size pebbles or cortical flakes. For the most part they display a triangular flaking surface located on a narrow edge. The pattern of reduction is unidirectional with crested elements used to initialize or resume the reduction process still visible on the core flaking surfaces. Lateral flakes are removed from the striking platform or from a provisionary opposed platform in order to keep the flaking surface narrow and triangular. This type of core corresponds to the wedge-shaped cores previously mentioned (*e.g.* Derevianko *et al.*, 2003). A few fronto-lateral flakes occur in the set, indicating that removals are detached from the corner between the flaking surface and the side of the core. This form of core management may be linked with the presence of cores with nosed or shouldered endscraper morphology, as they create a notch narrowing the flaking surface. Carinated endscraper core forms occur in small numbers with some of them showing orientation changes in the course of reduction. Carinated and nosed endscraper forms are listed as an Aurignacian feature based on analogies with the European record (Otte and Derevianko, 2001). These types are, however, not frequent in the UK1-2 set and are often combined with a reduction from the narrow face. This suggests that they may represent an opportunistic adaptation of UP microblade technologies to the shape of small pebble core blanks (Zwyns and Flas, 2010).

Carinated burins are absent with the exception of an antero-lateral neocrested blade that bears a few mi-

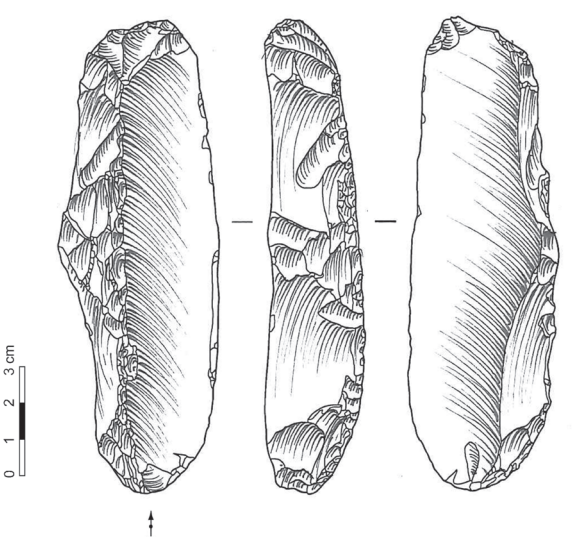


Figure 182: UK1-2, stratum 9, carinated burin on neocrested blanks (redrawn after Derevianko *et al.*, 2003)

croblade removals on its distal end, opposed to small platform preparations (Figure 182). Notable is the presence of a truncated-facetted core produced on a flake.

From a general point of view, the good representation of small platforms (<2 mm thick) and of thin abrasion suggests the use of organic hammers with an occasional use of stone hammers. Cores do not display a grooved flaking surface. Microblade negatives do not show clear parallel edges and are too irregular to be convincingly associated with pressure flaking as defined by Tixier (1984).

Unretouched blanks are poorly standardized and highly fragmented. Although retouched microblades are described as backed (Derevianko *et al.*, 2003), no abrupt retouch could be observed. Instead, retouch is rather thin, or semi-steep. One retouched microblade corresponds to a small-sized Font-Yves point (Demars and Laurent, 1992). This type of retouched element is quite common in Upper Paleolithic assemblages. More diagnostic are the Dufour bladelets (Demars and Laurent, 1992) which occur mainly in Aurignacian or Proto-Aurignacian contexts in Europe (*e.g.* Demidenko, 2001; Bon, 2002; Sinitsyn, 2003; Broglio *et al.*, 2005; Bordes, 2006; Teyssandier, 2006; Zwyns, in press) or the Near-East (*e.g.* Bergman, 1987, 2003; Chazan, 2001; Fox, 2003; Monigal, 2003; Soriano and Ploux, 2003; Goring-Morris and Belfer-Cohen, 2006) but also in the Zagros Aurignacian (Otte and Kozlowski, 2007; Otte *et al.*, 2007, 2011; Tsanova *et al.*, 2012) and in other assemblages from Central Asia (Derevianko, Islamov, Kolobova, *et al.*, 2008; Kolobova *et al.*, 2008; Flas *et al.*, 2010; Zwyns and Flas, 2010). The two examples here are fragments and present some atypical features. One is on the distal end of a rather thick blank with alternate retouch. The second is a mesial segment with an inverse retouch located along the left edge, a feature which is rather atypical in Aurignacian context. Some of the retouched blades appear similar to Aurignacian blades including a slightly strangled *(étranglée)* blade. The *lame Aurignacienne* type of tool was recognized in southwest France and is described as massive blades with continuous scalar retouch (Demars and Laurent, 1992). Although this broad definition implies a certain ubiquity, only a few blades in the UK1-2 assemblage could correspond to it. A fragment of bifacial tool produced on an unknown blank type is worth mentioning (Figure 183). In addition to the described material, various UP types of retouched tools were recognized, including a fragment of blade with bifacial retouch.

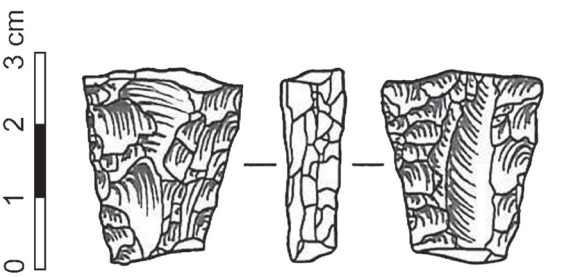


Figure 183: UK1-2 stratum 9 (redrawn after Derevianko *et al.*, 2003)

To summarize, the present analysis is in agreement with the view of the UK1-2 assemblage as mainly Upper Paleolithic. The laminar technology shows a general volumetric conception with unidirectional reduction and the use of crested elements. In addition, a separate reduction sequence oriented exclusively on small bladelet/ microblade blanks reinforces the idea of a fully developed Upper Paleolithic technology. This technology uses direct percussion, and no evidence for pressure flaking occurs in the assemblage. The elusive presence of Levallois elements, of facetted platforms, of bidirectional blade reduction (including one Mode B core) has to be interpreted carefully given the taphonomic issues suggested by the refits. In spite of the fact that, in the present analysis, the material from strata 11-8 is treated as a whole; it appears quite clear that the Levallois technological component is concentrated between strata 11 and 10. Vertical movement of artifacts coming from the Levallois-based strata 15-12 cannot be excluded. Moreover, the lack of connections between the excavation areas from UK1-1 and UK1-2 make attempts to correlate the sequences rather difficult. The evolutionary reconstruction proposed by Derevianko and Volkov (2004) will be discussed in the next chapter.

5.4 ANUY II

Taphonomic analyses have not yet been performed on this rich collection. Previously published work on the material underlines the existence of sterile horizons between the OH, and the preservation of combustion features seems to indicate that high energy post-depositional processes did not rework the sequence (Derevianko *et al.*, 2003). The apparent truncation of some strata (strata 7 to 11; OH1 to OH7) could indicate erosional processes affecting the upper part of the archeological sequence.

As mentioned earlier, the lithic assemblages from Anuy II OH6-12 are attributed to a single tradition typical of the middle part of the Upper Paleolithic (Derevianko, Markin, *et al.*, 2001; Derevianko *et al.*, 2003). The blade reduction is described as quite variable but dominated by a parallel pattern of reduction, including prismatic and narrow-faced cores. In addition, wedge-shaped, narrow-face, and prismatic cores are associated with a microblade production. All microblade cores have a plain platform and display parallel microblade removals on their flaking surface. The blanks bear parallel removals on their dorsal face. Derevianko and colleagues (Derevianko *et al.*, 2003) consider the 'micro-tool' category as the most characteristic for the Anuy II assemblage. It includes tools on microblade and bladelet blanks, (described as 'Gravettian micro-points') with converging edges, displaying marginal abrupt retouch but also micro-endscrapers, retouched microblades and angle borers. Endscrapers, backed knives, dihedral and angle burins are also mentioned.

The results of the qualitative analysis are in good agreement with these descriptions of the assemblage. Large blade cores are not numerous, but show a minor occurrence of bidirectional reduction, either on volumetric or flat-faced cores. The frequency of platform switches is not clear, and according the dorsal patterning observed, bidirectionality could appear as rather marginal. Platforms are mainly plain, with lips and traces of thin abrasion. Indeed, the production of bladelets and microblades is the most typical feature observed. Cores are produced on nodules and slabs of metamorphic rocks selected among the pebbles brought by the Anuy and the Karakol rivers. The first type of reduction takes place mainly on a triangular flaking surface located on the narrow face of the core. Removals are detached from plain platforms with an occasional sub-convergent orientation. Some of the cores show traces of posterior crests on the distal part of the flaking surface or opposed lateral removals maintaining the triangular shape of the flaking surface. Some the cores have their lateral surface shaped by a crest. These cores are categorized as narrow-faced cores, and according to the size of the removals, mainly produced small blade/bladelet blanks. Among other features, the lack of parallelism in the negatives and the smooth external edge of the cores (with thin abrasion), however, rules out the use of pressure flaking. More rarely, cores are reduced on a broad surface, adopting a carinated endscraper form or show a morphology between carinated and narrow-fronted. The latter illustrates a change of orientation in the reduction with the two flaking surfaces being perpendicular. Two atypical Mode B cores occur at the bottom of the sequence. Also, the occurrence of a flat-faced core in OH9 (Derevianko *et al.*, 2003, Fig.: 177, num. 5) and of a sub-volumetric core in OH11 (Derevianko *et al.*, 2003, Fig.: 178, num. 9) are noted, but these artifacts could not be studied.

Retouched blades include endscrapers, burins and sidescrapers (Derevianko *et al.*, 2003, Fig.: 179, num.2) types but also a rather massive blade with a curved profile and continuous retouch (Derevianko *et al.*, 2003, Fig.: 179, num.7). Burins are mainly angle burins on retouched blades. One example is an axial dihedral burin on an oblique truncation (Derevianko *et al.*, 2003, Fig.: 184, num. 11), and one is a multiple burin. Burins usually show a relatively narrow chisel. One reported burin is a *burin plan* with removals perpendicular to the blank axis (Mode B4) (Derevianko *et al.*, 2003, Fig.: 184, num. 10).

The retouched tool kit includes a small series of retouched bladelets and microblades. Among the types observed, pointed small blades with a distal oblique truncation have been previously typed as 'Gravettian micro-points' (Derevianko, Markin, *et al.*, 2001; Derevianko *et al.*, 2003). They differ significantly from *microgravette* points as they do not display a straight back made of continuous abrupt retouch but rather a

combination of semi-steep and steep retouch localized mainly on the distal part. Furthermore, they are produced on a small blade blank rather than on a microblade. Micro-endscrapers are produced on rather irregular bladelet blanks. One fragment of Dufour microblade of Dufour sub-type is documented on a straight unidirectional blank. It displays an alternate, thin, marginal retouch with the inverse retouch along the right edge. Bilaterally retouched small blades and microblade fragments are also present. Among the retouched tools, a series of endscrapers, including nosed endscrapers, show small bladelet removals on their front. Whether these artifacts are cores or tools is not clear (*e.g.* Derevianko *et al.*, 2003, Fig.: 179, num.2; 22). The presence of micro-endscrapers suggests a reduced size for this type of tool, but it could also imply a production of small bladelets comparable to the ones described for endscrapers of Caminade type (Morala *et al.*, 2005).

The collection from Anuy II clearly shows a majority of Upper Paleolithic features. The collection observed suggests a fully developed blade and microblade technology obtained by direct percussion. The volumetric conception of the cores is generalized, even though a certain degree of variability is observed. The results of this study are almost in full agreement with the previously published work. A thorough attribute analysis describing each OH independently could bring some additional insight on the assemblage's variability.

5.5 ANUY III

The small assemblage from the level 12 of Anuy III has been described as providing evidence of a well-developed parallel reduction from prismatic cores together with a significant proportion of microblades (Derevianko, Shunkov, *et al.*, 2000; Derevianko and Shunkov, 2002). The tool kit is dominated by Upper Paleolithic tools with only a few notch-denticulates as isolated Middle Paleolithic types. Upper Paleolithic types are described as carinated endscrapers, asymmetrical points on retouched blades and backed microblades (Derevianko and Shunkov, 2002).

In spite of a fairly reduced sample size, the Anuy III assemblage includes a series of retouched microblades. These artifacts illustrate a significant variability in terms of retouch types. The microblades are exclusively unidirectional blanks and display direct retouch, on the right or left edge with thin, semi-steep or steep retouch. Two of them have straight backs and are typed as backed bladelets. The blanks are likely detached from cores with carinated endscraper morphology. Notable is the occurrence of a small sub-volumetric bidirectional core.

5.6 SUMMARY

After comparing the results of this study with the general framework, several observations can be formulated. First, the existence of two UP traditions as proposed by Derevianko, (2011a; see also chapter 1) seems reinforced by the present reconstruction of the laminar reduction sequences. Two technological systems are present with deep structural differences in 1) blank production techniques, 2) in tool typology and 3) in technical systems. Second, even if this study is in a general agreement with the previously published material, technological interpretation may differ, leading to alternative proposals for the definitions of each tradition and for the assemblages associated with each. A first technological trend is fully expressed among the assemblages of Kara-Bom OH6-OH5 and UK1-1 OH5.4-5.5 and is characterized by the coexistence of Levallois points and volumetric blade technology. In the following Chapters, this variant is reffered to as Initial Upper Paleolithic (IUP) (Kuhn *et al.*, 1999; Kuhn, 2003). Kara-Bom MPH1, although originally described as Mousterian of Levallois tradition, finds its best fit within the IUP. The small sample size, the lack of diagnostic features and reliable chronological landmarks do not allow further assignments. In fact, the occurrence of Levallois flake cores and of MP tool types is not exclusively a Mousterian feature and are, meanwhile, parts of the variability observed among IUP assemblages. From a techno-typological point of view, Kara-Bom OH4 is considered as much closer to IUP than to any other described assemblages. Of course, MPH1 and OH4 lack some of the typical IUP markers, but this is not surprising given

their reduced sample size. The second technological trend is recognized in UK1-1 OH5.1-OH5.3, UK1-2 strata 11-8, Anuy II strata 6-12 and Anuy III stratum 12. Technological and typological characters of this trend indicate a developed Early Upper Paleolithic (EUP) technology. None of the IUP and EUP assemblages studied can be associated with the use of pressure flaking technique.

6 – Research question 1: technical traditions and laminar technology

As described in the previously, two distinct technological systems emerge as a result of the present analysis. In the following sections, a more global reconstruction comparing the technological systems is proposed. Besides the laminar technology, some typological elements are included when considered highly diagnostic and relevant for the comparison.

6.1 THE INITIAL UPPER PALEOLITHIC LAMINAR TECHNOLOGY

This technical tradition is identified at Kara-Bom in OH6 and OH5 and at UK1-1 in OH5.4 and OH5.5. In addition, it is argued that, although based on smaller samples, Kara-Bom OH4 and MPH1 share similarities with the trend described below.

6.1.1 LARGE TO MEDIUM BLADE REDUCTION SEQUENCE

The Initial Upper Paleolithic blade technology relies on the exploitation of high quality local raw material. This raw material mainly consists of fine-grained metamorphic rock (Figure 184). The blocks are likely selected for their large size, general rectangular in shape, and offering natural crests or sharp angles to initialize the reduction. The block is then flaked using a natural crest or by the shaping of an initial crest at the angle of the block. The first removals are likely detached behind the crest and progressively extend toward the broad face of the core. The occasional use of a median crest cannot be excluded. The technology produces massive, elongated blades, with parallel or convergent edges. A certain degree of gigantism can be observed in the blade production and represents one of the distinctive features of IUP assemblages. Cores are not strictly volumetric as they are reduced using two distinct surfaces interacting with each other. This approach is described here as sub-volumetric. The main flaking surface is located on a broad face and is flaked from two opposed surfaces. After a certain number of removals, the flaking surface tends to flatten. A thicker blade is then removed from the intersection with the narrow face, either using a natural edge of the block (*débordant*, naturally backed) or by the preparation of a posterior crest. This operation allows resumed reduction by shaping a new flaking surface convexity. This sequence is then repeated until the exhaustion stage. Most of the cores are considerably reduced with the last removals visible being medium size blades. Usually, a single narrow face bears traces of removals, and the other face sometimes shows an anterior crest. Flat-faced cores without signs of removals on their narrow face are rare. Depending on the degree of preparation visible on their edges, the latter may be categorized as Levallois blade cores. In addition, some narrow face cores occur but do not necessarily represent a distinct reduction process and could also reflect a different stage of exhaustion.

Beside the technical side blades, two types of blanks are detached. Some display parallel edges and some have more convergent edges. Looking at the reduction sequence, it appears difficult to disentangle these two productions as they are integrated into a single process. Furthermore, both of these blanks are retouched, thus confirming their respective intentional character. Up to circa 50% of the blanks show bidirectional removals on their dorsal face, reflecting that the bidirectional reduction represents here a succession of short unidirectional sequences.

Platform preparation is a highly distinctive feature of these assemblages. It shows a combination of plain, facetted, and dihedral platforms. A specific type of faceting, or trimming, occurs on some of the blanks. This preparation is typical of IUP assemblages but

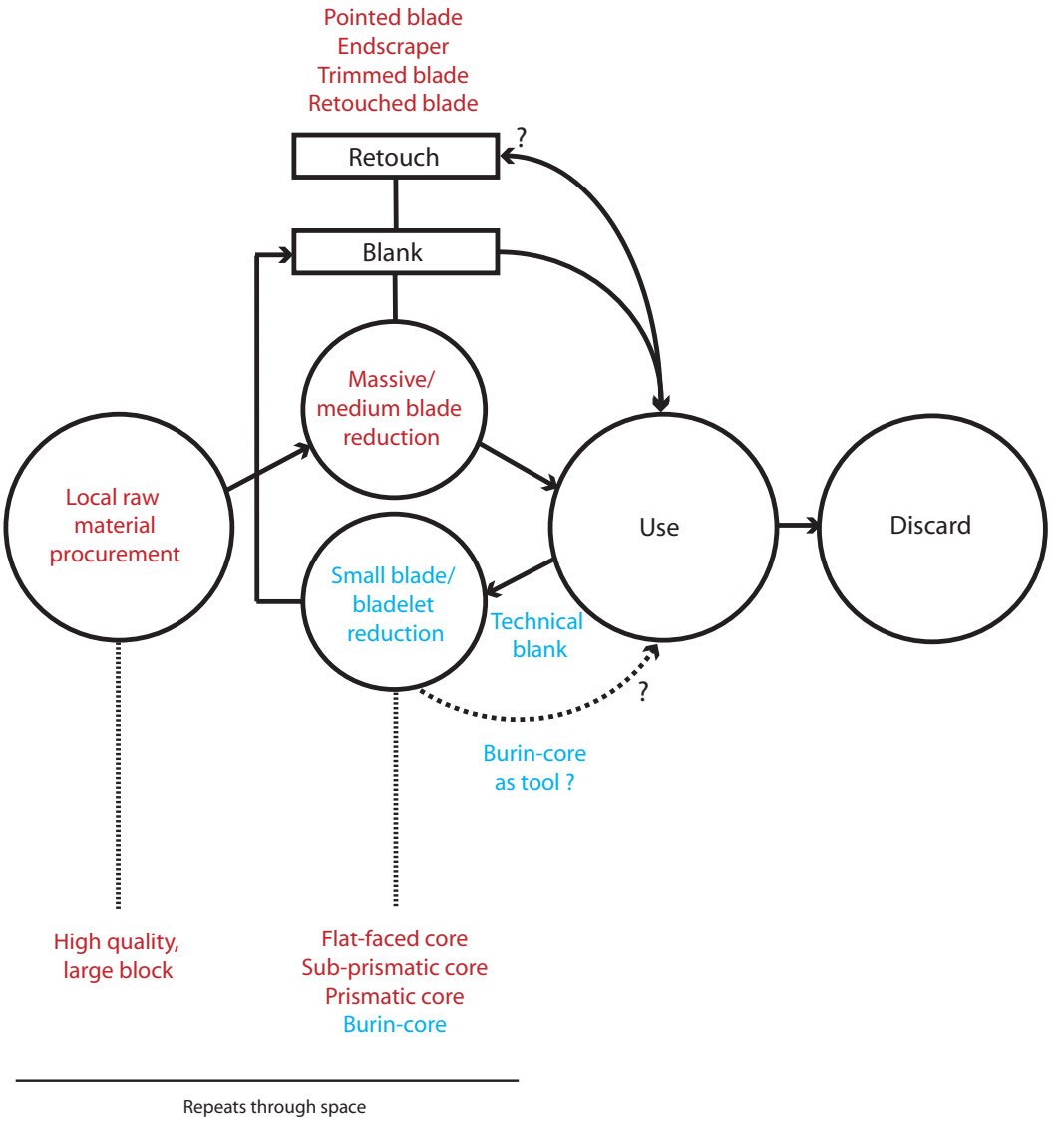


Figure 184: Analytical reconstruction of IUP laminar reduction sequences

may also reflect a singular response to the constraint imposed by the kind of percussion in use. In addition, some facetted *débordant* platforms are observed. They can be recognized by their clear and thin faceting, indicating a platform preparation rather than a crest. Generally speaking, such preparations may be related to the production of large and robust blanks. Extreme abrasion of the platform external edge is an additional recognizable feature. Although having a rather low frequency, it is observed among all studied IUP assemblages. The total absence of thin abrasion of the external edge and the platform and bulb attributes indicate hard-hammer percussion with a possible use of soft-stone hammer. Cores associated with this production are generally considerably smaller than the largest blade specimen. Discarded massive blade cores are unusual and neo-crested blanks occur in various sizes. These elements suggest, at least occasionally, an intense reduction of the large cores or their exportation.

6.1.2 SMALL BLADE TO BLADELET TECHNOLOGY

IUP laminar technology also includes the production of small blanks, ranging from the small blade down to the bladelet size. They are detached from Mode B cores exclusively produced on blades and which, typologically, fall into various categories of burin. They are characteristic of what is defined here as the burin-core (BC) technology. The BC blanks are selected among the thickest blades and laminar flakes produced by the large blade sub-prismatic reduction sequence. As described earlier, most of them are detached from the intersection between the two surfaces and are either *débordant*, naturally backed or crested. They usually display a trapezoidal or triangular section of minimum 10 mm and up to 40 mm thick. Some of the core blanks show traces of percussion on their cross-sections, indicating that at least occasionally, the core blank selected is intentionally snapped.

In the Chapters 3 and 4, BCs have been classified in several categories according to the quantity and to the location of their flaking surfaces (Mode B1-B7). This analytical classification is interpreted as reflecting different degrees of core exhaustion.

Modes B1 and B2 have a single flaking surface bearing a few unidirectional removals. They represent the initialization and the beginning of the reduction. In these early stages, the Mode B1 is the most frequent with removals detached from the proximal end of the core blank. Mode B2 occurs when the blank shows a relatively thick mesio-distal end. Mode B3 shows two flaking surfaces located on the two edges. Mode B5 represents a stage of active reduction. Removals are detached from two opposed platforms along a single edge. This mode is by far the most frequent in the studied samples, showing that the reduction ends frequently at this stage. Mode B5 also includes tested cores when they display the preparation of two opposed platforms. Modes B6 and B7 are not frequent and illustrate an advanced stage of reduction. Mode B6 shows a reduction from two opposed platforms along both edges, giving to the BC a lozenge shape. Mode B7 groups the BC with a flaking surface extending toward the broad face of the core.

BCs are characterized by their flaking surface parallel to the long axis of the core blank (Figure 185). The reduction proceeds by brief unidirectional sequences between platform changes or by alternate bidirectionality. As shown by the blank dorsal patterns and by some of the negatives on BCs, the entire length of the flaking surface is exploited. In other words, it is a bidirectional reduction from two opposed platforms on a single flaking surface. Removal negatives rarely cover the whole width of the flaking surface and indicate a frequent use of a single guiding scar. Thus, this suggests that BC technology is for the production of long, narrow and pointed blanks that may have a natural back or *débordant* character.

According to the high frequency of B1 and B2 cores, initial stages of the BC reduction appear as critical. In fact, some of them display nothing but a deep, hinged negative. Some of the main difficulties that such a technology implies are related to the external platform angle (EPA) and the technique of percussion. On the one hand, after snapping, core blanks with parallel edges often display an EPA close to 90°. On the other hand, features observed on both large and small laminar elements suggest the use of a stone hammer. Where the reduction of small size bidirectional cores with an organic hammer increases the risk of overshot accident (Pelegrin, 1995), high EPA values combined with a stone hammer increase the risk of hinge fracture and requires an increase in platform thickness (Dibble, 1997; Pelcin, 1997c; Dibble and Rezek, 2009). It, therefore, may explain the frequency and the relatively deep character of the hinge fractures occurring during the early stages of the BC reduction. Even assuming that the successful detachment of a first removal may decrease the EPA, angle management would remain a critical issue all along the reduction process. In fact, almost all BC reductions end by a succession of hinged removals that reduce the efficiency of the platform (Macgregor, 2005). Given the limited striking platform thickness available on BC, a deep hinge fracture is hard to fix and may compromise the reduction process. Among the possible ways to avoid such accidents, removing core tablets in order to obtain a lower EPA appears

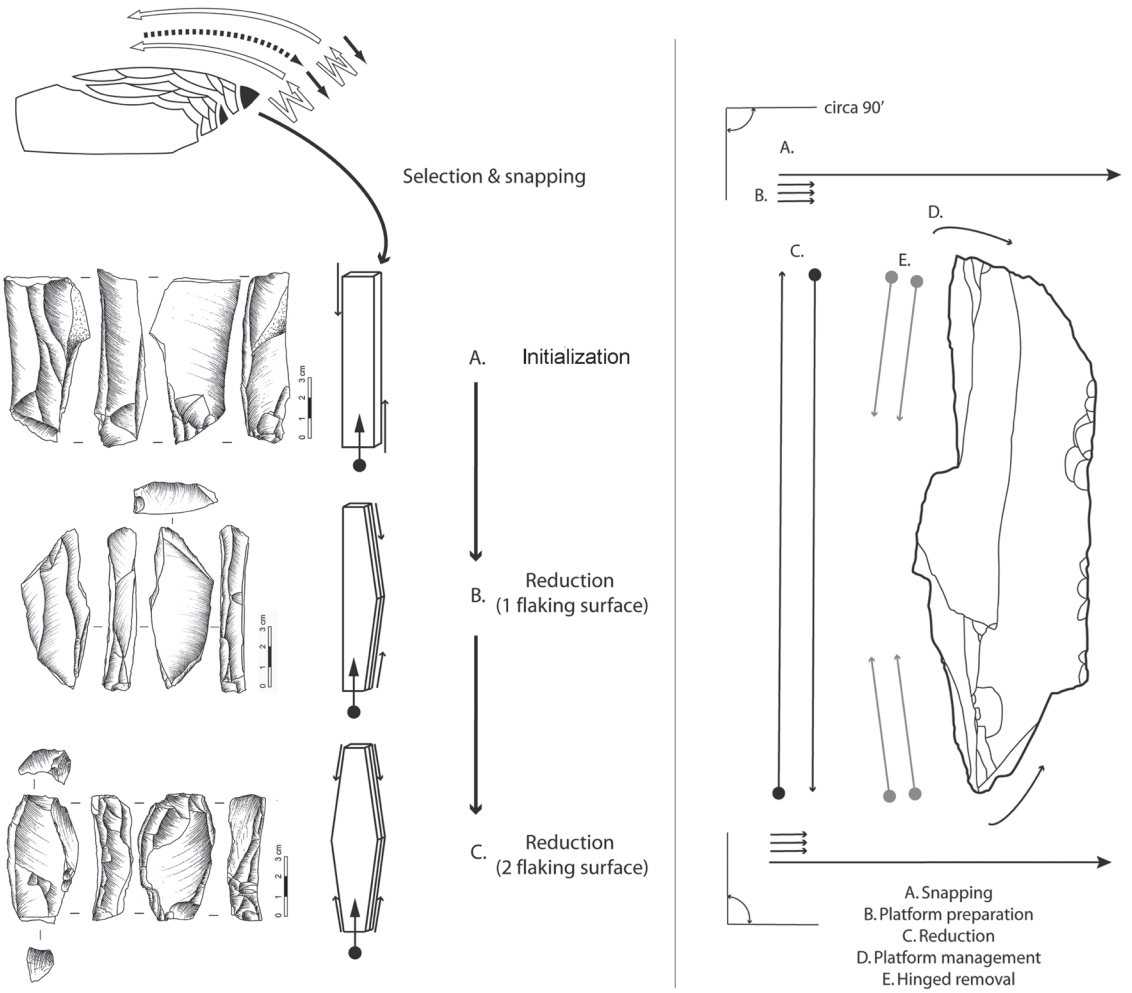


Figure 185: Analytical reconstruction of the BC technology

to be the most frequent. Switching platform appears to be another possibility to turn around the problem.

The size variability observed among the BC leads to the question of the intensity of the reduction. For example, differences in length between the largest and smallest shows a decrease of 75% (Figure 186 : A-D). To interpret this decrease as resulting from a continuous reduction would imply a concomitant decrease in width of the core blank, a considerable amount of tablet removals and/or several snapping events. Small core tablets are, however, almost absent. Although it remains possible, the existence of such reduction is difficult to demonstrate in the absence of refits.

On the contrary, the observed variability could reflect a certain lack of standardization in terms of core blanks. Core blanks are selected according to their thickness regardless of their length or width. Being technical pieces from a distinct reduction sequence, they show a rather high degree of variability in shape. Thus, given the technical constraints linked with the EPA and the percussion technique, it is assumed that BCs have a relatively short use life. They illustrate a discontinuous reduction process, and their variability

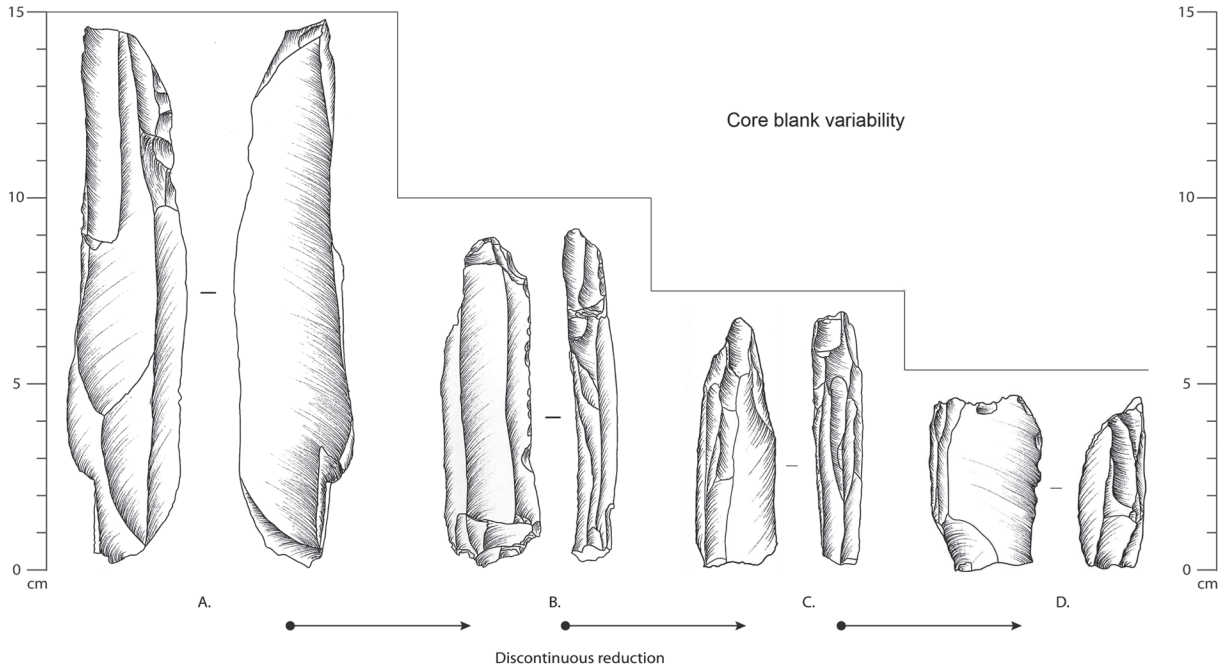


Figure 186: BC size and shape variability and reduction pattern

in size is more likely connected with the intensity of the large blade reduction sequence. As a result, BC represent a rather standardized technology with a poorly standardized production.

Beside the BC technology, rare small size truncated-facetted cores on blades are associated with IUP assemblages. They differ from the Mode B7 by the fact that their main flaking surface is located on the broad face of the core. In spite of their small size, these cores are technologically similar to those described for the sub-volumetric, large blade reduction.

The specificity of IUP technological system lies in the structural role of the *débordant*/crested blanks which represents a link between the sub-volumetric production of the large/medium size blades and the volumetric production of small blade blanks. Theoretically, any sub-volumetric or a volumetric technology using crested elements is likely to produce core blanks suitable for BC reduction. On the contrary, as BC reduction occurs almost exclusively on blade blanks, it depends on a volumetric or sub-volumetric approach as it requires the associated technical blanks. On the one hand, due to their lack of standardization, technical blanks cannot be fully considered as intentional (predetermined) products. On the other hand, given the role they play in the large blade reduction and the recurring character of the BC technology, it is reasonable to assume that their production is anticipated. In sum, whether BC blanks should be considered as byproducts *sensu strictu* is hard to assess as it depends on the role played by BC reduction and, more generally, small blanks within the technological and functional system of IUP human groups.

6.1.3 RELEVANT TYPOLOGICAL ELEMENTS

The IUP is characterized by a coexistence of parallel and convergent blanks. Both types of laminar blanks are frequently retouched, and, therefore, can be considered as desired end products. Among them, blades with proximal thinning are highly diagnostic. They show discontinuous direct retouch and a proximal thinning with semi-steep, steep or flat retouch. Complete examples show that these blades are pointed by

a bilateral semi-steep and steep retouch. As suggested by Rybin (2000), they represent an effective and easily recognizable type that could be considered as a "type fossil" for IUP assemblages. Fragmented, distal ends are less easy to recognize, and the proximal end should be considered as the most diagnostic. Elongated Levallois points with retouch on their proximal end are also rather typical of the IUP, for which a general interest in axial, pointed elements is noted. Endscrapers on blades are also quite frequent and can vary in size. Sickle-like blades could be seen as typical but are exclusively found within OH5 in Kara-Bom. According to this analysis, bifacial tools, such leaf-points or bifaces, should be considered as part of the IUP variability whether they are produced on blades or on other blanks. Such tools are, however, poorly standardized and doubts remain regarding their cultural ubiquity. The situation is the same regarding the notched tools, which are frequent although they are for the most part on flake blanks. They may correspond to a more expedient type of tool. Small laminar blanks are very rarely retouched and a significant use of unretouched blanks cannot be excluded.

6.2 EARLY UPPER PALEOLITHIC LAMINAR TECHNOLOGY

The described EUP technological system includes the following assemblages: UK1-1 OH5.1-5.3, UK1-2 strata 11-8, Anuy II OH3-12 and Anuy III stratum 12.

6.2.1 BLADE TECHNOLOGY

EUP blade technology (Figure 187) is based on an exploitation of local raw material including mostly metamorphic rock from the Anuy River basin (Postnov *et al.*, 2000). The quality may vary spanning from high quality fine-grained to medium coarse grained material. The size of the blocks is hard to determine, but it is assumed that they are selected for their suitable shape. Judging by the size of the preforms, they are generally smaller than in the IUP, although sometimes relying on the same sources (*i.e.* Ust-Karakol). This could then be seen as the result of a selection of blocks suitable for a medium-size blade production. Slabs may also be selected as they offer exploitable narrow flaking surfaces. In most cases, the reduction appears fully volumetric and semi-turning, generally unidirectional, and with a single semi-circular striking platform. A few bidirectional removals are sometimes visible on the cores, but they generally do not extend over the whole flaking surface and may represent the remains of a distal crest or, as suggested by Derevianko and Volkov (2004), a core management operation. Some cores display a volumetric reduction from the broad surface that produces short and wide blades or laminar flakes with parallel edges. In addition, genuine bidirectional cores are unusual, but they are present in these assemblages. Crested and neo-crested elements indicate core management operations. Blade blanks are of medium size and have almost exclusively parallel edges and unidirectional dorsal patterning. Bidirectional negatives are usually short and amorphous. These elements point to a reduction that proceeds by rather long unidirectional sequences turning around the edges of the core. The distal core management and the occasional bidirectionality could be interpreted as a way to obtain blanks with straight profiles. Platforms are usually rather small (<4 mm) and plain with an external edge prepared by soft abrasion and with a lip on the internal edge. These elements seem to indicate percussion by organic hammer although the occasional use of hard hammer cannot be excluded. Generally speaking, the blade production is quite variable and remains hard to define.

Blades are retouched in various ways, including blades with direct continuous scalar and thin retouch along one edge, endscrapers with distal or continuous retouch, angle burins, and burins on truncations. Retouched points are almost absent.

6.2.2 BLADELET AND MICROBLADE PRODUCTION

The production of small laminar blanks is the most diagnostic feature of these assemblages. It shows no apparent link with the larger laminar blank pro-

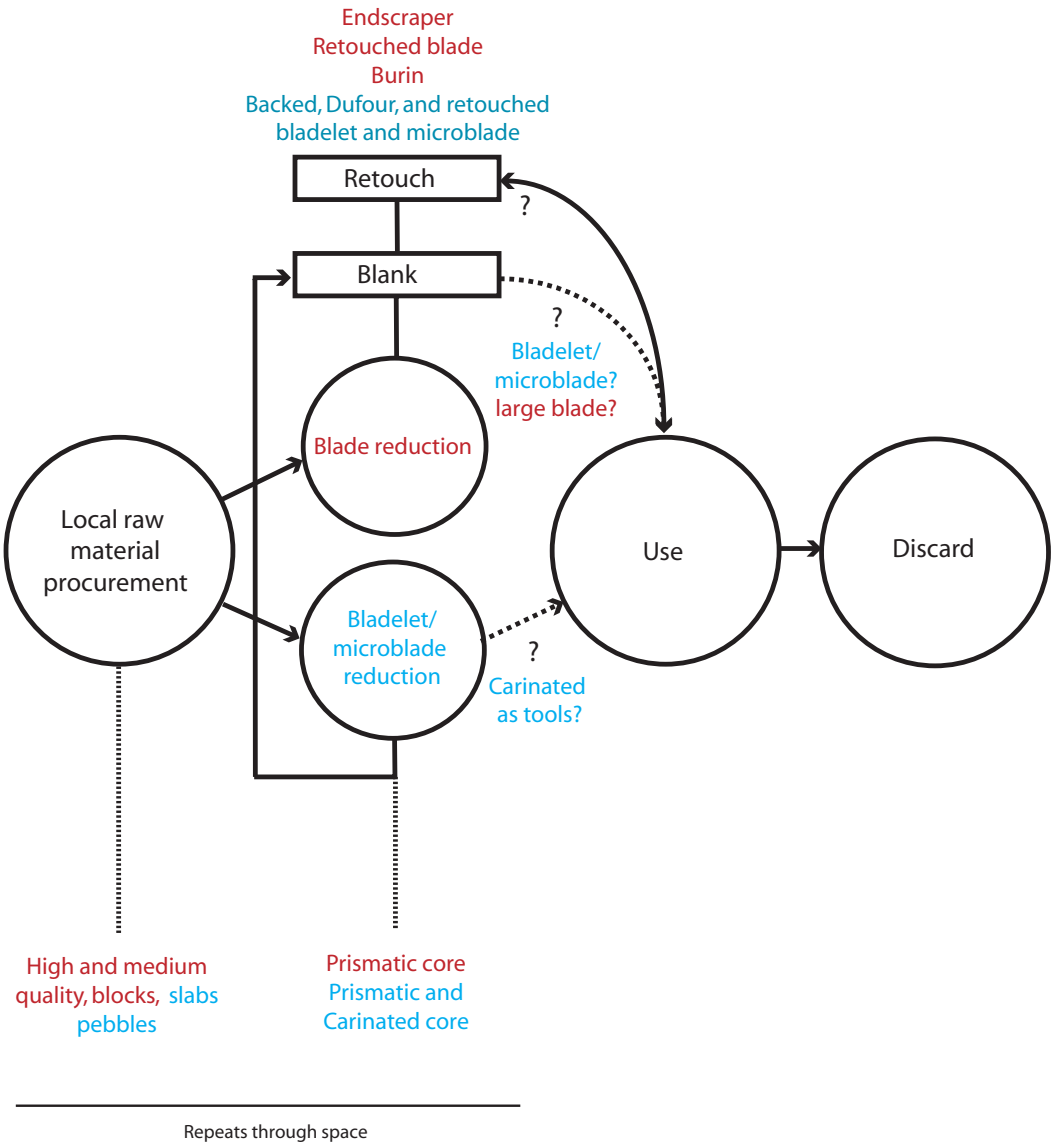


Figure 187: Analytical reconstruction of EUP laminar reduction sequences

duction and stands as a specific reduction sequence from the selection of the raw material onward. Small size slabs and pebbles of fine-grained metamorphic and, more rarely, of jasper-like material are collected from the Anuy River alluvial deposits. Three main types of cores are identified: narrow-faced cores, carinated cores, and cores with orientation changes. For the narrow-faced cores, the initial stage of reduction corresponds to the shaping of a central or lateral anterior crest along a narrow edge of the nodule. The reduction takes place along a triangular flaking surface with a keel-shape at its distal end. This peculiar shape is described in Ahmarian context as a 'keel' (Davidzon and Goring-Morris, 2003; Goring-Morris and Davidzon, 2006) and is shaped by lateral flakes detached from the main or from an opposed platform by the removal of a lateral overshot or by the shaping of a posterior crest. Occasionally, traces of a lateral crest are visible on the distal part of the flaking sur-

face. The reduction is strictly unidirectional with a frontal or semi-turning progression.

The carinated cores are named by analogy with tool types such as carinated endscraper or rabot. When they are produced on fragmented river pebbles, their morphology can, therefore, be seen as resulting from a raw material constraint. The split fracture of a pebble creates a striking platform from which unidirectional, frontal or semi-turning reduction takes place. The flaking surface is somewhat broader than for the narrow-faced cores and has a trapezoidal shape. The reduction system is relatively simple but may require lateral preparations to narrow the flaking surface. Fronto-lateral flakes may be detached from the corner of the flaking surface and by creating a notch may narrow the flaking surfaces to create a new guiding scar. This method modifies the core into something that can be typed as a shouldered or a nosed endscraper. The third main type of core is a combination between carinated and narrow-faced core. It illustrates orientation change in the course of reduction that can be seen as a response to a raw material constraint. After a pebble is split, the reduction starts as a carinated core, but following a change in the orientation of the core (or another split), the core is reduced as a narrow-faced core. It is noted that thick cortical flakes can occasionally be used as core blanks.

Due to their reduced size, some of carinated cores, including nosed-endscrapers and atypical carinated endscraper forms, tend to be seen as tools. It is not clear if the atypical endscrapers illustrate the final stage of a bladelet core reduction, a production of small lamellar flakes or if they are strictly tools. Although some burins bear negatives of lamellar spalls, they do not appear to play a major role in the production of blanks. Carinated burins and BC are atypical, if not completely absent. An occasional occurrence of sub-pyramidal and prismatic cores is noted.

The reduction system is adapted to the shape of the pebble but tends to switch to a narrow face when possible. The blanks produced are mainly bladelets and microblades, with unidirectional dorsal patterning and parallel edges. They have small, plain platforms and show traces of thin abrasion on the external edge. None of these cores display the whole set of typical pressure flaking features (*e.g.* grooved morphology of the flaking surface, deep bulb negatives or denticulate edge platforms, or regular parallel-edge negatives). Instead, in the studied samples, blanks appear relatively poorly standardized and have a relatively heterogeneous secondary treatment. The negatives observed on the cores and the platform attributes suggest the use of organic hammer.

6.2.3 RELEVANT TYPOLOGICAL ELEMENTS

The typological spectrum observed fits classic UP features. As previously mentioned, small endscrapers on laminar flakes or blades, sometimes showing a rather thick working edge, are numerous. Angle burins and burins on truncations occur and usually show a rather narrow and sharp working edge. Carinated burins are absent. Heavily retouched blades also occur, but no systematic series of Aurignacian type retouched blades is present. No biface is attributed to these assemblages. The most diagnostic tools are on bladelet or microblade blanks. They consist of bladelets with distal truncations and of backed and Dufour microblades. Some microblades with distal retouch also occur (micro-grattoir).

6.3 TWO DISTINCT UPPER PALEOLITHIC VARIANTS IN THE ALTAI

Based on the Kara-Bom OH6 and OH5 assemblages and on UK1-1 OH5.4-5.5 assemblages, IUP blade technology appears as a distinctive techno-typological system that combines elements indicating a Levallois background with a well-developed volumetric approach. Blanks tend to be massive and very elongated, with a peculiar treatment of the platforms including classic and partial faceting, dihedral and plain preparations. In addition, the IUP includes associations of highly recognizable typological elements. The combination of technological and typological features can be used as a proxy to outline a recurring specific technical scheme. So far, although based on a smaller sample and lacking some of the diagnostic IUP features, Kara-Bom MPH1 and OH4 find their best fit within the IUP technological system.

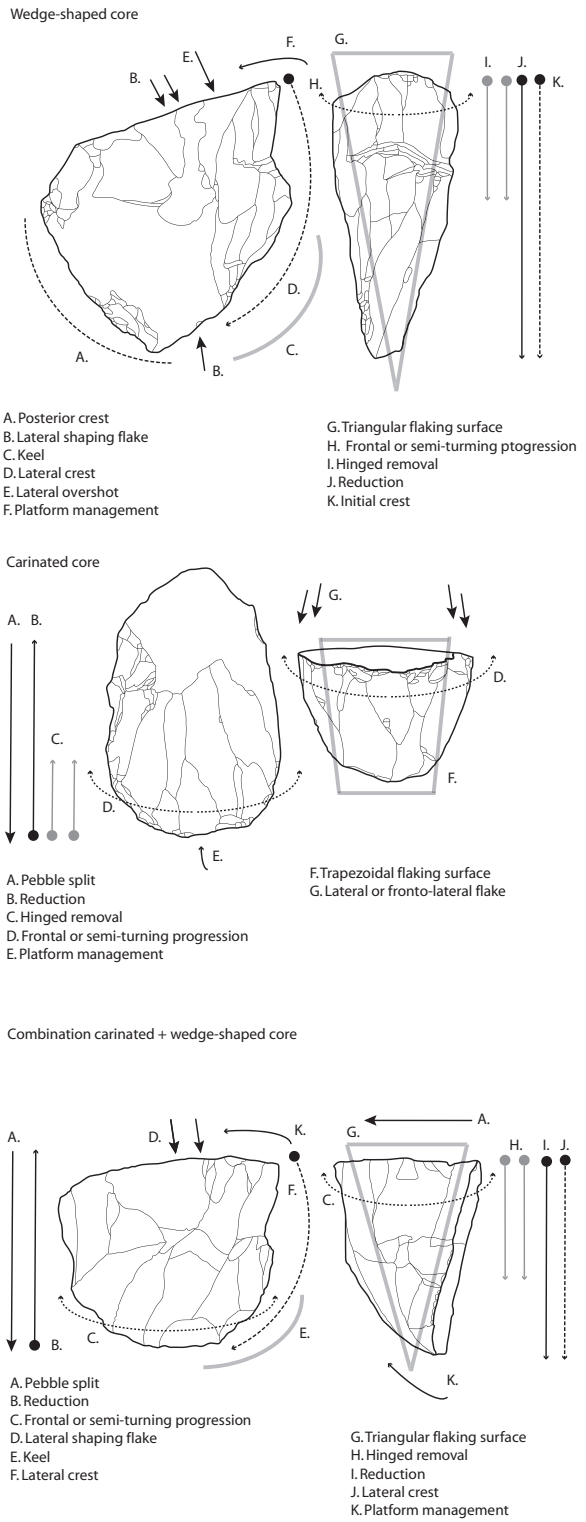


Figure 188: Analytical reconstruction of EUP bladelet/ microblade Technology

The main specificity of the EUP laminar system is that it shows the parallel use of two independent reduction sequences. Medium and small blanks are produced following two unrelated paths starting with the raw material selection. Blade technology appears more variable than for the IUP, and there is a lack of massive elements. BC technology is absent although crested elements are quite common. Levallois elements are rare or completely absent. Platforms are mainly plain and suggest an introduction of the organic hammer as a mode of percussion. A particular focus on microblade production shows the development of adaptive strategies to initiate reduction from small nodules. Slabs are reduced as narrow-fronted cores, and pebbles are first reduced as carinated cores before being reduced from the narrow face and turned into wedge-shaped cores. From this point of view, microblade production represents a clear diagnostic character and can be seen as a technological proxy for EUP assemblages. Typologically, UP types such as endscrapers and burins are well represented.

Formal and structural differences between the two traditions are clear and cannot be seen as the result of a raw material constraint. In both cases, the raw material in use is local with a selection for fine-grained metamorphic material. In the case of the BC technology, one could argue that recycling of technical spalls of various shapes and size could correspond to a response to raw material constraints. At Kara-Bom, this idea is contradicted by the proximity of good quality raw material sources (Brantingham *et al.*, 2000; Derevianko *et al.*, 2000; Derevianko and Shunkov, 2005). At Ust-Karakol, although it is assumed that human groups were mostly relying on material drained by the neighboring rivers, technological differences between the two traditions are still clearly marked.

Following the results of the present analysis, the existence of two distinct UP traditions is confirmed.

	IUP	**EUP**
Raw Material	Metamorphic, local	Metamorphic, local
	Blade Technology	
Blank category	Massive/medium blade	Medium/small blade
Platform preparation	Facetted+plain	Plain
Dorsal scar pattern	Uni+bidirectional	Unidirectional (?)
Profile	Straight	Straight+curved
Orientation	None	None
Core Mode	Flake	Mode B+Mode A
Reduction	Two interactive FS	Frontal, semi-turning
Conception	Sub-volumetric	Volumetric
	Small blanks technology	
Blank category	Small blade/bladelet	Bladelet/microblade
Platform preparation	Plain+facetted	Plain
Dorsal scar pattern	Bidirectional	Unidirectional
Profile	Straight	Curved, slightly curved, straight
Orientation	None	None (?)
Core Mode	Mode B	Mode A
Reduction	Frontal	Frontal+semi-turning
Conception	Volumetric	Volumetric
	Others	
Levallois	Yes	No
Convergent blanks	Yes	No (?)
Bifacial	Yes	No (?)
Specific tools	Pointed blade with proximal thinning	Small-size endscrapers

Table 107: Comparison between the main techno-typological features of the IUP and EUP

7 – Research question 2: an alternative chrono-cultural model

The second research question concerns whether there is a synchroneous devellopment of the IUP and EUP techno-complex (for more details about the dates, see Chapters 3, 4 and 6). The only open-air sequence were the two traditions have been recognized is UK1-1. The two traditions are part of the former 'cultural level 3' (Derevianko *et al.*, 1987) which is now sub-divided into five cultural horizons (Slavinsky, 2007) OH5.1 to OH5.5. OH5.1-5.3 is attributed to the EUP variant, and OH5.4-5.5 is attributed to the IUP variant. This then provides a relative chronology for these variants. Cultural level 3 was said to include three combustion features, two of which yielded conventional radiocarbon ages of 31,410 ± 1160 ^{14}C BP (SOAN-2515) and 29,900 ± 2070 ^{14}C BP (IGAN-1077) (Derevianko *et al.*, 1987). These features are located at the bottom of OH5.2 and are, therefore, associated with the EUP technological variant. In this context, they provide only a minimum age for the IUP variant.

Numerous questions remain regarding the differences observed within the UK1-2 sequence. EUP occurs clearly within strata 11-8 and the Middle Paleolithic occupation is associated with strata 15-12. This, however, indicates that the IUP component is either absent from UK1-2 or so elusive that it was not recognised. Furthermore, some refits underline the existence of post-depositional processes affecting the integrity of the assemblages, with vertical movements noted between strata 15-12 and 11-8 assemblages (Slavinsky, 2007). Indeed, the mismatch between sections up and down the slope indicate that erosion processes affected the interface between the Middle and Upper Paleolithic layers. Moreover, evidence of a rather intense rodent activity are observed in the lower in that critical area. (Derevianko *et al.*, 2003).

Conventional radiocarbon dates produced on isolated charcoal fragments from stratum 9 provided the following ages: 29,860 ± 355 (SOAN-3358), 29,720 ± 360 ^{14}C BP (SOAN-3359) and 33,400 ± 1,285 ^{14}C BP (SOAN-3257) (Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998; Derevianko *et al.*, 2003). These results are problematic as they show two different chronological signals. Two of the dates are fairly identical and do not overlap with the third one, even at two standard deviations. This third date is significantly older and overlaps at one standard deviation with the single radiocarbon date obtained on a charcoal fragment from stratum 10 and providing an age of 35,100 ± 2,850 (SOAN-3259). The RTL-result of 50 ± 12 ka obtained on stratum 9 is not of great help given its large standard deviation. It is noted that these results overlap at one standard deviation with the radiocarbon dates SOAN-3257 and SOAN-3259 once they are calibrated. More problematic is the upper part of the UK1-2 sequence for which radiocarbon results are not consistent with the stratigraphy; stratum 5 being younger than stratum 3. Due to taphonomic issues and because of the discrepancies observed, radiocarbon dates from UK1-2 cannot be considered as reliable.

In Kara-Bom, the main IUP occupation is located in levels OH6 and OH5 where charcoal samples from combustion features have yielded AMS dates of 43,200 ± 1,500 ^{14}C BP (GX-17597) and 43,200 ± 1,600 ^{14}C BP (GX-17596) (Goebel *et al.*, 1993). MPH1 is considered in this study as a possible IUP assemblage. This occupation has yielded two infinite ages, one on charcoal and the other on bone collagen, indicating a minimum age of circa 44 ka. A conventional date of 32,000 ± 600 ^{14}C BP (GIN-5934), obtained from collagen, has been attributed to OH4. However, the sample was located downslope and Derevianko and Rybin (2003) consider its association with the archeological assemblage unclear. A second conventional date of 33,800 ± 600 ^{14}C BP (GIN-5935) from a charcoal fragment is said to be associated with OH4. Derevianko and Rybin under-

line the fact that this sample was collected from a section that was left exposed for several years and may have been subject to contamination. Two AMS dates on isolated charcoal fragments are associated with OH4: 34,180 ± 640 ^{14}C BP (GX-17595) and 33,780 ± 570 ^{14}C BP (GX-17594). These might indicate that this occupation is considerably younger than the classic IUP.

Radiocarbon ages available for Anuy II span from 30 (OH12) to 21 ka ^{14}C BP (Orlova, 1995; Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998). These dates may indicate a development of EUP toward full UP with the sequence ending prior to the LGM. With a similar technology, level 12 of Anuy III has yielded a single RTL date that is very similar to the RTL results from UK1-2 stratum 9 but this date also has a large standard deviation. The correlation proposed by Derevianko and colleagues (Derevianko and Shunkov, 2002), mainly on the basis of visual observation of the sediments, needs to be supported by more chronological data and sedimentological analysis.

Data from UK1-2 used to support an in-situ development of the EUP are not reliable due to taphonomic issues and to the lack of correspondence with the UK1-1. It is still unclear whether the IUP occurs in that sequence. Research question 2 of a parallel development of IUP and EUP lacks support at this time. Instead, the clearest example of a relative chronology comes from the UK1-1 assemblage which indicates a chronological succession between the two technological traditions. Radiometric data provide a coarse-grained picture that seems to fit with the idea of a succession of a two phases. The earliest IUP dates indicate a possible occurrence prior to 44 ka, and it is well documented around 43 ka. The OH4 dates could represent a late occurrence of a technology derived from an IUP tradition. The earliest EUP dates suggest a first appearance of this tradition around 31 ka, with most of the dates ranging between 30 and 26 ka. Anuy II could testify to a late occurrence of EUP technology. Based on the available data set, a regional of model chrono-cultural of succession is proposed.

7.1 TESTING THE MODEL: REGIONAL COMPARISONS

In the previous sections, the analysis of key open-air sequences focused on the definition of two distinct technological trends. Based on chronological and taphonomic elements, Research question 2 appears problematic. Instead, a chrono-cultural model emerged in which IUP and EUP assemblages occur in chronological succession. In this section, a review of the regional records including relevant caves and open-air sites is presented as an attempt to test the model. Descriptions of the assemblages that were not included in the studied sample, including MP assemblages, are summarized based on a critical reading of published material with a special focus on chrono-cultural successions.

7.1.1 OPEN-AIR SITES

Kara-Bom

MPH2

At Kara-Bom, the lowermost cultural layer, MPH2, reached in the first excavations in squares B-L/14-17, is likely associated with layer 5 of Okladnikov's scheme. Subsequent excavations under the field direction of Petrin (Derevianko, Petrin, *et al.*, 1998; Derevianko, Petrin, and Rybin, 2000) have yielded additional material that will be described here. The layer was excavated over a surface of 25 m², with the main concentrations located between D-I/10 and Z-I/7-9. Two concentrations of artifacts were noted; one is in squares Z-I/9 (-434 cm below datum) and the other is in squares E-J/8-10 (-470 cm below datum). The cultural layer reaches a maximum thickness of circa 30 cm. Horizontal large schist slabs are reported associated with the lithic assemblage. According to Nikolayev's original section, lithological sub-strata 9b (MPH1) and 9B (MPH2) are separated by the sediment matrix of stratum 9. Sub-strata are, however, not distinguished starting from square line 9. Excavation plans show that in some squares plotted pieces attributed to MPH1 and MPH2 are sepa-

rated by only a few cm. When comparing the depths provided for the above-mentioned Z-I/9 and E-J/8-10 concentrations and the section drawing, it is not clear whether the concentrations belong to MPH1 or MPH2. So although it seems clear that the two MPH layers are distinct, it is possible that some pieces were attributed to the wrong layer.

The fauna is usually described as badly preserved and the material from MPH1 and MPH2 is grouped together. The main species identified are *Allactaga species, Equus species, Coleodonta antiquitatis, Bison species, Capra sibirica, Mammuthus primigenius* (only in MPH1), *Panthera spelea* and *Marmota baibacina* (Derevianko, Petrin, and Rybin, 2000; Vasiliev, 2003). As noted by Wrinn (2010), the presence of carnivores combined with human activity results in an ambiguous picture, but cut-marks and percussion marks still indicate butchering activities and marrow extraction on ungulates (mountain goat, bison and various equids).

The only chronological land-marks are provided by the infinite radiocarbon ages obtained on bone samples from the overlying MPH1 assemblage which provided a minimum age of 44 ka ^{14}C BP. EPR dated bone samples from lithological strata 9 and 11 bracket the human occupation to between 62.2 and 72.2 ka BP. However, some methodological problems have been raised by Kuzmin (2000) regarding the EPR method (sometimes reported as similar to ESR). First, he points out that bone is not a reliable material for ESR analysis in general (Grün, 1997). Second, Kuzmin notes that EPR method as used in Kara-Bom is not classic ESR. He suggests that assuming a linear dose response curve is incorrect as the components of natural radioactivity have not been determined (Kuzmin, 2000). The EPR method was used as an experimental protocol in Kara-Bom and in Orkhon-7 (Mongolia) but applied to no other sites afterwards. In a brief publication, EPR results were compared with radiocarbon dates from the Orkhon-7 site (Astakhin *et al.*, 1993). EPR calendar ages match with radiocarbon results, presumably uncalibrated, due to the large standard deviations on EPR dates. Moreover, some radiocarbon results were finite ages of over 60 ka and none of the results had lab-numbers. Although it was sometimes mentioned as ESR, EPR dating is a different method that requires independent evaluation (Kuzmin, 2000). Therefore, based on the one radiocarbon date, MPH2 can be considered to have a a *terminus ante quem* of 44 ka ^{14}C BP. Based on the study of Fedeneva and Dergacheva (2003), Wrinn (2010) considers that the type of sediment associated with MPH1 and MPH2 is not incompatible with an attribution to the Ermakovo stage (OIS5a-d/OIS4). In their study, Fedeneva and Dergacheva identified three cold stages interrupted by two warmer events. The presence of species such as *Coleodonta antiquitatis* (woolly rhinoceros) in the associated fauna would indicate a rather cold climate. As the bones of this species do not seem to bear human modifications, the association of these remains with the archeological material is not certain.

According to Derevianko *et al.* (2001), in the lithic assemblage (N=649) all the cores except one are flat-faced. Levallois cores (N=20) are mainly recurrent-parallel and the few cores with point removals are interpreted as representing the last stages of reduction. Rybin (2004) reconstructs a reduction sequence producing laminar flakes from tabular cores. The first steps are the production of a crest by radial and sub-radial removals, followed by the detachment of a series of unidirectional blanks. Through the detachment of lateral crest or *débordant* flakes, the flaking surface is made convergent and is oriented toward the production of pointed blanks. The latest stages are then described as a return to blade production. This chronological reconstruction is, however, not supported by quantitative data (Dibble, 1995a).

Moreover, a refitted sequence indicated more basic reduction (Figure 189). A first phase consists in the removal of transversal *débordant* flakes. The surface exposed is then used as a striking platform and prepared by faceting. An initial elongated cortical flake is removed, followed by a series of Levallois points detached from a sub-cortical surface (Slavinsky and Rybin, 2007). Posterior transversal flakes are removed from the back of the core along the right narrow face. These flakes are likely involved in the management of the convexity. Genuine crested elements are missing, but it seems that side blades where removed regularly during the detachment of

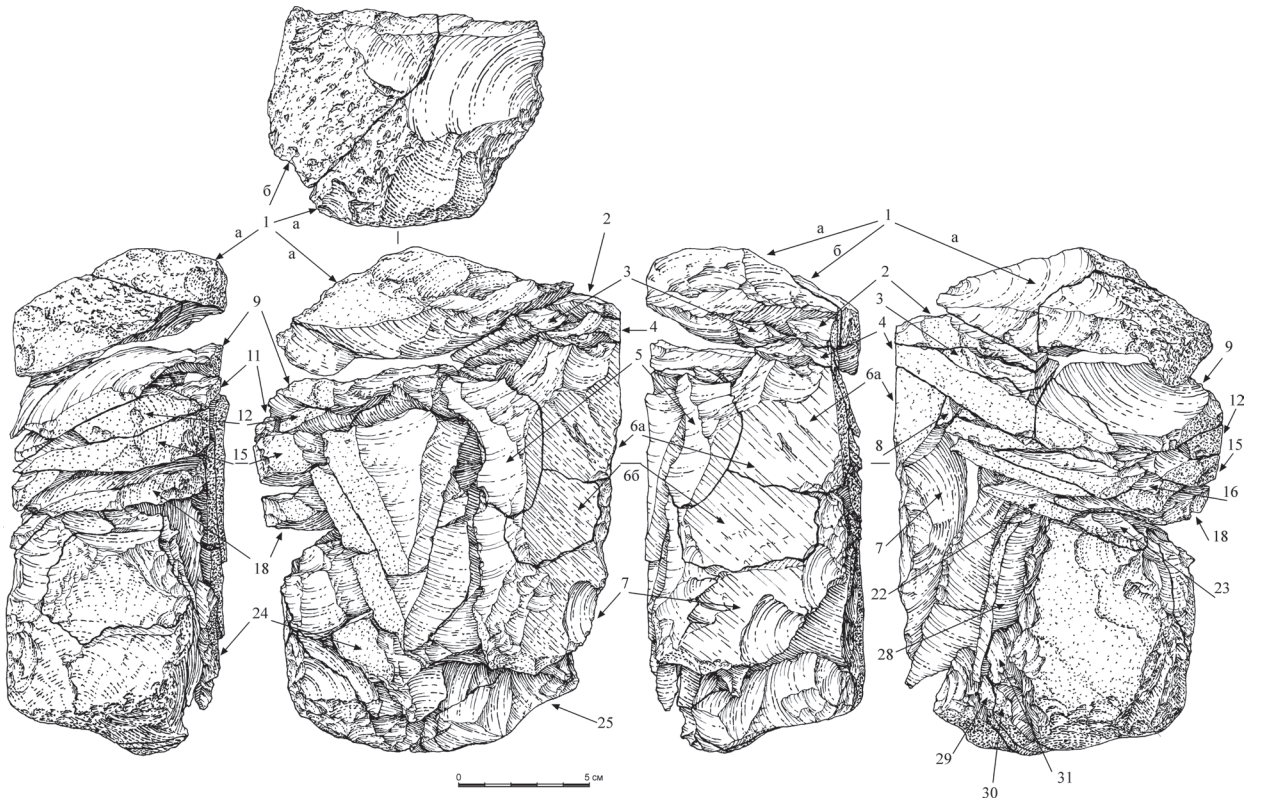


Figure 189: Kara-Bom, MPH2, refitted core (after Slavinsky and Rybin, 2007)

the pointed blanks (Figure 190). The system is unidirectional convergent and recurrent but compared to classic Levallois it shows atypical features such as the lack of preparation on the periphery of the core's lower face. Although the sequence is oriented toward a production of points, concomitantly, it leads to the detachment of *débordant* and laminar blanks. Compared to IUP reduction, it appears as a distinct approach related to a distinct production goal. The main similarity is the use of a single narrow side of the core for the management of convexities, with the opposed narrow side being cortical. The management operation is, however, adapted to a unidirectional convergent reduction system with opposed removals occurring at the very end of the reduction.

Notable is the occurrence of a unidirectional convergent Levallois core with a triangular flaking surface (Rybin and Kolobova, 2009: Fig. 4, num. 1, 3; Fig. 6 num.3). These cores show a reduction ending by the removal of a large flake that covers most of the flaking surface. Rybin and Kolobova (2009: Fig. 8, num. 1, 3) also mention the presence of truncated-facetted pieces. Two BC-like pieces are reported with one showing a single hinged removal preceded by what seems to be a platform prepared by a single blow. The latter is located on the fractured section of a blade with regular dorsal removals and parallel edges (Derevianko, Petrin, *et al.*, 1998: Fig. 26, num. 4). The second BC-like artifact appears to be on a laminar flake and bears one hinged removal on the tip. It is not clear from the publication if the removals visible on the side are anterior or posterior to the removal of the blank. Radial or discoidal cores on pebbles appear to be present as well (Derevianko, Markin, *et al.*, 2001: respectively Fig.117, num. 7 and Fig.118, num. 7).

Technological elements related to a genuine blade production are clearly lacking. Cores with clear blade removals are absent. The large initial crested blade illustrated could be associated with Levallois

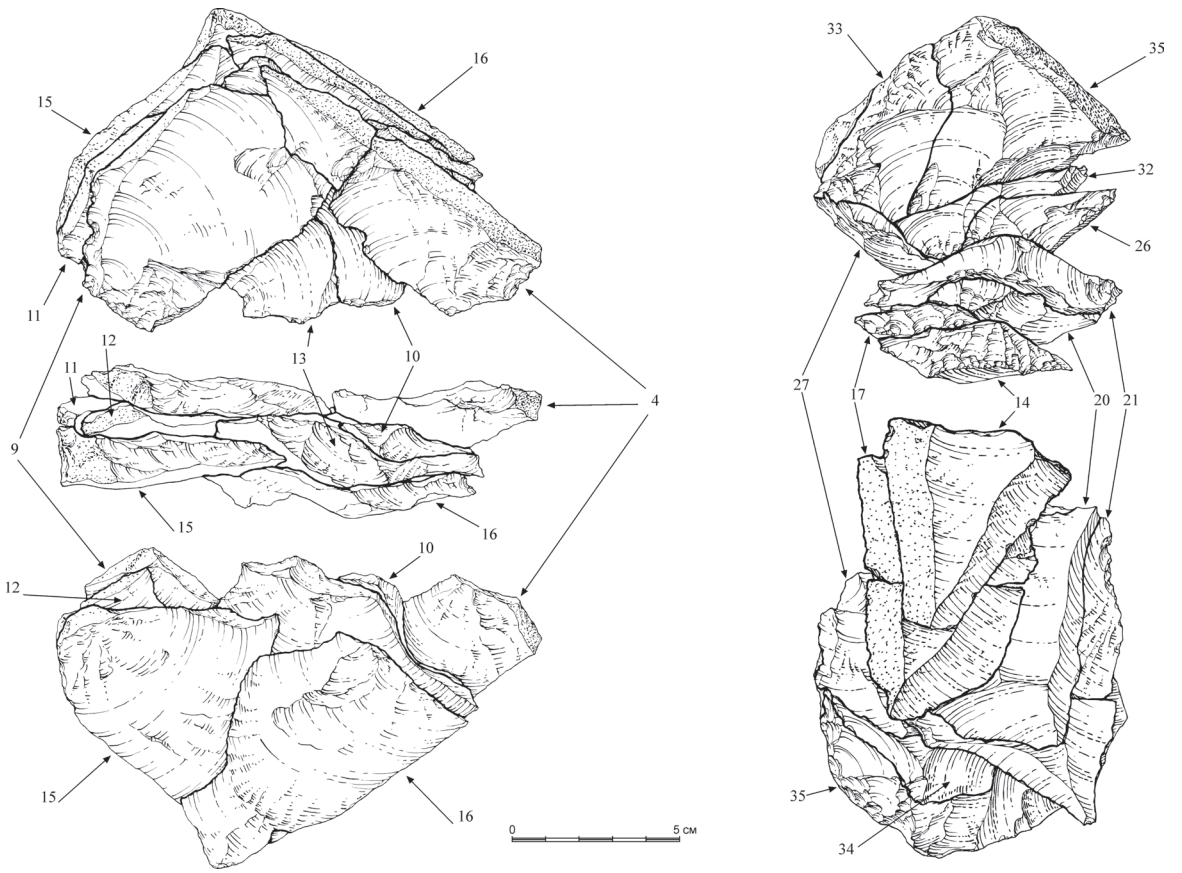


Figure 190: Kara-Bom, MPH2, isolated sequences from the refitted core of Figure 189. Left: transversal flaking; Right: pointed blanks

point production. The presence of BC-like forms would imply a sub-volumetric reduction, but they are poorly reduced and small blanks are not clearly represented. A few neo-crested and *débordant* elements are illustrated (typed as 'knives' in Derevianko, Petrin, *et al.*, 1998, Fig. 30, num. 4, 5, 8). Some of these elements, however, could be detached as posterior crests on a Levallois core.

Precise counts are not provided, but the number of elongated blades is said to be relatively small. This may be due to the high fragmentation (Derevianko, Petrin, *et al.*, 1998), but it is clear that technological elements illustrating a strict blade production are lacking. Only a few blades display regular removals on their dorsal face, and no other technological elements testify to their production *in situ*. Although bidirectional blanks and removals are illustrated, dorsal scar patterning is described as mostly unidirectional (Rybin, 2004). As shown by the refits, opposed flaking may occur in the course of the core shaping, but the general pattern is unidirectional.

Derevianko and colleagues (Derevianko, Markin, *et al.*, 2001) note that if the assemblage does not include Levallois elements only, more than half of the tools (N=57) are on Levallois blanks. Tools are mostly on blades (N=38), some being Levallois blades (N=20), but they are highly fragmented (N=27). The assemblage has yielded numerous Levallois points (N=34), some of which are retouched (N=14). The size and shape of these points tends to be quite variable, showing a low degree of standardization. The second most common tool type is notches (N=27). Blades and flakes with regular retouch, denticulates and knives are the remaining common tools (Derevianko, Petrin, *et al.*, 1998).

OH3-OH1

These units are briefly described as their sample size is reduced and they lack diagnostic elements. They are described in the publish material as a whole, together with OH4. The OH3 assemblage (N=135) has yielded a few cores (N=2) and some tools (N=20). OH2 (N=28) includes a single core and a few tools (N=8), and the OH1 assemblage (N=27) is characterized by a small set of tools (N=6). Due to their sample size, these assemblages cannot be directly compared with the underlying human occupations.

AMS radiocarbon ages obtained on charcoal samples collected from below and from inside OH3 indicate an age between 35 and 30.5 ka ^{14}C BP. It is noted that the youngest date, 30,990 ± 460 ^{14}C BP (GX-17593), does not overlap with the two others at the two sigma ranges (Goebel *et al.*, 1993). OH2 and OH1 have not been dated directly except for a single radiocarbon date of 38,080 ± 910 ^{14}C BP (GX-17592). As noted by Goebel *et al.* (1993), this date is the only one that does not match with the stratigraphic succession.

Some broad observations can be made regarding the lithic material. OH3 shows some techno-typological similarities with the underlying layers. For example, the presence of a large, retouched blade with a curved edge, similar to the sickle-like blades from OH5 (Derevianko *et al.*, 1998: Fig. 47, num. 9), a distal fragment of a point (Derevianko, Petrin, *et al.*, 1998: Fig. 47, num. 1) with bilateral scalar retouch, and a laminar flake fragment with a rather unclear inverse truncation (Derevianko, Petrin, *et al.*, 1998, Fig. 47, num. 8) are among the most notable typological elements. Burins are present, and one of them, typed as a retouched blade, could be similar to a BC. Some blanks seem to show bidirectional removals, and ochre is reported associated with the assemblage. Material illustrated for OH1 includes a large blade core with a posterior crest and bidirectional removals.

To summarize, the lowermost assemblage from Kara-Bom can be characterized as a technology mostly oriented to the production of pointed flakes but elongated points, laminar flakes and convergent blades may be produced in the context of such a reduction sequence. According to the refits, the use of a lateral crest can occur during the reduction process. Although it can appear similar to IUP technology, the reduction system is mainly convergent and unidirectional as opposed to the bidirectional, parallel IUP reduction. The single refitted sequence may also not be representative of the whole assemblage. Regular blades, although not numerous, are associated with the assemblage, but laminar reduction is poorly documented. From this point of view, MPH2 is similar to MPH1 except that the Levallois technological system is more pronounced and better documented. The chronological attribution of MPH2 remains problematic. The assemblage is considered as prior to 44 ka ^{14}C BP and could correspond to a cold phase. The upper part of the sequence is represented by small assemblages that are difficult to characterize. The chronology of the upper part of the sequence requires some clarification as it is not clear if the upper levels belong to OIS2 or OIS3.

UK1-2

As the Middle Paleolithic is poorly documented in UK1-1, the following section focuses on the lower and middle sections of UK1-2. The main Middle Paleolithic assemblages are associated with strata 19, 18 and 17-13. Stratum 19 is dated to 133 ± 33 ka BP (RTL-661) by the RTL method applied on alluvial sediments, and stratum 18 is dated to 100 ± 20 ka BP (RTL-659) and 80 ± 18 ka BP (RTL-658) (Derevianko *et al.*, 2003). The RTL dating methodology (Vlasov and Kulikov, 1989) is still not fully published and should be cross-checked with other methods (Huntley, 1992; Kuzmin, 2000; Wrinn, 2010). Kuzmin (2000) underlines the discrepancies between the radiocarbon and RTL dates obtained on layer 9. Indeed, when using the Intcal09 curve (Reimer *et al.*, 2009) the oldest calibrated radiocarbon age obtained for layer 9 is still 10 ka younger than the RTL ages. For layers 19 and 18, standard deviations of RTL ages are so large that, with a two-sigma range, the assemblages could correspond to a period ranging from OIS5e to the beginning of OIS3. The large mammals are described as mostly ungulate species (Derevianko *et al.*, 2003; Vasiliev, 2003; Wrinn, 2010). Forest species of small mammals are mainly

represented in strata 19-11 (Derevianko *et al.*, 2003; Agadjanian and Serdyuk, 2005). An attribution to the Ermakovo period (OIS5-OIS4) is suggested (Derevianko *et al.*, 2003).

Stratum 19

Most of the artifacts from stratum 19 (N=49) are weathered by water circulation. According to Derevianko and colleagues (Derevianko *et al.*, 2003) the overall characteristic features of the lithic artifacts (side-scrapers, notches and denticulate tools) indicates a Mousterian cultural attribution.

Stratum 18

Stratum 18 yielded a larger lithic assemblage (N=532). The technology is described as recurrent Levallois. Refits show a reduction strategy rather similar to Kara-Bom MPH2, but with a more pronounced bidirectional reduction (Figure 191).

According to Postnov (1999), reduction starts with the preparation of two platforms and with some shaping of the lateral sides of the core, followed by a series of unidirectional removals (Figure 191). The second phase is illustrated by a switch to the opposed

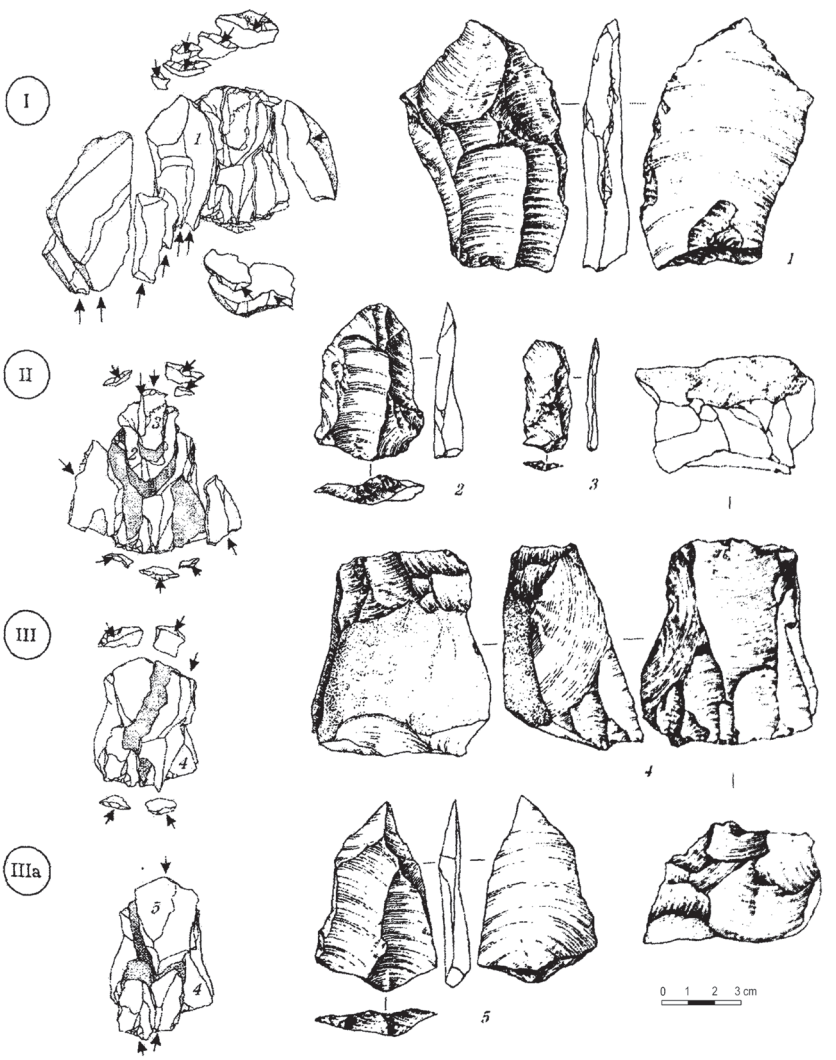


Figure 191: UK1-2, stratum 18, refitted core and reduction sequence reconstruction (after Postnov, 1999)

platform with a short series of removals, and the last phase is characterized by bidirectional removals. The core has an asymmetric section and bears removal negatives on the narrow face. According to Postnov's schema, side removals occur mainly during phases I and II. Some of the removals are transversal, but one of the phase II removals is in the axis of the flaking surface and could correspond to the hinged negatives visible on the narrow face. The method stretches the definition of Levallois (*e.g.* Boëda, 1990, 1994) as the core preparation consists of the set up of two opposed platforms. Levallois flakes and atypical Levallois points are, nevertheless, among the produced blanks.

Other illustrated flat-face cores do not exhibit evidence of lateral removals and rather indicate subradial preparations and bidirectional reduction. One of the pebbles illustrates radial initial preparations (Derevianko *et al.*, 2003: Fig. 148, num. 5) or a more advanced stage of reduction (*e.g.* Derevianko *et al.*, 2003: Fig. 148, num. 8; Figure 192).

The number of blades reported by Derevianko and colleagues (Derevianko *et al.*, 2003) indicates a relatively well represented blade production although blade cores seem absent from the assemblage and evidence of parallel flaking is rare (Derevianko, Markin, *et al.*, 2001). Elongated pointed blades are present, some of which bear bidirectional removals (Derevianko *et al.*, 2003: Fig. 151, num. 12). Tools are dominated by Levallois products (N=33), including flakes (N=5), blades (N=8), retouched blades (N=3), points (N=5), retouched points (N=4), and atypical points (N=8). Also common are notches and becs tools.

Strata 17-14

These strata have yielded small assemblages: 17 (N=34), 16 (N=35), 15 (N=60), 14 (N=72) and 13 (N=34). Each stratum includes a combination of blades and Levallois elements, but complete cores only occur in strata 14 and 13. Stratum 14 has yielded a radial flake core. Stratum 13 has yielded 3 cores including a Levallois blade core (Figure 193) with two opposed platforms and lateral preparations. As previously mentioned, material from these strata has been refit with artifacts from strata 11-8 (Slavinsky, 2007) indicating some taphonomic issues. These vertical movements may be linked with the fact that stratum 13 is not recognized everywhere on the site, as shown by the northern and eastern sections (Derevianko *et al.*, 2003).

As opposed to UK1-1, the IUP is not clearly expressed in the UK1-2 sequence. According to the stratigraphic data at hand, one would expect the IUP would be located between strata 15 and 11.

To summarize, the UK1-1 sequence has yielded a Middle Paleolithic assemblage in stratum 18 which finds its closest analogy with Kara-Bom MPH2, although the described material indicates a more pronounced bidirectionality. As for MPH2, convergent blades are presents but cores and technological el-

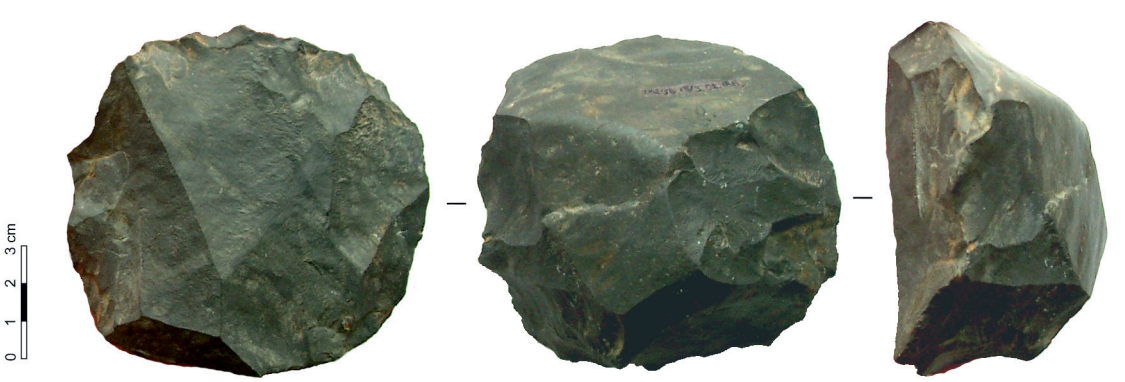


Figure 192: UK1-2, stratum 18, radial core



Figure 193: UK1-2, stratum 13, Levallois blade core

ements linked with their production are lacking. Flat-faced cores are linked with the production of Levallois flakes, typical and atypical Levallois points and, most probably, with some of the elongated spalls. One of the illustrated cores shows removal negatives from the narrow face but may be not representative of the overall assemblage. Given the large standard deviation of the RTL dates obtained on sediments from stratum 18, this assemblage belongs to a period from OIS5e to the beginning of OIS3. Small assemblages associated with strata 17 to 13, although showing some MP features associated with a blade component, are difficult to characterize. Evidence for blade production is more numerous in strata 14 and 13, but these assemblages are at least partly re-deposited.

Anuy I

The site of Anuy I is located along a terrace of the Anuy River, about 500 m south of Denisova Cave. The site was discovered in 1983 by Derevianko and Molodin and excavated between 1986 and 1989 over a surface of 204 m² (Derevianko and Zenin, 1990; Goebel, 1994). Paleolithic material was discovered over a 70 m² surface. The 5 m thick stratigraphy is divided into 11 lithological strata and includes 3 cultural layers. Cultural layer 1 is associated with the modern soil formation of stratum 1 and is attributed to the Holocene based on the identification of pottery sherds. The second cultural layer is associated with gravel lenses in stratum 4 and includes a lithic assemblage (N=11), fauna (N=108) and 2 flake cobbles. The level is said to be re-deposited (Derevianko and Zenin, 1990; Derevianko, Shimkin, *et al.*, 1998) and its cultural attribution remains unclear. Cultural layer 3 is associated with strata 6 and 7, which are described respectively as a light brown loess-like loam and a dark brown loam rich in fragmented material. This layer produced a lithic assemblage of 279 pieces. None of these levels have been directly dated. Although the fauna has not been published, Goebel (1994) reports that taxa associated with layer 3 are mainly steppe and forest-steppe adapted.

The lithic assemblage from cultural layer 3 includes core-like fragments (N=19), blades (N=19), flakes (N=144), tools (N=44) and pebbles (N=14). Although blade cores are described as Levallois (N=3), they are also said to represent traditional single platform, mono-frontal cores (Derevianko, Shimkin, *et al.*, 1998). Indeed, the illustrated specimen (Derevianko, Shimkin, *et al.*, 1998: Fig.69, num.1) is a volumetric, semi-turning core with unidirectional, convergent removal negatives. The striking surface is plain, although it shows several negatives of tablet removals. In addition, a small radial core is reported. A microblade core on a flake is typologically close to a carinated endscraper (Derevianko, Shimkin, *et al.*, 1998: Fig.69, num.7). A core fragment on a pebble displays microblade removals (Derevianko, Shimkin, *et al.*, 1998: Fig.69, num.8). A small and thick endscraper on a flake is similar to the specimen described in EUP deposits from Anuy II (Derevianko, Shimkin, *et al.*, 1998: Fig.70, num.6). Burins are

present but not numerous (N=4), and tools on pebbles are said to be atypical. A fragmented, unidirectional, large blade and a large crested blade are also part of the assemblage. Bifacially flaked artifacts (N=2) are reported although the published example is amorphous and may be a core fragment.

The small assemblage from cultural layer 3 is not diagnostic, but by the blade technology and the microblade core suggest analogies with the EUP of the nearby site of Anuy II.

Anuy III

The previously described sequence of Anuy III includes assemblages excavated on a surface of 12 m² and attributed to the MP (from the bottom to the top) in strata 19, 18, 16, 15, and 13 (Derevianko, Shunkov, *et al.*, 2000; Derevianko and Shunkov, 2002). These assemblages are not directly dated, but a minimum age is provided by a single RTL date of 54 ± 13 ka BP obtained on sediments from layer 12 (Derevianko and Shunkov, 2002). The rest of the profile is correlated with the sequence of UK1-2 mainly on the basis of lithostratigraphic similarities. Given the methodological issues related to the RTL technique, assessing the chronology of the Anuy III sequence will require additional direct dating.



Figure 194: Anuy III, stratum 18, leaf-points

Stratum 18

Stratum 18 is the richest assemblage (N=819) including mono-frontal single platform cores (N=2), flakes (N=170), blades (N=12), byproducts (N=585), and tools (N=50). The core observed represent the initial flaking of a pebble blank, with the preparation of a striking platform and the removal of a cortical laminar flake from the broad face. Among the tools, a series of bifacial pieces (N=4) are among the most recognizable features (Figure 194). Two are elongated lozenge-shaped bifacial leaf-points, one of which has a plano-convex section. Two others are fragments, one being a possible distal fragment with convergent straight edges (Derevianko, Shunkov, *et al.*, 2000) and the other being oval-shaped with a rather symmetrical section. Mousterian tool types are represeted by sidecsrapers (N=3) and knives (N=7).

Anuy III strata 13 to 18 show the occurrence of typological elements associated with bidirectional convergent and laminar blanks. The few cores available are not really diagnostic, except for one specimen from stratum 16. The latter shows unidirectional reduction from the flat-face, as is described in Levallois-Mousterian assemblages such as Kara-Bom MPH2. From the same layer, a possible BC was described. More unusual is the presence of leaf-points as bifacial artifacts are rather rare in the region. Generally speaking, the so-called MP assemblages include Levallois and laminar elements, but given their small sample size they are difficult to categorize. Some isolated technological features also overlap with the IUP. Therefore, it is not clear yet if the Anuy III layers 13-18 belong to the MP or the IUP,

and the chronological attribution of the assemblages is still pending.

Stratum 16

The stratum 16 assemblage (N=81) has yielded a mono-frontal core, flakes (N=37), blades (N=6), by-products (N=16) and a set of tools (N=23). According to personal observations, the core is flat-faced with a triangular flaking surface displaying the negative of a large flake as the last removal. The other negatives are unidirectional and convergent, except for a broad flake detached from the distal part of the flaking surface. A thick mesio-proximal blade shows a hinged removal along its long axis removed from the section of the blade. This element is similar to the first stages of BC reduction. Previous removals are observed, but it is hard to determine if they occurred prior to the removal of the blade blank. Pointed levallois and pseudo-Levallois bidirectional blanks also occur in this assemblage (Derevianko, Shunkov, *et al.*, 2000). A mesio-distal fragment of a bidirectional cortical blade with an inverse distal truncation and a notch and proximal direct retouch along the right edge illustrates a production of medium/large size blanks. In this case, it seems that bidirectionality occurs rather early in the process.

Stratum 15

Stratum 15 has yielded more artifacts (N=132) including chips (N=76), flakes (N=37), blades (N=3), and a set of tools (N=15) (Derevianko, Shunkov, *et al.*, 2000). Like stratum 13, the material described is not really diagnostic although a Kombewa flake and a proximal fragment of a backed knife are reported. Platform faceting occurs starting from layer 15 and in all underlying assemblages.

Stratum 13

The stratum 13 assemblage is fairly small (N=10), and the attribution to the MP is based on a couple of identifiable pieces including a distal fragment of pointed blade with bilateral retouch and a sidescraper (Derevianko, Shunkov, *et al.*, 2000).

Tiumechin

The Tiumechin sites (50° 43’ N; 85° 8’ E) are located along the left bank of the Ursul River near the confluence with the Kaierlyk and Elo rivers. The site was discovered in 1977 by Posdrednikov (1977), and three main locations have yielded Paleolithic artifacts.

Tiumechin 1

Tiumechin 1 is located on a slope, on the second terrace of the Ursul River and was excavated in 1978 by Shunkov (1986). A stratigraphy with five distinct lithological strata has been described, but the lithic material is dispersed over a 3.2 m thickness throughout strata 1-4 (Derevianko, Markin, *et al.*, 2001). According to Tseitlin (Derevianko, Markin, *et al.*, 2001), these strata are associated with the second terrace of the Ursul River that was deposited during the Sartan period (OIS2). Strata 5 and 6 respectively correspond to the alluvial plain and the river bed. No fauna was found at the site. The archeological assemblage is re-deposited, and in the absence of datable material, a minimum age is provided by the deposition of the (Goebel, 1994; Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998; Derevianko, Markin, *et al.*, 2001). According to Shunkov (1990), the archeological assemblage (N=576) is attributed to a single Mousterian techno-complex. Based on the identified cores (N=30), Levallois cores (N=21) dominate the set. Some of them are flat-faced unidirectional convergent. The latter have radial preparation negatives along the edges of a triangular flaking surface and likely correspond to a recurrent approach. Levallois blanks are flakes (N=14), blades (N=32) and convergent blanks (N=17). Facetted striking platforms (including *chapeau de gendarme*) are frequent. Most of the retouched tools have direct marginal retouch, but other kinds of retouch also occur. Based on a detailed typological analysis, Mousterian tools (mainly sidescrapers) are predominant, followed by Levallois implements. Tiumechin 1 is, therefore, attributed to a Mousterian with a strong Levallois component (Derevianko, Markin, *et al.*, 2001).

Tiumechin 2

Tiumechin 2 is located 2 km east from Tiumechin 1 at the confluence of the Tiumechin and the Ursul rivers. The site was excavated in 1979 over a surface of 50 m² (Shunkov, 1982, 1990; Derevianko, Markin, *et al.*, 2001). A stratigraphy divided into three distinct lithological strata covers a thickness of 1.9 m. Artifacts are dispersed from the ground surface down to a depth of 1.4 m, crossing the three lithological strata. According to Goebel (1994), the assemblage is located in bedded alluvial/colluvial sediments. The site remains undated. The lithic material (N=364) is represented by cores (N=10), flaked pebbles and pre-cores (N=14), blanks (N=222) and tools (N=62). Radial cores dominate as Levallois cores and blanks are absent. According to Shunkov (1990), denticulates are extremely frequent and the assemblage is atypical.

Tiumechin 4

Tiumechin 4 is located 1.2 km east from Tiumechin 1. Following a 12 m² test-pit made in 1981, the site was excavated in 1983 over a surface of 100 m² (Shunkov *et al.*, 1993). An additional area of 10 m² was excavated in 1990 to reassess the stratigraphy and to collect samples (Derevianko, Markin, *et al.*, 2001). A stratigraphy of 8 lithological strata has been described, the archeological material being located in the lower portion of stratum 5. Based on a geomorphological argument, the deposition of stratum 5 is attributed to the late Karginian stage (OIS3-OIS2). The material is re-deposited by erosional processes, and the cultural layer is described as a mixture of different cultural components. Among the most typical artifacts, a series of elongated and narrow leaf-points shows similarities with the material from Anuy III stratum 18 or from the old collection of Ust-Kanskaya. In addition, although Derevianko and colleagues (Derevianko, Markin, *et al.*, 2001) mentions that no core or core-like pieces have been found, typical microblade cores of carinated endscraper types occur in the collection.

To summarize, the assemblages from the Tiumechin sites are problematic as they are in secondary positions. Although Tiumechin 1 has been described as techno-typologically homogenous, this assemblage could also represent a mix of different MP variants or include IUP material. Given the context, the atypically high frequency of denticulates from Tiumechin 2 could also reflect taphonomic processes, such as mechanical edge damage. Tiumechin 4 represents the unusual association of elongated leaf-points and microblade cores, likely reflecting mechanical admixture of different cultural components.

Kara-Tenesh

The Kara-Tenesh is located in the territory of the Altai Republic, along the left bank of the Nizhni Kuius River. It lies on an erosional slope in the Bel mountain valley at an altitude of 850-800 m asl. The site was discovered in 1974 by Kadikov who excavated a thick layer of Afanasievao settlement (Pogozheva and Kadikov, 1979). After the discovery of Paleolithic artifacts on the site, Okladnikov conducted excavations between 1979 and 1981. Although detailed stratigraphic descriptions started in 1982, they were completed during a restudy of the section by Petrin, Nikolaiev, Dergacheva and Fedenova between 1992 and 1993 (Derevianko, Markin, *et al.*, 2001). The section is divided into 11 lithological strata with stratum 3 containing the only cultural horizon. Stratum 3 consists of a laminated greenish and dark gray loam with an admixture of silt, sand and humus. Iron oxides, pieces of charcoal and carbonate concretions are reported. Together with the underlying stratum 4, stratum 3 is reported as affected by solifluction. Based on geochemical and geomorphological observations, Nikolayev (1995) infers that stratum 2 accumulated during cold conditions of the Sartan period and that stratum 3 accumulated during damp conditions of the late Karginian period. Strata 4 and 5a include cryogenic formations that led the authors to attribute them to the inter-Karginian or to the Ermakov period (OIS5-OIS4) (Derevianko, Markin, *et al.*, 2001).

A set of conventional radiocarbon dates has been obtained on bone samples collected in stratum 3 (Orlova, 1995; Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998). If the results indicate that the deposit may belong to the Karginian interstadial (OIS3),

they also show a high degree of variability: 42,165 ± 4,170 ^{14}C BP (SOAN-2485), 34,760 ± 1,240 ^{14}C BP (SOAN-2135), 31,400 ± 410 ^{14}C BP (SOAN-2486), and 26,875 ± 625 ^{14}C BP (SOAN-2134).

The lithic assemblage from stratum 3 (N=1297) is said to be produced for the most part on pebbles and nodules of local fine-grained chert (Derevianko, Markin, *et al.*, 2001). A total of 14 cores, 5 preforms (a few removals but no platform) and 4 core fragments are described in the literature. Half of the identifiable cores are described as Levallois (N=7) but this category also includes pre-cores (N=2) and fragments (N=1). According to Derevianko and colleagues (Derevianko, Markin, *et al.*, 2001), core preforms are treated by radial removals and no clear primary removal could be observed. The remaining cores include a flake core, a blade core and two micro-cores. The Levallois flake core is bi-convex and shows a last preferential flake scar following a radial preparation. The micro-cores are bi-convex and are described as showing a radial reduction pattern. A broken pebble shows a transversal flaking surface which seems to have been prepared by radial flaking. A series of flakes were detached from the widest side of the sub-triangular flaking surface.

The blade core illustrated shows a flaking surface on a narrow face with bidirectional removals (Derevianko, Markin, *et al.*, 2001: Fig. 150 num. 3), although it is described as mainly unidirectional. The main striking platform is prepared by faceting. A narrow-face blade core is mentioned. The rest of the cores are on pebbles and are described as rather expedient. The pebbles are split and the broken section is turned into a flaking surface. A few examples show a triangular or sub-triangular flaking surface. Two cores are described as sub-prismatic and oriented toward the production of medium/short blades, and a bidirectional bladelet core is mentioned but not illustrated.

According to previous studies (Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998; Derevianko, Markin, *et al.*, 2001), blades and fragments of bladelets/microblades reach 35 % of the blanks (N=672) with the remaining part grouping flakes and laminar flakes. Flakes are mainly of reduced size and blades are relatively massive, including bidirectional blade blanks. Although plain platforms are said to prevail in the set, facetted platforms and at least occasional partial faceting also occur. Although the authors note a very low frequency of cortex on the blank dorsal patterns, they also illustrate the presence of large crested blades that likely indicate on site blade reduction.

One of the most interesting aspects of the Kara-Tenesh assemblage is the rich set of retouched blades (Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998; Derevianko, Markin, *et al.*, 2001). The toolkit (N=110) mainly consists of retouched blades and fragments of retouched blades (N=63). The numerous fragments are described as representing a secondary treatment by intentional breakage. This interpretation is inferred from the fact that some fragments were refit and show the different steps of secondary treatment, before and after the breakage. The combination of scalar and thin retouch is frequent, and this tends to be continuous and/or rather invasive. Among the retouched blades, IUP diagnostic elements are blades with proximal inverse retouch (Figure 195) (Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998; Rybin, 2000; Derevianko, Markin, *et al.*, 2001). Some of these are complete tools (N=3) reconstructed from fragments, proximal fragments (N=2) and pointed distal fragments (N=3). The proximal thinning consists in semi-circular thin and flat inverse retouch expanding on the ventral face. The rest of the blanks tend to have continuous, direct, thin and scalar retouch along one or both edges. Similar treatment is also applied with inverse retouch. The distal part of the tool is pointed by bilateral, direct, thin, semi-steep retouch. One of the complete tools shows attempts to rejuvenate the tip by retouch after a distal breakage. According to the published material, the latter tool is produced on a bidirectional blank with the point taking place on the proximal end and with a thinning obtained after retouching a broad distal end. More generally, blanks are both bidirectional and unidirectional blades of various sizes. Some of the illustrated examples bear lamellar parallel or convergent removals on their dorsal face (Figure 195 : 1, 3, 4)

These removals are described by Goebel in other assemblages as ‘trimming’ and are implicitly con-

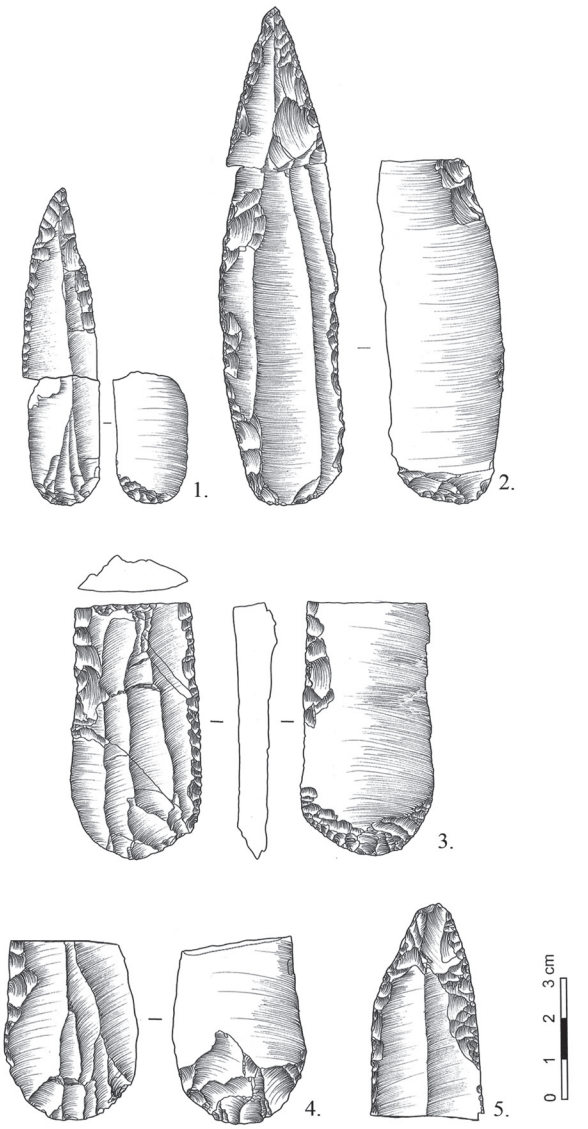


Figure 195: Kara-Tenesh, pointed blade with inverse thinning (1-2), retouched blades with inverse thinning (3-5) and pointed blade (6) (redrawn after Derevianko *et al.*, 2001)

sidered as a form of preparation prior to the blank removal (Goebel, 1994). This type of removal is also described in the transitional assemblages *(Paleolithique intermediaire)* from Umm-el-Tlell facies 3 (Syria) (Boëda *et al.*, 2002). It is a defining character of the Umm-el-Tlell point and is either considered as a bladelet production method as alternating bladelet production imbedded in the larger Levallois blank *(pointe de type 1 et 2)* or blade production (Boëda and Bonilauri, 2006) or as a platform preparation (Bourguignon, 1996, 1998). In the present case, these negatives are interpreted as removals anterior to the large bank detachment. As opposed to the convergent Umm-el-Tlell points, the detachment of such small lamellar flakes may not be of any help regarding the detachment of the large blade with parallel edges. Therefore, it does not represent a technical solution exclusively linked with the core edge preparation.

Nerevtheless, Kara-Tenesh did not yield a large series of bladelets with retouch or use-wears that could support the idea of alternating production. Assuming that the removals are intentional, such dorsal removals associated with proximal inverse retouch could also represent a form of basal thinning. In the case of a dorsal treatment anterior to the ventral one, it would appear as anterior to the blank removal itself.

Similar proximal retouch is observed on other types of artifacts. One example is a thick laminar flake that shows bidirectional removals on its dorsal face and lateral flaking along the edges. A series of large inverse retouch removals is visible on the proximal end of the blank. Although this specimen has a truncated-facetted morphology, it seems from the unpublished drawing that the lateral retouch is posterior to the blade removals observed on the ventral face. This suggest that the last use of this artifact may have been as a tool with a use different from the pointed blades but with a similar proximal treatment. Another blank bears invasive retouch covering the entire dorsal face and a proximal inverse truncation that is comparable to a basal thinning. This artifact is similar to a bifacial leaf-point described in UK1-1 OH5.4-5.5, although apparently thicker.

A backed knife (Derevianko, Markin, *et al.*, 2001: Fig. 152 num. 14) and a backed point are illustrated by Derevianko (Derevianko, Markin, *et al.*, 2001: Fig. 152 num. 8). Judging by the available illustrations, the reported bifaces are rather atypical and non-diagnostic. Endscrapers (N=3) and sidescrapers (N=11) are produced on blades and on blade fragments but also on flakes (respectively N=10 and N=4). A retouched blade, although less elongated, has a curved distal end that is similar to the so-called sickle-like blades described in the OH5 assemblage of Kara-Bom (Derevianko, Markin, *et al.*, 2001: Fig. 151 num. 7). Two burins on retouch blades are mentioned but not illustrated.

To summarize, the Kara-Tenesh assemblage includes IUP typical techno-typological features. Large blades with uni- and bidirectional scar patterns seem for the most part to have been produced in another location. As in Kara-Bom, intentional blade snapping seems to occur rather frequently, although not in the context of BC technology. One of the most interesting features of this assemblage is that it includes clear examples of pointed blades with proximal thinning and also other types of tools with a similar preparation. Other elements, such as a radial flake core and micro-cores, indicate a production of medium to small flakes on site. Although the available radiocarbon dates are inconsistent, it is worth mentioning that the oldest age obtained (SOAN-2485) overlaps with Kara-Bom OH5 and OH6 but has a large standard deviation. Discrepancies may be caused by taphonomic problems as part of the deposits from stratum 3 are reported as affected by solifluction. The impact of this geological process, however, may have been relatively limited as numerous broken artifacts could be refitted. Aside from these refits, no taphonomic analysis has been performed, meaning that the proposed comparisons should be viewed with caution.

Karaturuk

This site is located along the Uznezi River, in the Katun Basin. It has been known since 1964 and was excavated using several test pits of circa 5 m² each. Five lithostratigraphic strata are reported, from which cultural remains (N=223) where identified at the contact between strata 4 (loam, yellowish gray) and 5 (sandy loam) (Derevianko, Shimkin, *et al.*, 1998). Cores (N=10) are conical, wedge-shaped and flat-face unidirectional forms. The category of endcrapers (N=20) also includes core-like forms similar to carinated endscrapers. Burins are reported as numerous. A bifacially retouched triangular tool is produced on a thin slab of white quartzite. The morphology of the removals on this piece (especially on the tip) is said to be typical of pressure retouch (Derevianko, 1998). The site is not dated but is attributed to the end of Upper Paleolithic. The association of narrow-faced cores and carinated core-like endscrapers is also found at the beginning of the Upper Paleolithic in sites such Anuy II or UK1-2.

7.1.2 CAVE SITES

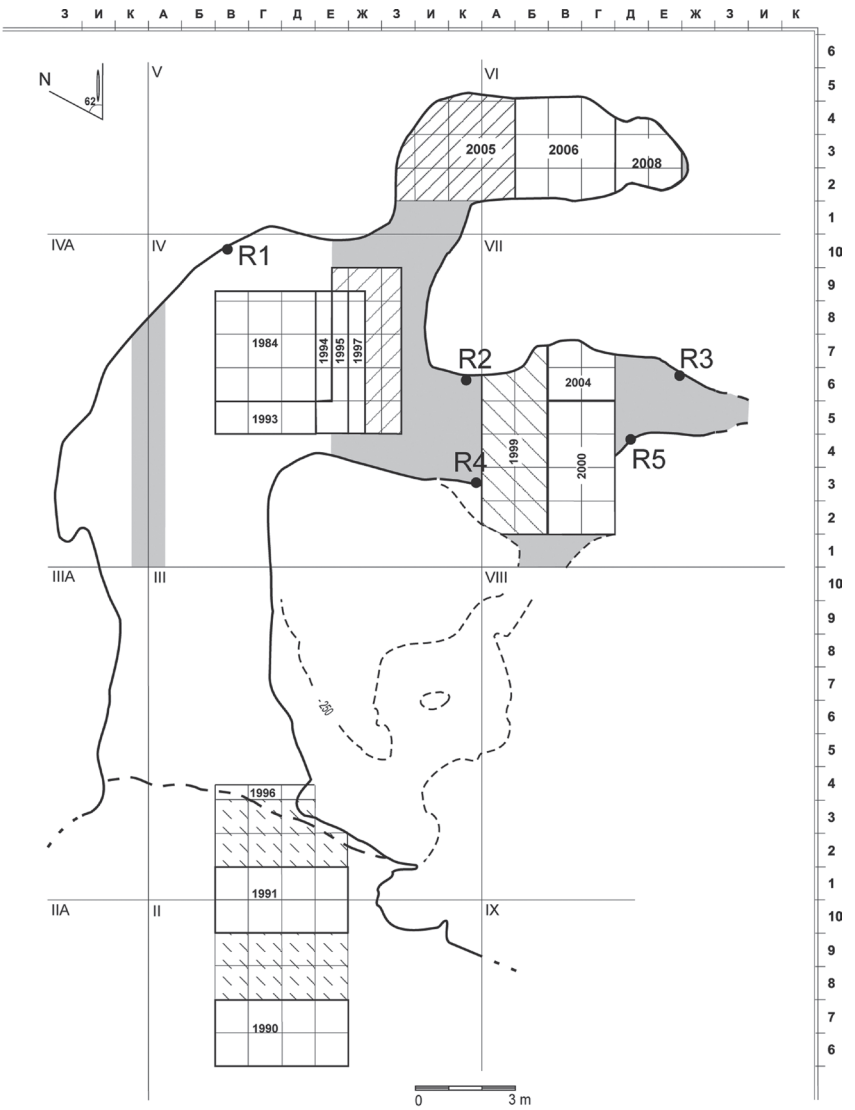
Denisova Cave

Denisova Cave (51°23'48"N, 84°40'35"E) (Figure 196) is located in the district of Altai Krai, on the right bank of the Upper Anuy river valley. The entrance stands 28 m above the river level at an altitude of 690 masl. It includes a 120 m² central chamber, a southwestern gallery of 9 m in length and between 1 to 4 m width, and two narrow, dark galleries of 50 to 70 m in length (Derevianko, Markin, *et al.*, 2001). Denisova Cave has been used as a reference sequence to support a first occurrence of MP during the Middle Pleistocene, to argue for a local transition from MP to UP and for a regional paleo-climatic reconstruction. Due to its importance for the broader debates, the site will be described here in more detail.

First archeological finds were made by Ovodov in 1977 as a result of a 4m deep test pit on an area of 2 m² (Okladnikov and Ovodov, 1979). Excavations started in 1982 under the direction of Derevianko.



Figure 196: Denisova Cave



R1 - reference point

IV - sector

- recent surface

- drip line

1989 - excavations of pleistocene sediments

- holocene sediments, excavated in year 1995

- holocene sediments, excavated in year 1999

- holocene sediments, excavated in year 2005

- crumbling zone

Figure 197: Denisova Cave, plan of the excavation (adapted from Derevianko *et al.*, 2003; courtesy of B. Viola)

The first stages of excavation were conducted in both the entrance area and the central chamber, and yielded evidence from early metal ages to Late Medieval (Derevianko and Molodin, 1994). Starting from 1984, Pleistocene deposits were excavated in the entrance zone over a surface of 19.5 m², in the central chamber over a surface of 32 m² but also in the south and east gallery (Derevianko *et al.*, 1985, 1987, 2003; Derevianko, Shunkov, *et al.*, 1993, 2009; Derevianko, Shunkov, Tsybankov, *et al.*, 2010; Derevianko, Shimkin, *et al.*, 1998; Derevianko, Markin, *et al.*, 2001) (Figure 197).

Entrance zone (Sector 2 and 3)

∗ Stratigraphy and Lithological Description

Pleistocene deposits follow the morphology of the outcrop with a maximum thickness of about 8.5 m (Figure 198). Fifteen lithological layers have been defined by Derevianko and colleagues and divided in two main sedimentary units (15-11, subaqueous deposits and 10-1 slope deposits) (Derevianko, Markin, *et al.*, 2001). The depositional processes are interpreted as a spring-water environment filling a small reservoir resulting from the morphology of the outcrop. This process is reinforced by a relatively high degree of subsoil water activity linked to the Anuy river basin. The deposits are driven into the pit by the water action, and the intensity of subsoil water activity may have varied (Derevianko, Markin, *et al.*, 2001).

The lower unit (layers 15-11) has a maximum depth of 3.5m and shows an alternation of thin laminated sands (fine and thinly grained, yellow-grey and ocher-yellow), sandy loams (washed out, yellow-brown) and clays (fluidy-flaky, varying from grey to chocolate-brown). The latter display features testifying to the just mentioned post-depositional deformations (Derevianko, Markin, *et al.*, 2001).

According to Derevianko, Markin, *et al.* (2001), the middle unit (layers 10-5) has a similar depth of 3.5m and consists of laminated sandy loams and cemented loams including organic material. The sandy loams vary from grayish-brown to yellowish-brown with different degrees of consolidation. They contain various organic materials such as humic patches, charcoal and soot but also *eboulis* deposits coming from the roof and cave walls itself. Horizons of organic materials are cemented in a grey and brown loam, containing *eboulis* displaying random orientations. These include coarse elements of a relative big size. The upper part of the profile (layers 4-1) is about 3m in depth and contains a high density of *eboulis* and medium-sized and unsorted coarse elements in a chaotic position. The matrix consists of a dark-brown and ashen-grey sandy loam including organic elements such as plant roots. The archeological material is located in layers 5 and 6 (Upper Paleolithic), layers 7 and 8 (described respectively as an initial stage of Upper Paleolithic and transitional stage toward Upper Paleolithic), and layers 9 and 10 (Middle Paleolithic) (Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998; Derevianko *et al.*, 2003).

∗ Fauna

Bones are preserved in the middle part of the section only. Baryshnikov (Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998; Derevianko, Markin, *et al.*, 2001) identifies 21 species of large mammals belonging to carnivores *(Alopex lagopus, Vulpes corsac, Vulpes vulpes, Canis lupus, Ursus arctos, Ursus rossicus, Martes zibellina, Mustela eversmannii, Crocuta spelea, Panthera spelea),* proboscidians *(Mammuthus primigenius)*, ungulates *(Coleodonta antiquitatis, Equus hydruntinus, Equus ferus, Capreolus pygargus, Cervus elaphus, Bison priscus, Procapra gutturosa, Saiga tatarica, Capra sibirica, Ovis ammon)*. Comparisons between layers are difficult because the distribution of faunal remains is uneven (Table 108). Layers 7 and 6 have yielded numerous finds (244 and 178 specimens respectively), layers 10, 9 and 8 have yielded 50, 56 and 65 specimens, and only 8 bones were found in layer 5. Both layers 5 and 6 have yielded one specimen of *Alopex lagopus,* typically associated with tundra and taiga environments.

Among the 39 small-vertebrate taxa identified by Agadjanian, 36 are small mammals (for more details see Shunkov and Agadjanian, 2000; Agadjanian and Serdyuk, 2005; Agadjanian, 2008). These do not differ from the modern taxa, suggesting a maximum

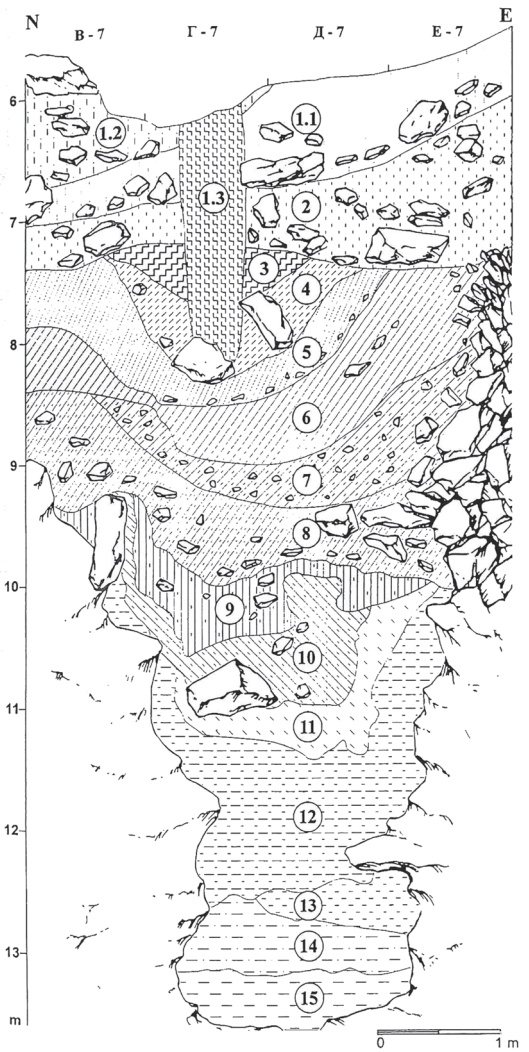


Figure 198: Denisova Cave, entrance zone, B7-E7 section (after Derevianko, Markin, *et al.*, 2001)

	Steppe sp.%	Forest-Steppe sp.%	Wood sp.%	Rocky sp.%	Tundra-Taiga sp.%
Layer 5	42.8	/	42.8	/	*
Layer 6	69	9.5	7.1	13.1	*
Layer 7	76.1	11.5	4.4	8	/
Layer 8	86.2	3.4	6.9	3.4	/
Layer 9	82.8	6.9	6.9	3.4	/
Layer 10	22.2	44.4	11.1	22.2	/

Table 108: Denisova Cave, entrance zone, environnemental signature of large mammals per layer. * represents single specimen (data from Derevianko, Markin, *et al.*, 2001)

age of Middle Pleistocene. The structure and the composition of the faunal assemblage differ clearly from the modern situation in the Anuy River that emerged during the Early Holocene. According to these results, Shunkov and Agadjanian (2000) proposed the following climatic reconstruction. Layer 10 corresponds to a warm and arid episode with the appearance of woodland species in layer 9. Layer 8 differs completely showing a drop in temperature and an increasing aridity. Woodland species are significantly less represented. After a possible depositional break, layer 7 forms during a cool and damp climate with a progression of forest and grassland. In layer 6, small mammal remains indicate an environmental change following a sedimentation break. It seems that climatic conditions become more steppic or semi-desert with a fall in temperatures.

29 species have been identified among the bird remains with an assemblage dominated by *Lagopus lagopus* (53.9%), *Tetroagallus altaicus,* and *Pyrrhocorax pyrrhocorax,* which altogether represent 66.2% of the identified species. No evidence of human consumption of birds has been found.

∗ Palynology

Malaeva (1995) recognized two main horizons according to the spore distribution in the entrance profile. The lower horizon consists of palyno-zone I (layers 14-11), palyno-zone II (upper part of layer 11 to10) and palyno-zone III (layers 9-7 and lower 6) (Malaeva, 1995).

Palyno-zone I is characterized by a high content of woodland species (birch and pine, layers 14 to 11, alder birch and alder in layer 10, with a decrease of pine pollen. Pollen of grasses and bushy plants rises to around 40 %, slightly decreasing in layer 10, and the spore rate fluctuates between 2% and 10%. Average quantity of birch pollen reaches 44% which indicates a stable influx of a nearby forest. Exotic and broadleaf species are present from 6-9% in layers 14 to 11, and only 1.5 to 5% from the upper part of layer 11 to 10.

According to Malaeva (1995), the transition between the lower and upper palyno-horizon (layers 9 to 6) is marked by a sharp 8% to 20% in woody-bushes species. Birch stays prevalent with a very fluctuating occurrence, and there is a good representation of alder. Spruce pollens reach 49 % in layer 7 but generally occurred in relatively small quantities. Broadleafed species still occur but less significantly than in the lower horizon. Palyno-zone III (layers 9-7 and the lower part of layer 6) is characterized by a good occurrence of *Daphne mesereum* pollen and by the highest representation of spruce. The upper part of layer 6 is described as palyno-zone IV with a quasi–total absence of broadleaf species (Malaeva, 1995).

∗ Chronology

Paleomagnetic analysis reveals a normal polarity attributed to the Brunhes epoch. An opposite polarity occurs starting at the top of layer 11 and continues in layer 10 through to the base of layer 9. It is attributed to the Blake inversion which occurs between 120 and 104 ka BP (Derevianko, Shunkov, *et al.*, 1993). Both lithological and biostratigraphical studies show a sedimentary break between layers 10 and 9. Therefore, it is assumed that the Blake episode applies on only on the top of layer 10 and to layer 11. The RTL date of 66 ± 16 ka BP (RTL-549) is discarded because of contamination by sediment coming from layer 9 (Derevianko, Markin, *et al.*, 2001). If layer 10 is really contemporaneous with the Blake inversion, it should be, therefore, considered as a part of the Kazantsevo period (OIS5e). This interpretation matches with the climatic signal given by pollen and micromammals analyses, indicating an interstadial type of landscape (Malaeva, 1995; Shunkov and Agadjanian, 2000; Agadjanian and Serdyuk, 2005). Following a sedimentary break, and according to the association between the fauna and flora taxa, layer 9 continues to the end of Ermakovo stadial (OIS5-OIS4) (Derevianko, Markin, *et al.*, 2001). This layer has yielded RTL dates of 50 ± 12 ka BP (RTL-608) and 66 ± 16 ka BP (RTL-549). In addition, a single AMS radiocarbon date of 46,000 ± 2,300 (GX-17602-AMS) on a charcoal sample is available (Goebel, 1994; Kuzmin, 2004). According to pollen analysis, layer 8 illustrates a retreat of the forest area and an opening of the landscape. This could correspond to the climatic deterioration occurring at the end of the Ermakovo period. Cold and relatively damp conditions domi-

nate at the time of layer 7 deposition as meadows and grassland areas expand. Layer 7 seems to show similarities with layer 11 in the Main chamber. The latter is attributed to the Karginian period (OIS3). Layer 6 displays a sharp reduction of forest and grassland biotopes as well as an extension of steppe biotope in a cool and arid climate which might correspond with the Sartan period (OIS2). A single AMS radiocarbon date of 14,190 ± 140 ^{14}C BP (GX-17,896) obtained from a charcoal sample is reported (Goebel, 1994). The top of the profile has yielded three radiocarbon dates on charcoal from Layer 1: 10,800 ± 40 ^{14}C BP (SOAN-2865), 10,690 ± 65 ^{14}C BP (SOAN-2866) and 9,890 ± 40 ^{14}C BP (SOAN-2864) (Derevianko *et al.*, 1993).

Central Chamber (sector 4)

∗ Stratigraphy and lithological description

In this part of the cave, the sequence exposed reaches a thickness of 4.5 m. A total of 14 lithological divisions (layer 9-22) have been recognized by Derevianko and colleagues (Derevianko, Markin, *et al.*, 2001) (Figure 199). Layers 9, 11, 12, 14, and 22 are subdivided into sublevels following variations observed in the sediment texture. The lenticular layers 15, 16 and 18 were identified in the middle of the excavated area only. The stratigraphy of the south-eastern wall, from the 1995 excavation, is the most recently studied. The profile has been divided into

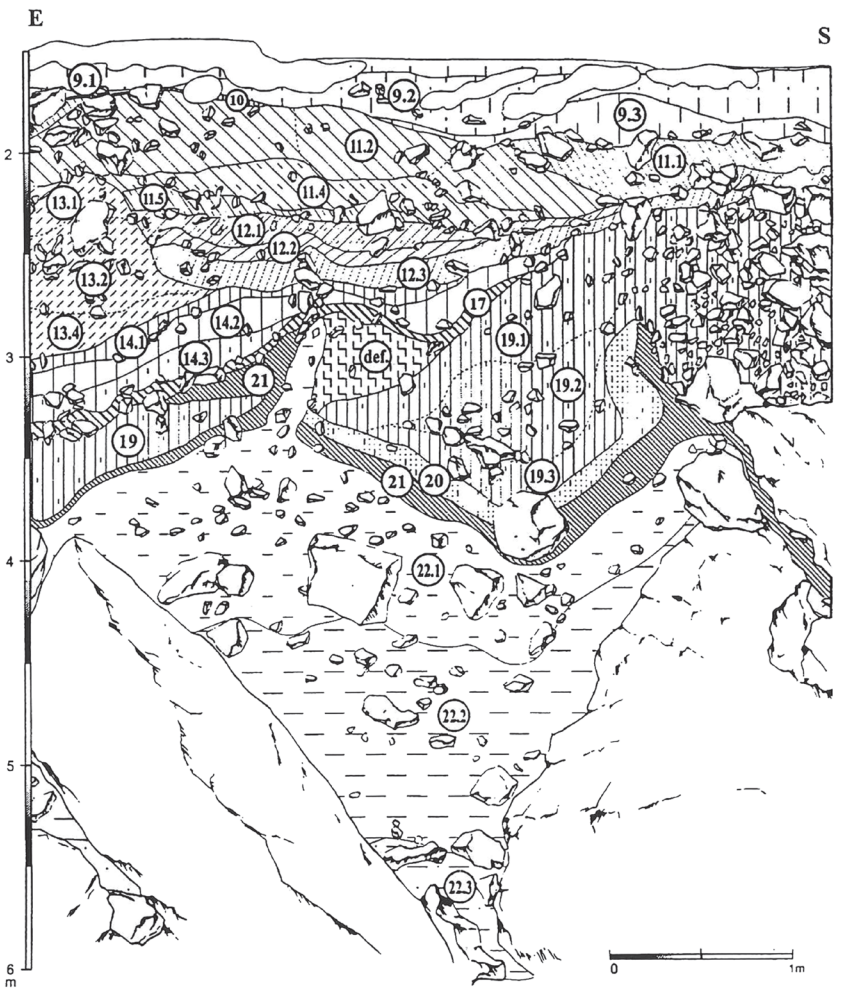


Figure 199: Denisova Cave, central chamber, section (Derevianko, Markin, *et al.*, 2001)

three main units, possibly separated by depositional hiatus (Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998; Derevianko and Rybin, 2003).

According to Derevianko and colleagues (Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998; Derevianko, Markin, *et al.*, 2001; Derevianko *et al.*, 2003), the lower unit includes layers 22 and 21. Layer 22 is 2.5 m thick and divided into three sub-levels, namely 22-3, 22-2 and 22-1. The lower half of layer 22 is composed of loam and large limestone blocks. It contains debris of eroded limestone and fragments of calcite. The main part of layer 22 is composed of ochre-colored or pale yellow loam in which limestone blocks are relatively rare. Ferriferous and manganese concentrations are common and affect bone preservation. Sediment accumulation is likely the result of high energy processes involving physical and chemical weathering of the limestone bedrock (Derevianko, Markin, *et al.*, 2001). The occurrence of young calcite formations shows the role played by the dissolution of the limestone in the depositional process. The upper part of the layer displays geometric deformations which could testify to stream activity. Layer 21 clearly differs by its dark color and composition. Its thickness reaches 15 cm, and it is made of loam saturated by organic material (charcoal, sooty matters). Maloletko (1991) considers that layer 21 is the result of a catastrophic event during a mud flow that accumulated around 1.5 m of sediments.

The middle unit includes layers 20-11.This section is formed by a series of lenticular loams rich in plants roots, varying in color from brown to red-brown in the lower part and to grayish brown and dark grey in layer 11 (Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998). Accumulation of debris, from the wall, the roof and from stalagmite can be found in various sedimentary units. Derevianko and colleagues acknowledge that it is not always possible to distinguish clearly boundaries between these layers (Derevianko, Markin, *et al.*, 2001). Depositional processes include low-energy gradual filling, removal of the material from lateral galleries, but also U-shaped features observed on sections that may illustrate stream activity and the formation of gravitational cones (layer 19). Bioturbations are in some cases clearly observed, like in layer 13, which is interpreted on the basis of the faunal remains as a hyena den. Layer 10 is a 1 cm thick horizon containing organic material along with ferriferous and manganese formations (Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998; Derevianko, Markin, *et al.*, 2001; Derevianko *et al.*, 2003). This could correspond to a slowing of the sedimentation process or a depositional break separating layer 9 from layer 11 .

The upper part of the deposit is represented by layer 9 with has a thickness reaching 0.5 m. The matrix includes pale yellow loess-like loam, with lenses and roots, fine detritus and whitish phosphate accumulations. The deposits display geometric deformations and bioturbations. The contact between Pleistocene and Holocene deposits is said to be flat and distinct. (Derevianko *et al.*, 2001).

∗ Fauna

The central chamber has yielded remains from 117 different species (Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998). Large mammal remains are dominated by steppe inhabitants (Table 109), both in the number of species and in the quantity of faunal specimens *(Vulpes corsac, Mustela eversmanii, Ursus rossica, Crocuta spelea, Coleodonta-antiquitatis, Equus hydruntinus, Poephagus mutus, Bison priscus, Procapra gutturosa, Saiga tatarica, Ovis ammon)*. In all levels, forest-steppe species *(Cuon Alpinus, Equus ferus, Cervus elaphus)* and rocky species *(Mustela altaica, Capra sibirica)* also occur. Forest dwellers are present throughout the entire profile except in layer 9 and no significant change between levels is observed in the large mammal faunal spectrum. Only the frequency of species from different biotopes slightly changes as we follow the profile upward. Notable is the small number of finds in layers 20 and 21 (Derevianko, Markin, *et al.*, 2001).

A taphonomic study by Germonpre (1993) underlined the high degree of fragmentation. Only 10% of the analyzed material (N=2990) from the 1992 excavation (entrance and central chamber) were identified. According to her results, breakage may be due to the combined results of rock fall, trampling, sediment load, human and carnivore activity. She

	Steppe	Woodland	Forest-steppe	Rock dwellers	Tundra/Taiga
Layer 9	64.3%	0.0%	7.1%	26.2%	2.4%
Layer 11	71.4%	3.9%	6.5%	17.5%	0.6%
Layer 12	73.3%	1.9%	13.3%	9.5%	1.9%
Layer 14	67.5%	13.0%	10.4%	9.1%	0.0%
Layer 19	72.7%	6.8%	10.2%	8.0%	2.3%
Layer 20/21	78.9%	10.5%	5.3%	5.3%	0.0%
Layer 22	58.8%	13.7%	7.8%	11.8%	7.8%

Table 109: Denisova Cave, central chamber, environmental signature of the large mammals per layer (data from Derevianko, Markin, *et al.*, 2001)

notes that most of the bones are fresh and usually not weathered. The preliminary results also indicate a higher frequency of carnivore activity in the cave than in the entrance zone. In fact, the frequency increases as one moves deeper in the cave but remains much lower than in typical hyena accumulations. Germonpre (1993) notes that most of the remains were not attributed to stratigraphic layers (see also Escutenaire, 1994; Goebel, 1994) and are assigned *a posteriori* using spatial coordinates.

Agadjanian identified 37 of 40 species belonging to the small mammals (Shunkov and Agadjanian, 2000; Agadjanian and Serdyuk, 2005). *Stenocranius gregalis* and *Alticola strelrovi* are the most common genus and represent arid and high mountain steppe environments. The occurrence of *Lagurus lagurus* seems to confirm this trend. Woodland species *(Clethrionomys)* appear through the whole Pleistocene profile. *Asioscalops altaica* and *Myospalax myospalax,* found in almost each layer, cannot be associated with permafrost climatic conditions. An infrequent occurrence of *Cricetutus barabensis* and *Microtus oeconomus,* associated respectively with steppic and river-bed environments, is noted in every layer.

According to the spectrum of small mammals, Pleistocene landscapes during the sediment accumulation are characterized by large open areas but also by a permanent forest signal. Woodland species are particularly numerous in layers 22 and 21 *(Clethrionomys)* with a notable change in layer 20 where steppes species increase *(Alticola)*. This could represent a regression of the forest and an extension of the mountain-steppe area (Shunkov and Agadjanian, 2000; Agadjanian and Serdyuk, 2005). Between layers 19 to 14, the main groups of small mammals have stable frequencies. A major change occurs starting from layer 12 to layer 9. It is marked by the reduction of woodland species in favor of those associated with mountain-steppe landscapes. One can note the sharp increase of *Lagurus* which reaches its maximum in layer 9.

In addition, 50 species of birds have been identified. The spectrum is dominated by alpine species (among others *Leucosticte arctoa, Lagopus lagopus* and *Plectrophenax nivalis*). Woodlands species are rare (Derevianko, Markin, *et al.*, 2001).

∗ Palynology

Malaeva sampled the southeastern wall for pollen during the 1995 excavation. She identified five main horizons, subdivided into several palyno-zones (Malaeva, 1995).

Horizon I constitutes palyno-zones 1 to 12 and is correlated with layer 22. It is rich in pollen from birch, pine and alder together with the steady presence of broadleaf species. In this horizon, 17% of the

extinct species are represented by woody, grassy and cryptogamous plants which are exotic for the modern flora of northwestern Altai. According to these results, the climate might have been temperate and dry with small fluctuations in moisture. The landscape is composed of forest, the developed sub-belt of 'warm steppe forest', broad-leaved species and by pine and birch.

As the layer 21 has yielded only poor information, horizon II (palyno-zones 13 and 14) covers layer 20 to layer 14. Palyno-zone 13 shows the prevalence of birch pollen over other taxa. Birch is typical of the lower sub-belt. The broadleaf species, namely linden, oak, elm and maple, are commonly found in forest near river valleys. Birch and related taxa cover northern slopes, as the south-facing slopes are covered by steppe vegetation (worm woods, cereal and grasses). Palyno-zone 14 starts from the upper part of layer 19 through layer 17 and continues until layer 14. Spruce pollen increases and Siberian pine appear in the spectrum. This represents a transitional phase and a change in the nature of the forest signal (Malaeva, 1995).

Horizon III includes palyno-zones 15 and 16. Palyno-zone 15 corresponds to layer 12.3 and follows the trend which started in level 14 with a dominance of spruce, the increasing of Siberian pine and the appearance of *Daphne mesereum*. Palyno-zone 16, detected in layers 12.2 and 12.1, is a transitional phase marked by a sharp increase of birch pollen, balanced by a co-occurrence of spruce. However, the frequency of the latter is lower than in the previous pollen zone.

Horizon IV corresponds to palyno-zone 17 and is found in layer 11. It is marked by a decrease in terms of birch pollen frequency and by a high content of dark-needled species, such as spruce and Siberian pine. A considerable quantity of *Polygonum viviparum* and *Polemonium* appears. This corresponds to an activation of the dark-needled forests and to the spreading of grassland areas. The forest-steppe birch association gradually disappears. It seems to testify to a damp and relatively cold phase.

Horizon V, corresponding to the palyno-zone 18, is associated with layer 9. A very high percentage of grass species is recorded (up to 90%). Dark-needled species are common in the dendroflora spectrum. According to Malaeva (Malaeva, 1995; Derevianko, Markin, *et al.*, 2001), it seems that some data related to a dry phase are detected in layer 9. Also, she notes an increase in variability of grass taxa.

∗ Chronology

A first set of conventional radiocarbon dates has been produced on humic sediments from layer 21 and yielded ages of >34,700 ^{14}C BP (SOAN-2488) and 39,930 ± 1,310 ^{14}C BP (SOAN-2499) (Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998). The lower part of the profile has been dated by Kulikov (Derevianko, Shunkov, *et al.*, 1993) using the RTL method (Vlasov and Kulikov, 1989)(Table 110).

Stratum	RTL	Lab number
14	69 ± 17	RTL-611
21	155 ± 31	RTL-546
22.1	171 ± 43	RTL-737
22.1	182 ± 45	RTL-738
22.1	223 ± 55	RTL-739
22.1	224 ± 45	RTL-547
22.2	282 ± 56	RTL-548

Table 110: Denisova Cave, central chamber, RTL dates (after Derevianko, Agadjanian, *et al.*, 1998)

Gnibidenko recognized two inversions of the magnetic polarity. In light of the RTL results, he interpreted these inversions as Biwa I (220-176 000 BP) in layer 22.1 and Biwa II (330-266 000 BP) in layer 22.2 (Derevianko *et al.*, 1998). It is also argued that the important quantity of exotic flora detected in layer 22 could reflect an early age of these deposits in the Middle Pleistocene (Derevianko *et al.*, 2003). The middle part of the profile has yielded a single radiocarbon date. An age of >37,235 BP (SOAN-2504)

was obtained on an unknown bone sample collected in the middle portion of layer 11.

Based on the paleoenvironmental data set, Shunkov and Agadjanian (2000: Fig. 9) proposed a climatic reconstruction correlated with the major Siberian climatic horizons. They note that the warm conditions of the initial stage of Upper Pleistocene are represented by pollens and small mammal fauna in stratum 22. They consider the Kazantsevian (OIS 5e) stage as a terminus *post quem* for layer 22, making layers 21 to 12 contemporaneous of the Yermakov stage (OIS5-OIS4)(Shunkov and Agadjanian, 2000; Agadjanian and Serdyuk, 2005). Layer 11 is correlated with the Karginian stage (OIS3) and layer 9 would belong to the Sartan stage (OIS2). Some other authors have argued that biostratigraphical material is not really suitable for dating purposes because it is locally specific (Malaeva, 1995; Derevianko, Markin, *et al.*, 2001).

Thus, two main hypotheses emerge regarding the earliest human occupation at Denisova Cave. The first one is based on the RTL dates, and the second one on the composition of the small mammal assemblage. According to Kuzmin (2000) (but see also Wrinn, 2010), the RTL dating technique has some methodological uncertainties (Huntley, 1992). Moreover, they stress that luminescence dates applied on sediments increase the risk of sample contamination by unbleached particles that would potentially overestimate the results (*e.g.* Aitken, 1994). It is necessary, therefore, to cross-check the RTL dates with other methods in a more controlled environment (Kuzmin, 2000). The magnetic reversals recorded in layers 22.1 and 22.3 are attributed to Biwa I and Biwa II on the basis of the RTL dates, but they could also be attributed to the Blake reversal (Wrinn, 2010) as identified in the entrance of the Cave. In this situation with two conflicting chronological interpretations, the present study adopts the conservative point of view that the earliest human occupation from the central chamber belongs, at least partly, to OIS5e (Kuzmin, 2000; Shunkov and Agadjanian, 2000; Agadjanian and Serdyuk, 2005; Wrinn, 2010). Nevertheless, this chronological model is hypothetical until it obtains further support and may also be considered as a minimum age.

∗ Human remains

Two teeth, Denisova 1 and 2, have been found in the 1984 collection. Denisova 1 is an upper central incisor found in layer 12. It has been described as morphologically similar to Shanidar 2 upper central incisors but strikingly different than the Krapina specimens, suggesting that they belong to Neandertal closer to the Asiatic group rather than to the European one (Turner, 1990). Shpakova, accepting the occurrence of archaic traits (as the relatively large size and the high degree of enamel attrition), however, reaches the conclusion that

> 'the combination of metric and non-metric traits of teeth from Okladnikov and Denisova caves, then, speaks in favor of anatomically modern humans affinities' (Shpakova and Derevianko, 2000).

Based on morphological comparisons, Viola *et al.* (2011) identifies this tooth as a very worn incisor from a large bovid.

Denisova 2 is a deciduous molar (right first lower) found in layer 22.1 that would date to at least OIS 5e. It then represents one of the earliest human fossils from Central Asia (Derevianko, Markin, *et al.*, 2001; Viola *et al.*, 2011). Denisova 2 is heavily worn and does not provide clear morphological data.

South and east gallery

Starting from 1999, excavations began in the south gallery and have yielded a sequence for which the upper part is attributed to the Holocene period and the lower part to the Pleistocene (Reich *et al.*, 2010). The Pleistocene section is rather short as it is exposed on about 2m thickness. It starts with layer 9 and is followed by dark grey and brownish loam from layer 11. Starting in 2005, another excavation area in the east gallery yielded a comparable sequence (Derevianko, Shunkov, *et al.*, 2009; Derevianko, Shunkov, Tsybankov, *et al.*, 2010). The results of the excavation remain for the most part unpublished.

∗ Stratigraphy and lithological description

So far, layers 9 and 11 have been identified in the east gallery. Recent radiocarbon dates have shown that some of the bone tools associated with layer 11 are intrusive and probably comes from layer 9 (Reich *et al.*, 2010). The exact nature of the post-depositional disturbance is not yet identified. In spite of the absence of contact between the sections, layers are correlated with the stratigraphy from the main chamber based on the archeological material and on litho-stratigraphic descriptions. The sub-levels are not clearly correlated and do not occur in every part of the cave.

∗ Chronology

Chronological data are provided by a series of AMS radiocarbon dates on bone collagen (Table 111). Except for two samples (KIA-25285; AA-35321), all samples were pre-treated by ultrafiltration (Jacobi *et al.*, 2006; Brock *et al.*, 2007). Some of the samples display human modifications such as cut-marks. In the east gallery, dates were obtained on a bone tool fragment and on a rib with regular incisions. In addition, two unmodified bones from the south gallery were dated (Goebel, 2004; Krause, Fu, *et al.*, 2010; Reich *et al.*, 2010).

The dates on bones with human modifications show large discrepancies as none of the results overlap, even at two standard deviations. A second group of dates shows infinite ages and likely indicate an age beyond the limit of the radiocarbon method. A bison bone with cut-marks from layer 11.2 can be included in this group. However, younger ages are associated with layer 11.2 (Reich *et al.*, 2010). This cannot be easily explained by contamination as all samples have yielded similar acceptable C:N values (*e.g.* Jacobi *et al.*, 2006). Instead, these results suggest an artificial association between some Upper Paleolithic artifacts and older material. Furthermore, this raises issues regarding the integrity of the archeological layer 11 in the east gallery. The nature and the degree of disturbance are currently hard to evaluate. Addressing taphonomic issues would require specific analyses such as, for example, soil micromorphology or artifact refits.

∗ Human remains

So far, two fossils have been described. In 2000, layer 11.1 of south gallery yielded a tooth (Denisova 4) in square G2 belonging to a young adult and identified as a third or second upper molar (Reich *et al.*, 2010; Viola *et al.*, 2011). Generally speaking, the Denisova 4 molar is very large and falls outside the Neandertal and MH range. It appears also larger than the rare third molars and differs in morphology with the second molars from Asian Middle Pleistocene hominins. The morphology lacks Neandertal typical features. In the south gallery, dated samples are reported from layer 11.2 and, therefore, provide a maximum age for the Denisova 4 molar, although it is noted that none of the bones bear cut-marks. Denisova 3 is the proximal epiphysis of a juvenile manual phalanx uncovered in layer 11.2, square D2 of the East gallery (Krause, Fu, *et al.*, 2010; Reich *et al.*, 2010; Viola *et al.*, 2011). The phalanx belongs to a second individual with an age evaluated at around 6-7 years old. Mitochondrial DNA was extracted from both fossils and the exceptional conservation of the phalanx allowed a reconstruction of the nuclear DNA. A previously unknown genetic sequence was reconstructed and is now referred to as Denisovan (see Chapter 1). It is noted that two of the dated samples (OxA-V-2359-20; OxA-V-2359-21) were found in the direct vicinity of the phalanx in square D2. Both of these samples display human modifications and have yielded young ages (Table 111).

Lithic and bone artifacts

As previously noted, archeological material plays an important role in the layer attribution and in the correlation between the different sectors of the cave. Table 112 summarizes the correlations between the layers and their global attributions as published by Derevianko and colleagues (Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998; Derevianko, Markin, *et al.*, 2001).

∗ The Middle Paleolithic

In the entrance zone, layers 9 and 10 are attributed to the Middle Paleolithic. The following observations are made based on the published material from the

Lab Number	Location	Sample	Human modification	Layer	Age ^{14}C BP	δ13C	δ15N	%C	%N	C:N
OxA-V-2359-16	east gallery	Ovis/ capra	/	11.2	>50,000	-18.8	5	45	16.5	3.2
OxA-V-2359-15	east gallery	Ovis/ capra	cut marks	11	15,740 ± 65	-18.6	3.9	46.1	17.1	3.2
OxA-V-2359-14	east gallery	Bison	cut marks	11.3	>50,000	-19.6	6.2	46.3	17	3.2
OxA-V-2359-20	east gallery	Rib	Regular incisions	11.2	30,100 ± 210	-17.9	7.3	44.5	16.5	3.2
OxA-V-2359-21	east gallery	?	Bone tool blank	11.2	23,170 ± 110	-19.2	3.7	45.7	16.9	3.2
OxA-V-2359-17	south gallery	Ovis/ capra	/	11.2	>50,000	-19.2	6.2	46.1	16.9	3.2
OxA-V-2359-18	south gallery	Bison	/	11.2	>50,000	-19.4	5.8	45.8	16.9	3.2
KIA-25285	south gallery	Hyena	/	11	48,650 ± 2,380	/	/	/	/	/
AA-35321	south gallery	Charcoal	/	11	29 200 ± 360	/	/	/	/	/

Table 111: Denisova Cave, summary of the chronological data from south and east galleries (after Krause *et al.*, 2010)

	Entrance	Central chamber	South gallery	East gallery
Late UP	5			
Early UP	6-7	9	9	9
Transitional	8	11	11	11
MP	9-10	12-22		

Table 112: Denisova Cave, summary of the lithic assemblage attributions (after Derevianko, Markin, *et al.*, 2001)

1989 collection (Derevianko et al, 2001). In layer 10, large pebbles of chert and metamorphic rocks are brought to the site and tested. The main reduction system seems to be oriented toward flake production, as shown by radial and sub-radial Levallois cores and retouched blanks. A Levallois core with point removals is mentioned, and Levallois points with facetted platforms (including *chapeau de gendarme* types) occur. The general directionality of the removals is not clear as the same artifact is drawn as uni- or bidirectional depending on the author (*e.g.* Derevianko *et al.*, 2003: Fig.82 num.12; Goebel, 1994 Fig., 6.33 a). Elongated flakes/laminar flakes occur, but genuine blades are rare. Among the retouched tools, there are transverse sidescrapers, notches on Levallois flakes, and Levallois points with bilateral scalar and thin re-

touch (Derevianko *et al.*, 2003: Fig.82; Goebel, 1994 Fig., 6.33). Goebel (1994) mentions that nearly half the tools included in his sample are fashioned on Levallois blanks. Layer 10 includes a biface that seems to be produced on a rather thick blank (Derevianko *et al.*, 2003: Fig.82, num. 11). According to the drawing, this artifact could also be considered as a core judging by the pointed removal visible on one of its faces.

In layer 9 primary reduction takes place at the site. Medium size flakes are the most common blanks whereas only an occasional occurrence of blades is noted. Small Levallois flake cores with sub-radial patterning and cores with laminar removals are present. One of these is on a pebble fragment with some small laminar removals on a narrow face, and it has some previous flake removals on the broad face. Another one shows a single laminar removal along the edge of a cortical flake. One artifact is described by Goebel (1994, Fig. 6.33, K) as a flat-faced blade core with two opposed facetted platforms. On the drawing, it seems that the flaking surface is instead on the narrow face and extends onto the broad face. The core appears to be on a laminar flake/blade blank with an anterior crest, and it is similar to a BC. Levallois points are well represented and are similar to those described in layer 10 with facetted (including *chapeau de gendarme*) or dihedral platforms and with some bearing discontinuous lateral retouch. Retouched tools are dominated by sidescrapers of various forms, including convergent forms and one on elongated flakes, and by retouched flakes. Blades are still uncommon but seem to be more numerous than in the layer 10. Some show a bidirectional dorsal pattern from two opposed platforms, and some have a typical Levallois blade dorsal patterning (lateral preparation, convergent removals). More intriguing is the high frequency of burins mentioned by Derevianko, Markin, *et al.* (2001), a tool type that is not reported by Goebel (1994). This type of tool is usually more typical of UP assemblages. The reported burins are angle burins on irregular blanks, some of them showing traces of edge damage. Notches and denticulate are among the most common tool type in these assemblages.

In sum, Goebel's characterization of layers 10 and 9 as Levallois Mousterian seems the most appropriate (Goebel, 1994). Derevianko and colleagues (Derevianko, Markin, *et al.*, 2001) consider these assemblages as Middle Paleolithic with a pronounced Levallois component. They also note an important increase in blades and in UP type tools in layer 9 and suggest that it may reflect diachronic changes or differences in sample size. Indeed, some of the described artifacts and technological features may overlap with IUP variability. This includes bidirectional blades and a possible BC.

In the central chamber, layers 22 to 12 are attributed to Middle Paleolithic. The following observations are based on the published material from the 1984 and 1993-1995 collections. The lowermost archeological layer 22.2 has yielded 7 artifacts only, but the assemblage from layer 22.1 is larger (N=312). Among layer 22 finds, blanks are mainly flakes. Cores show sub-radial dorsal scar patterns and some are reported as Levallois. According to Derevianko and colleagues (Derevianko *et al.*, 2003), Levallois elements are represented by points. Sidescrapers are reported, some being similar to Quina-type. A large flake shows laminar removals on its narrow edge. The latter differ from the BC as it is not produced on a blade blank. In that layer, no blank seem to be associated with this core. A convergent blank of a relatively large size is also reported, but it seems to contrast with the general aspect of the assemblage.

Layer 21 assemblage (N=294) is characterized by a low frequency of blades and by polyhedral or radial flake technology. Platforms are mainly unprepared. The toolkit is described as varied but does include mainly unretouched tool types. In sum, this assemblage is not diagnostic and may represent a rather expedient technology (Derevianko, Markin, *et al.*, 2001).

The cultural attribution of the layers 22-20 assemblages is rather confusing. In some publications, authors consider it as showing all the characteristics of a typical Mousterian (Derevianko *et al.*, 1985). In subsequent publications, the same authors suggest that the toolkit composition indicates early stages of MP but with some techno-typological features cor-

responding to a Late Acheulean (*e.g.* Derevianko, Shunkov, *et al.*, 1993; Derevianko *et al.*, 2003; Derevianko, 2011). Comparing the Altai with the situation in Europe (*e.g.* Bosinski, 1982; Tuffreau, 1982), Shunkov (2005) underlines the fact that MP human occupations could also belong to the Middle Pleistocene. What features in the toolkit that point to the early stages of MP as opposed to a classic MP remain unclear. Also, references to Acheulean are problematic given that bifacial technology and cleavers are absent in these layers (Escutenaire, 1994). Reference to the 'early stage of the MP' or to the Late Acheulean seem more driven by chronological arguments than by clear techno-typological markers. As noted by Escutenaire (1994), before being dated by RTL, the assemblage was attributed to the Mousterian (Derevianko *et al.*, 1985; Derevianko, Markin, *et al.*, 2001). Note too that layers 21 and 22 appear fairly different from each other. Layer 22 appears as a small assemblage with Mousterian affinities and a Levallois component, while layer 21 lacks elements to propose a cultural attribution.

According to Derevianko and colleagues (Derevianko, Markin, *et al.*, 2001), layers 20 to 12 (N=7545) are described as techno-typologically homogenous with respect to significant differences in lithic artifact frequencies between layers (Figure 200). The richest Middle Paleolithic assemblages are associated with layers 19 (N=1760), 14 (N= 1484) and 12 (N=2500). This does not seem to be related to the size of excavated areaor to the layer thickness.

In layer 19 and 14, cores are oriented to flake production and are described as varied, including Levallois, radial, with one or more platforms. Levallois cores are described as triangular, square and tortoise shapes. Flakes are the main blanks produced with an infrequent occurrence of blades. Levallois blanks are flake, blade and convergent blanks. The latter have mainly *chapeau de gendarme* platforms. The most common retouched tools are, in order of frequency: sidescrapers, denticulates, Levallois types (retouched and unretouched) and notches. A backed knife is illustrated and attributed to Layer 19 (Derevianko *et al.*, 2003: Fig. 61, num. 15).

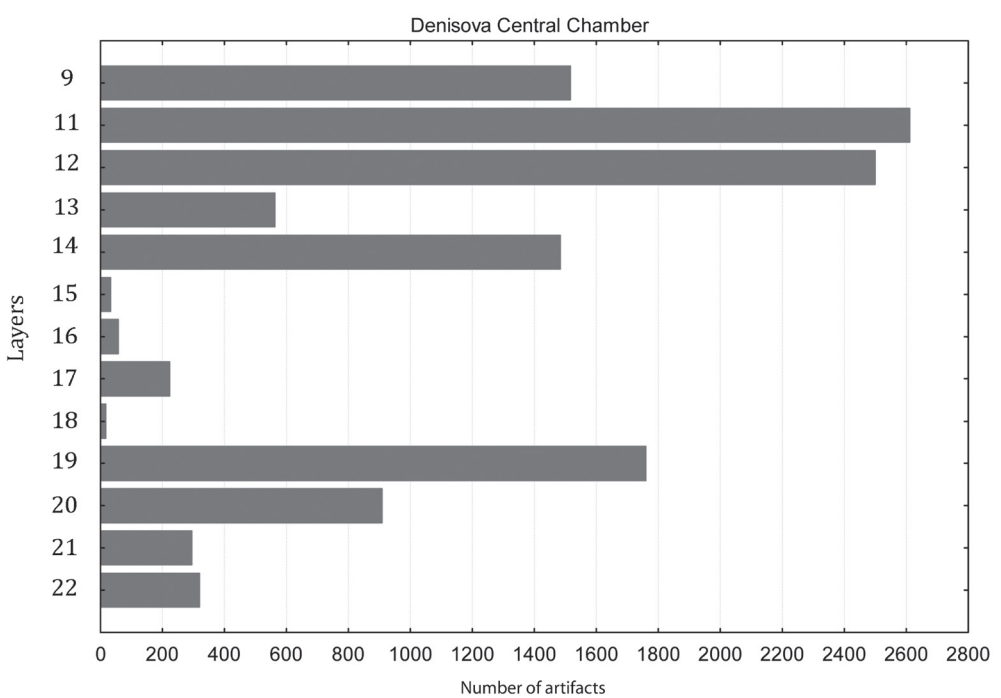


Figure 200: Denisova Cave, central chamber, number of lithic artifacts per layer (data from Derevianko, Markin *et al.*, 2001)

Layer 12 shares the same main features as Layers 19 and 14. It is a flake-based assemblage with a low frequency of Levallois elements and blade production. It seems, however, that some differences can be noted. One of the convergent blanks bears some inverse retouch on the proximal end, similar to a basal thinning (typed as a denticulate tool in Derevianko *et al.*, 2003, Fig. 64, num.1). A BC-like artifact is illustrated on what appears to be a thick side blade. It has a flaking surface located along the right edge with two opposed platforms (Derevianko *et al.*, 2003: Fig. 64, num.6). Also, a triangular bidirectional Levallois core occurs with traces of removals on the narrow face, indicating a possible sub-volumetric approach. A small endscraper with bifacial retouch and a mesio-distal fragment of a point with bilateral retouch, similar to some of IUP examples, are also present. A bifacial side-scraper is illustrated (Derevianko *et al.*, 2003. Fig. 64. 2).

To summarize, layers 20 to 12 show a low frequency of Levallois elements, although typical example are represented in almost every level. Blades seem to be rather rare, with a frequency not exceeding 5%. It is, however, noticed that sidescrapers are frequent and are sometimes produced on longer blanks. According to Derevianko and colleagues (Derevianko, Markin, *et al.*, 2001), the faceting index is also rather low. It is noted that, although not numerous, new elements occur starting from layer 12. Although the quantity of blades does not significantly increase, some technological features, such as regular and parallel dorsal scars, sub-volumetric cores, or BC, may indicate a change in the production system. Some typological elements, such as convergent flakes with basal thinning or bifacial flaking, appear for the first time in the sequence.

The Middle Paleolithic layers from the Central chamber and from the entrance differ with the former being described as non-Levallois and the later as Levallois Mousterian. The meaning of this variability is difficult to assess partly due to the absence of a stratigraphic connection between the excavated areas.

∗ 'Transitional' assemblages

In the entrance zone, Layer 8 is described as transitional from Middle to Upper Paleolithic (Derevianko, Markin, *et al.*, 2001). The 1989 collection (N=1310) is dominated by flakes with only 38 blades mentioned. Among the cores described, flat-faced cores with laminar removals occur. They show mostly bidirectional negatives, some being clearly associated with a bidirectional reduction (Derevianko *et al.*, 2003: Fig. 88 num. 5). Some others seem to illustrate distal management on a unidirectional flaking surface (Derevianko *et al.*, 2003: Fig. 88, num. 7). One illustrated example shows hinged removals extending onto the lateral side of a flat-faced core (Derevianko *et al.*, 2003: Fig. 88 num. 6). Bidirectional and unidirectional blade blanks coexist. Levallois artifacts occur although they are less frequent than in layers 10 and 9. Among the retouched tools, some UP types occur, with small circular endscrapers and blades with continuous scalar retouch. MP tools are still present, mainly convergent sidescrapers on blade blanks, transversal sidescrapers, notches and retouched Levallois points. Notable is the presence of a Keilmesser (Derevianko *et al.*, 2003: Fig. 90 num. 9).

According to Derevianko, Markin, *et al.* (2001), the layer 8 assemblage is considered as illustrating a gradual transition between MP and UP as it shows a decrease in Levallois elements and a coexistence of MP and UP tool types. For Goebel (1994), layer 8 illustrates a Levallois technology and is clearly Mousterian. He considers the presence of some tool types commonly associated with UP assemblages in the region as rather unusual. Indeed, it appears that some of the technological features are similar to those described in IUP assemblages or in the UP, but within a Mousterian context.

In the central chamber, layer 11 is suppose to illustrate a gradual transition toward 'the initial stage of the UP' (Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998; Derevianko, Markin, *et al.*, 2001; Derevianko, 2011a). The main technological features are described as a dominance of parallel flaking, with a decreasing frequency of Levallois and radial reduction. Cores are either unidirectional or radial,

and blanks are dominated by flakes. If the frequency of blades is comparable with the underlying levels, some of them indicate the introduction of new technological solutions. The occurrence of massive uni- and bidirectional blades with parallel edges is noted. One example of a refitted blade is over 20 cm long, with parallel edges bearing bilateral retouch on the proximal end. The retouch is scalar and thin and extends to the mesial part of the blank along the right edge (Derevianko *et al.*, 2003: Fig. 67 num.1). Furthermore, fragments of bifacial leaf-points (N=4) occur for the first time in the central chamber sequence (Derevianko *et al.*, 2003: Fig. 67 num. 3; Fig. 69, num. 5 and 7). These artifacts find their closest analogy in the IUP material described in UK1-1. A series of 15 microblades is reported but none of them is retouched. Two carinated endscrapers are mentioned but not illustrated.

The categorization of this assemblage depends on the association of typological features with both MP and UP affinities (Derevianko, Markin, *et al.*, 2001). While the main part of the assemblage is Mousterian, some of the artifacts clearly overlap with the techno-typological spectrum described in IUP assemblages from open-air sites. Notable is the quasi-absence of identifiable blade cores, although the frequency of massive and medium blades increases.

The assemblage from the south gallery could not be observed and has not been published and, therefore, it will not be discussed here. Regarding the east gallery, the excavation is still on-going, and only a preliminary description is proposed in the frame of this study. Personal observations of a lithic sample from east gallery layer 11.3, excavated in 2009 (Derevianko, Shunkov, *et al.*, 2009), is in agreement with the previous studies in the sense that two main technological and typological components could be observed. The first one is linked with primary reduction or with a rather expedient technology but also with retouched tools such as convergent and Quina-type sidescrapers. Flake are produced from small pebbles (Figure 201). This is strongly reminiscent of the Mousterian component described in the central chamber.

The second component overlaps with the variability seen in IUP assemblages. A core is illustrated, and although it has the morphology of a volumetric core, it is heavily reduced and does not bear clear blade negatives (Derevianko, Shunkov, *et al.*, 2009: Fig.1, num.1). A large unidirectional blade core on a pebble occurs in the sample (Derevianko, Shunkov, *et al.*, 2009: Fig.1, num.3)(Figure 202). This artifact is important as blade cores are rather rare in the set.



Figure 201: Denisova Cave, east gallery, layer 11.3 flake with neo-cortex



Figure 202: Denisova Cave, east gallery, layer 11.3 blade core

This core has two distinct flaking surfaces, the main one being located on the flat face of the core and the second one on the narrow face. In this case, it seems that the narrow face is used at the end of reduction and was not involved in the initial phase, although one of the earliest removals is located at the intersection of the two surfaces.

Two BCs were identified in the sample (Derevianko, Shunkov, *et al.*, 2009: Fig. 2, num. 1, 4) (Figure 203, above). One is on a thick cortical bidirectional blade. The flaking surface is located along the right edge and extends onto the ventral face. Small blade blanks are struck from two opposed platforms. The second BC is on a thick neo-crest blade and has a flaking surface located along the right edge of the blank. The core is reduced from two opposed platforms, one of which is prepared on the ventral face. These two artifacts are described by Derevianko, Shunkov, *et al.* (2009) as *torstoye nucleus*. Two possible BC from layer 11.4 are illustrated in (Derevianko, Shunkov, Tsybankov, *et al.*, 2010). One of these shows some initial removals along the edge of a laminar flake and is typed as a burin. The other is typed as a core and seems more reduced. The core blank cannot be clearly identified from the publication, and so the attribution to the BC category requires confirmation.

So it appears that characteristic features of the IUP occur in level 11.3 and probably in layer 11.4 in the east gallery. Among these, BC are important as they imply the existence of a sub-volumetric production of large blades which is also illustrated by a blade core with two distinct flaking surfaces and by the crested morphology of the BC blank. BC also illustrate a volumetric production of small blades.

Among the diagnostic artifacts, Levallois-like convergent blanks with laminar proportions occur, and they bear bidirectional dorsal patterns from two opposed platforms (Figure 203, below). An example of a faceted *débordant* platform may indicate a preparation at the border between surfaces. Bidirectional blades with marginal retouch on their parallel edges exist in the layer 11.3 assemblage (Derevianko, Shunkov, Tsybankov, *et al.*, 2010).

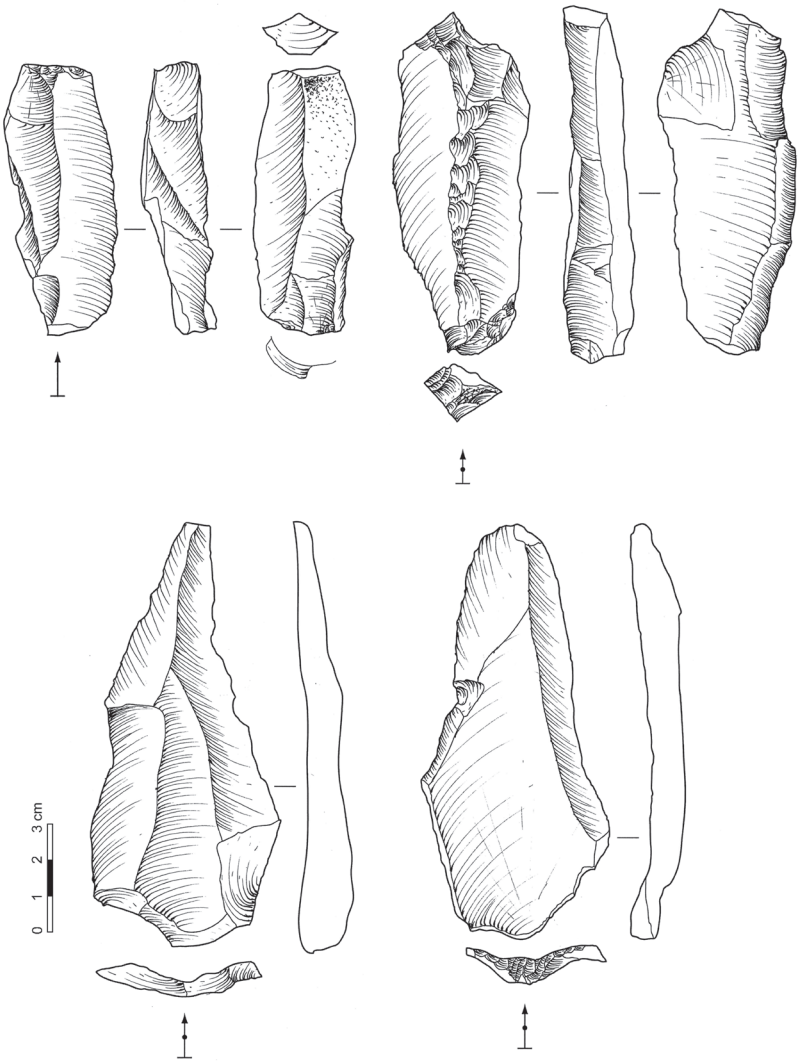


Figure 203: Denisova Cave, east gallery, layer 11.3, burin-cores (above) and Levallois laminar blanks (below)

To summarize, transitional assemblages from Denisova Cave include typical IUP technological and typological elements. These elements are best represented among assemblages from the central chamber and the east gallery. They are associated with a Mousterian component which is better represented than in open-air site assemblages such as UK1-1 OH5.4-5.5 and Kara-Bom OH5 and OH6.

∗ The Early Upper Paleolithic

The EUP is mainly represented in layers 6 and 7 of the entrance zone and in layer 9 of the central chamber. Entrance zone layer 5 is attributed to the Late UP and will not be described here.

In the entrance zone, the layer 7 assemblage (N=537) has yielded a bidirectional blade core with a flaking surface on a broad face. The core is reduced from two opposed platforms and preserves a posterior crest. Some of the last hinged removals show an attempt to extract a side blade (Derevianko *et al.*, 2003: Fig. 93 num.3). Notable is the presence of two small cores. One of these is cubic and has a single flaking surface with negatives of unidirectional bladelet/microblade removals (Derevianko *et al.*, 2003: Fig. 92 num.3).

It can be typed as a carinated core. The second one is a wedge-shaped core on a jasper nodule with a flaking surface on its narrow face (Derevianko *et al.*, 2003: Fig. 92 num.5). While the blade core overlaps with the variability of the IUP, small-size cores are consistent with the EUP attribution. Only a few Levallois blanks are mentioned, with two convergent flakes and three blades. The retouched toolkit is still mostly on flake blanks. The predominance of scrapers and the decrease of notches, denticulates and Levallois are retained as UP features.

Layer 6 (N=679) includes two cores showing a clear UP morphology. A volumetric core with a flaking surface on the narrow edge and a posterior crest is related to blade reduction. A narrow-faced microblade core with a flaking surface on the narrow edge and some heavy lateral thinning comes from the same layer. The striking platform is prepared by lateral flaking similar to a crest preparation. Endscrapers on blades are among the most diagnostic UP features, some of them being rather thick and typed as carinated. Backed bladelets and bladelets with continuous semi-steep retouch and distal truncations are reported together with retouched microblades. A fragment of a bifacial piece is derived from layer 6 and represents a rare example of such a type associated with UP levels. Some typological links to the MP are illustrated by the presence of sidescrapers.

In the central chamber, layer 9 has yielded an assemblage (N=1513) that documents the shift to EUP. Cores are not very informative from a technological point of view. They include prismatic and radial forms. Of these one is a single, small, prismatic bladelet core typed as an endscraper (Derevianko *et al.*, 2003: Fig. 72, num. 18). The quantity of blades and bladelet/microblades increases significantly. Retouched elements include blades with bilateral scalar retouch, backed blades and bladelets. Two bifacial pieces are derived from layer 9. One is a reduced distal fragment (Derevianko *et al.*, 2003: Fig. 72, num. 1). The second one appears similar to the leaf-point on a blade described in UK1-1 with an invasive retouch on the dorsal face. It, however, differs from the IUP specimens as the inverse flat retouch is described as covering the distal part of the blank, the mesial right and left edges. The proximal part is missing (Derevianko *et al.*, 2003: Fig. 72, num. 17). One endscraper is similar to a small flat-face core with bifacial removals (Derevianko *et al.*, 2003: Fig. 72, num. 16). A geometric microlith has been reported and represent a unique case for the Paleolithic of Altai (Derevianko, Shunkov, *et al.*, 1993).

∗ Bone tools and ornament

One of the more spectacular features of the Denisova assemblages is the rich collection of bone and ornamental artifacts associated with layers 5 and 6 from the entrance zone, with layers 11 and 9 from the main chamber (Figure 204), and with layer 11 in the east gallery.

In the entrance zone, the layer 6 assemblage contains a proximal fragment of needle with an eye, three cylindrical beads made of bird bones, and three ring-shaped beads made of ostrich eggshells. The later material is said to be unique for the Altai (Derevianko, Markin, *et al.*, 2001; Derevianko *et al.*, 2003). The layer 5 assemblage includes bone artifacts (N=6) with two needle fragments, a perforator, a bone tool with a longitudinal groove along the left edge, and a large bone tool with a smooth point.

In the central chamber, the bone artifacts associated with layer 11 are the following: two needles, including one with an eye, and five awls (Derevianko, Markin, *et al.*, 2001; Derevianko *et al.*, 2003). In addition, ornaments and related pieces are represented by nine pendants of perforated animal teeth (Figure 204), including four fox canines, three canines and one incisor of deer, one bison tooth, eight modified tubular bones including five with circular grooving, a fragment of ivory, bead preforms (two beads carved in a piece of mammoth tusk with a central perforation), a bead made of tubular bone with a central perforation, three modified fragments of tubular bones (traces of cutting and ends flattened) and two fragments of perforated beads made of bone. Five ornamental pieces made of stone are reported, including two perforated pyrophylithe fragments and three beads made of stone (Derevianko, Markin, *et al.*, 2001).

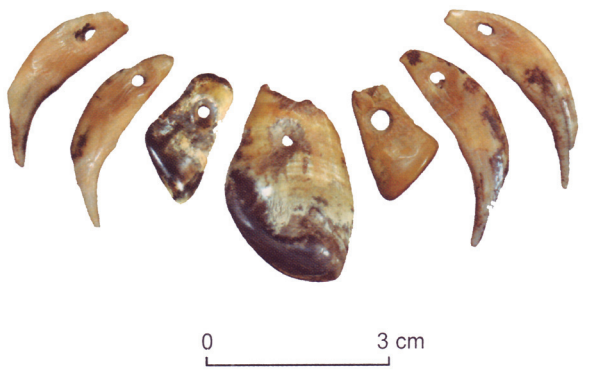


Figure 204: Denisova Cave, central chamber, ornaments (Derevianko and Shunkov, 2005)

In additions, some finds were found in association with bones and lithics in two pits located in square D6 (80 x 55 x 34 cm) and in square D7 (100 x 55 x 42cm). The collection includes bone artifacts (N=18), a perforated stone pendant and a bead made of ivory. The bone artifact collection includes two needles (one with an eye), two distal fragments of a perforator, three perforated animal teeth (one deer canine, one fox canine and one bison incisor), five unidentified tools (including three with circular grooving), one rib fragment with regular incisions, two perforated bone fragments and one bead made of bone.

It is noted that both of these pits were located close or in the interface between layer 11 and layer 9. One pit is reported at the top of layer 11, and the other one 'at the foot' of layer 9. Their limits and stratigraphic position are unclear, but the assiociated artifacts show analogies with those derived from layer 11 (Derevianko, Markin, *et al.*, 2001).

Layer 9 yielded bone artifacts (N=8), including three needles (two with eye) and a distal fragment of a perforator. Ornaments include a perforated deer tooth, a perforated piece of mammoth tusk and a perforated piece of bone with some regular 'inlays'.

In the east gallery, the on-going excavation has already yielded a bone tool blank and a rib with regular incisions. Although associated with layer 11, both of these samples were directly dated and have provided younger ages than expected. In addition, a fragment of stone bracelet made of polished pyrophylithe was uncovered in layer 11 (Derevianko, Shunkov, Volkov, *et al.*, 2005). This artifact type is unknown in other IUP or UP collections. The raw material would indicate a source located 200 km southwest from the Cave (Derevianko, Shunkov, *et al.*, 2008).

To summarize, a rich set of bone tools and ornaments in Denisova Cave is presumably associated with layers that are said to represent the earliest phases of the UP. It includes numerous eyed needles, perforated animal teeth, and beads. Ornaments made of stone are well-documented is the central chamber and in the east gallery. However, the stratigraphic location of some of these pieces is unclear, and some of the direct dates obtained on a bone tool blank and on a bone with incisions call into question the integrity of layer 11. If the stratigraphic and the dating issues can be resolved, the association of pieces such as the stone bracelet with the UP would the earliest example of its kind among these assemblages, not only in Asia, but also in Europe.

Denisova Cave: summary

Denisova Cave is among the richest sites in the area, documenting human occupation probably starting from the last interglacial to beyond the end of the Pleistocene. The cave is divided into four separate excavation areas. The MP layers 21-12 from the central chamber illustrate a techno-typological variant in which typical Levallois and laminar elements, although present, are poorly represented. This contrasts with the MP from layers 10 and 9 in the entrance, and perhaps also with the small assemblage from layer 22 in the central chamber, which are characterized as a Levallois Mousterian. The IUP can be identified based on a combination of typological, technological and chronological elements. These elements are identified in layers 12, 11 and 9 of the central chamber, layers 8 and 7 in the entrance zone and layer 11 in the south and east galleries. Nevertheless, layers 12 and 11 from the central chamber, layer 8 from the entrance and layer 11 from the galleries also include a significant Mousterian component and possible intrusive material from subsequent occupations, as

shown by the dated bone tools from the east gallery. Layers 11 and 9 from the central chamber and layers 7 and 6 from the entrance zone document the appearance of microblade technology.

Taking into account that cave sites can be subject to taphonomic processes and may represent different types of occupations than open-air sites, Denisova cave does not contradict the proposed chrono-cultural model. In the central chamber, IUP proxies appear in the sequence in layer 12 prior to the first well documented occurrence of microblades in layer 9. In the entrance zone, IUP elements appear in layer 8 and microblades in layer 7 and 6. In Denisova Cave, IUP and EUP assemblages are less clear-cut and display different associations than in the studied open-air sites. The presence of hyena teeth in layer 13 suggest a certain degree of carnivore activity in the central chamber could explain the possible intrusion of IUP elements from layer 11 in layer 12 or the intrusion of Mousterian artifacts within the IUP assemblage. Another possibility is that the Denisova assemblages could be seen as a unique variant of the IUP. In this case, the well-marked Mousterian component in Denisova Cave would illustrate a facet of IUP variability as defined in open-air sites and would reflect differences in site-use.

Ornaments and bone tools are associated with the IUP/EUP layers although some issues remain regarding their stratigraphic and cultural attribution. In the central chamber, the material coming from pit structures is located close to the interface between layer 11 and layer 9 and does not rule out a possible intrusion from layer 9 or other overlying layers. In the entrance zone, bone tools and ornaments are clearly associated with the EUP and UP layers. In the east gallery, direct dates on a bone tool blank and a rib with regular incisions have shown a mismatch with the dates of the cut-marked bones and other bones which indicating an UP age. This could be related to the presence of a disturbed area for which the nature of the post-depositional processes has yet to be identified. The bracelet described as associated with layer 11 is unique as such artifacts are usually associated with later periods which are also represented in the cave.

Finally, the human fossils indicate a complex history with several potential inhabitants. The tooth from layer 22.1 in the central chamber is undiagnostic. The upper incisor from layer 12 described first as a Neandertal and then as a modern human with archaic features is likely a large bovid (Viola *et al.*, 2011). In the south and east gallery, Denisovan remains are associated with layer 11. The association between the human and cultural remains is still unclear as small bones and teeth can move easily through sections. The faunal remains suggest that hominins were not the only inhabitants of the cave, as seen by a relatively high carnivore activity. Therefore, what is needed are more substantial remains in a well dated context.

Maloyalomanskaya Cave

This cave site is located in Paleozoic limestone massif in the Onguday region, on the territory of the Republic of Gorny Altai. It lies along the left bank of the Malyi Yaloman River at 12 km from the confluence with the Katun River (Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998). The valley is steep and narrow, with a flood plain but no alluvial terraces. The cave is oriented to the south and opens at 27 m above the current level of the river. It consists of two main galleries. The east gallery is rather small, at circa 8 m long and 3 m wide. The west gallery is circa 16 m long and leads to a large chamber. A team of geologists (Maloletko, Panychev and Baryshnikov) and paleontologist started excavating the site in 1983 and with two test pits. In 1988, the second phase of investigation began under the direction of Derevianko and Petrin (Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998; Derevianko, Markin, *et al.*, 2001). A total of 45 m² have been excavated, covering mainly the entrance of the cave and the western corridor. Two main sections are documented, one from the 1983 test pit and one from the E/1-8 wall (Figure 205).

Stratigraphy and lithological description

The stratigraphy is divided in six strata based on lithostratigraphic criteria (Figure 206). Derevianko and colleagues (Derevianko, Markin, *et al.*, 2001) note that sediment deposition is also associated with erosional processes. Stratum 1 is described as a lami-

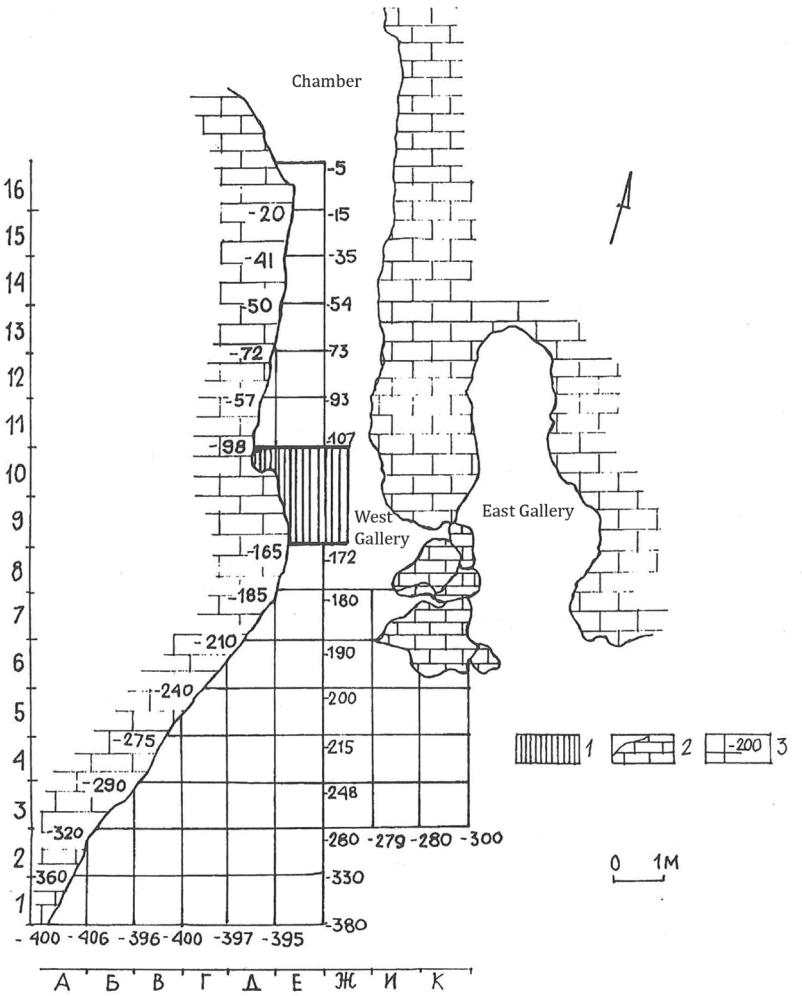


Figure 205: Maloyalomanskaya Cave, excavation plan (Derevianko, Markin, *et al.*, 2001)

nated gray to black loam containing limestone, porphyritic debris and burned organic material. Stratum 2 is a brown loessic loam, rather homogenous, with small pieces of limestone, bones and charcoal. Stratum 3 is sub-divided into two sub-strata. The upper one consists of black and grey laminated sediments with charcoal and burned sediments. About 12 laminations are noted varying from 1 to 6 cm thickness, making as a whole a 20 cm thick sub-stratum. The sediments appear more homogenous on the western part of the section, with thinner laminations (Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998; Derevianko, Markin, *et al.*, 2001).

According to (Derevianko, Markin, *et al.*, 2001), blue spots are visible and interpreted as possible 'organic admixture'. The lower sub-stratum is a circa 20 cm thick brownish gray loam saturated with limestone debris and slabs. Small pieces of bone and 'ellipsoid organic inclusions'(?) are noted. While the interface between strata 2 and 3 is clear, the interface between strata 3 and 4 is not and may reflect a period of erosion. Stratum 4 is red/brown clay which becomes darker in the lower portion. In the western wall, the interface between stratum 3 and 4 is reported with stratum 4 starting with parallel lamination of sediments sloping toward the entrance of the cave. Brown, blue and dark grey streaks are described in

the sediments, with a high frequency of limestone and charcoal pieces and with the presence of bone splinters. Stratum 4 does not occur in the entrance of the cave and is mainly identified from the northern wall of the 1983 test pit. Stratum 5 is a slope deposit and consists of a matrix of brown loam containing humus. It occurs only in the entrance zone (Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998; Derevianko, Markin, *et al.*, 2001). The northern wall from the 1983 test pit shows that stratum 4 may have been relatively thick at the time of the deposition. The U-shape profile may indicate water circulation in the narrow corridor eroding the upper part of stratum 4, the latter being preserved only against the western bedrock wall. This erosional event is noted by Derevianko and colleagues (Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998) and may be prior or roughly contemporaneous with the deposition of the stratum 3.

Strata 3 and 4 have yielded Paleolithic artifacts. Two hearth features were identified in stratum 3; one in squares E/11-12 and one in squares E/6-8 found in three small pits (Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998; Derevianko, Markin, *et al.*, 2001). Archeological material found in association with stratum 1 includes potsherds, an iron knife and fragments of animal bone. Potsherds are attributed

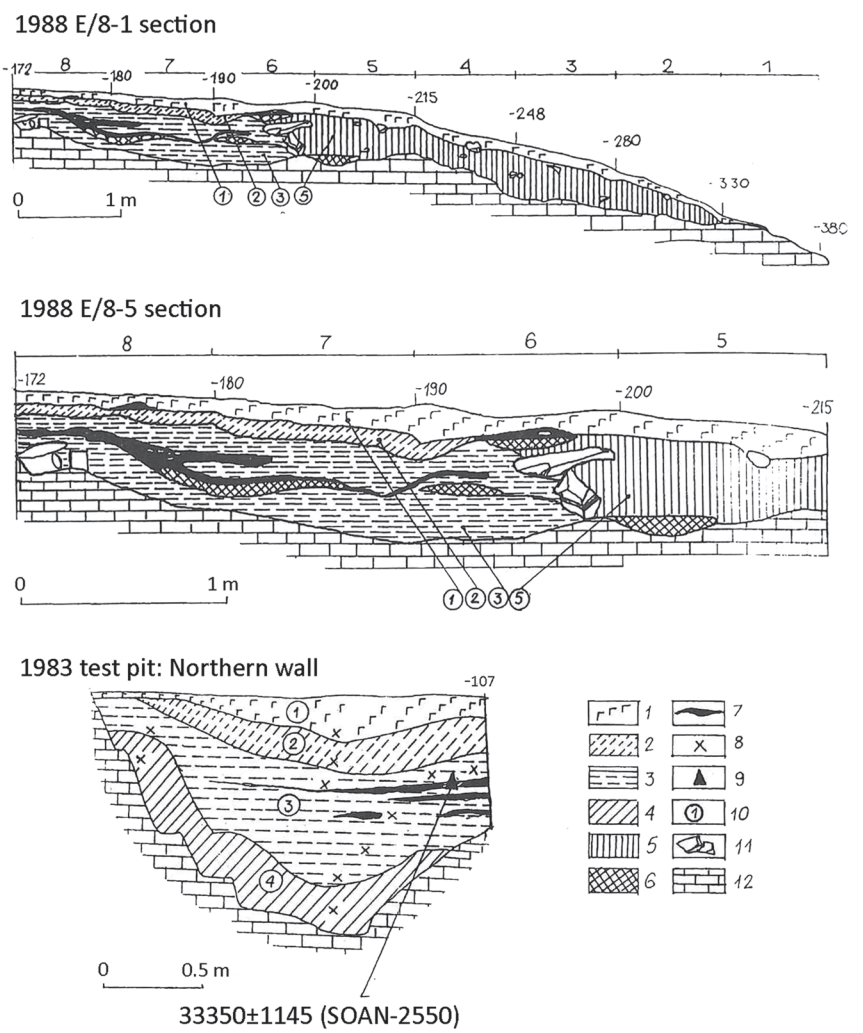


Figure 206: Maloyalomanskaya Cave, sections (after Derevianko, Markin *et al.*, 2001)

to the Holocene (Afanasievo culture), but the knife indicates subsequent occupations.

Fauna

Although the association between the fauna and the strata is not clearly reported, the following taxa have been identified in the cave: *Talpa europea, Sorex species, Crocidura species, Chiroptera species, Lepus timidus, Ochotona cf. alpina, Pteromys volans, Citellus undulatus, Marmota bailbacina, Apodemus species., Cricetus cricetus, Myospalax myospalax, Alticola species, Clethrionomys rufocanus, Clethrionomys rutilus, Lagurus lagurus, Arvicola terrestris, Microtus gregalis, Microtus oeconomus, Microtus agrestis, Microtus arvalis agrestis, Microtus species, Canis lupus, Vulpes vulpes, Crocuta spelea, Unci uncia, Felis manul, Equus species, Coleodonta antiquitatis, Capra siberica* and *Lepus tolai* (Derevianko, Markin, *et al.*, 2001).

Palynology

Remains of 'rotten vegetation' are reported from the lowermost stratum, and, although they are interpreted as human features, the nature and provenience of these remains is still uncertain (Derevianko, Markin, *et al.*, 2001). The survival of such material in a clay matrix over 40 ka would seem unlikely. As noted by Derevianko and colleagues (Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998) stratum 3 has strongly eroded stratum 4 and palynological analysis carried out on these strata may reflect admixtures. More generally, the pollen sequence is said to testify to steppe vegetation throughout the whole sequence with typical alpine meadow in stratum 2. Concentrations of coagulated pollens have been interpreted as evidence of buried blossoms. Derevianko *et al.* suggest that strata 1 and 2 may have accumulated in cold conditions as opposed to strata 3 and 4 which may have accumulated in warmer conditions (Derevianko, Markin, *et al.*, 2001), but this interpretation requires further verifications.

Chronology

A single conventional radiocarbon date was produced on a charcoal sample derived from the upper part of stratum 3 and provided an age of 33,350 ± 1,145 ^{14}C BP (SOAN-2550) (Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998).

Human remains

The discovery of a single human tooth has been reported (Alekseeva and Maloletko, 1984), but no descriptions are as yet available.

Lithic assemblage

The assemblage is small (N=67), and artifacts are rare and mainly associated with a hearth in squares E/11-12. Lithic artifacts are produced on sandstone and chert, pebbles and slabs. Small flakes (N=34) are the most numerous, followed by blades and blade fragments (N=11) and tools (N=10). No clear core

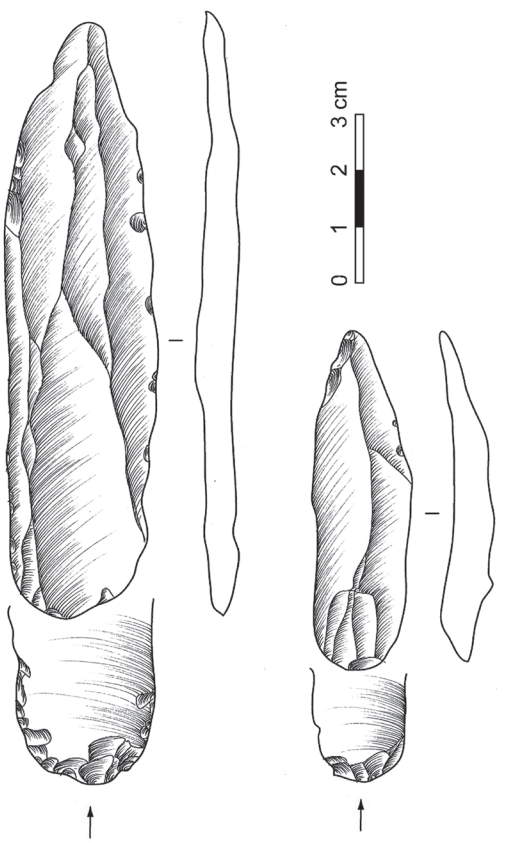


Figure 207: Maloyalomanskaya Cave, blade with inverse thinning (redrawn after Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998)

is included in the collection, although two core-like pieces are reported, one bearing parallel removals. Three technical flakes bear unidirectional laminar removals and laminar blanks show uni- and bidirectional scar patterns, with the occurrence of facetted platforms. One illustrated piece seems to show a partial faceting of the platform (Derevianko, Markin, *et al.*, 2001: Fig. 59, num. 7). A Levallois flake with a sub-radial morphology occurs in the set, together with Levallois points. Some of these points display thin retouch along their edges. A side scraper and a series of notched and denticulate pieces represent the largest part of the retouched tool-kit. The most diagnostic retouched tools are two pointed blades with proximal thinning (Figure 207).

One of these is on a medium-size unidirectional blade and shows some scalar/flat invasive inverse retouch on the proximal end, with semi-steep retouch extending slightly along the right edge. The other example is a short unidirectional blade with an inverse proximal truncation. The blade bears some bladelet/trimming negatives of the dorsal face.

Ornaments

Two artifacts of interest are reported associated with the Paleolithic assemblage. One is a pebble split along the longitudinal axis. The dorsal face is described as bearing traces of ochre preserved in hollows. Derevianko *et al.* reported a vertical line made of ochre on the western wall of the cave and suggest an association with this pebble (Derevianko, Markin, *et al.*, 2001). They consider it likely that it represents a fragmentary drawing. In addition, a canine described as Siberian elk *(Cervus canadensis sibiricus)* is perforated and bears eleven incised lines. This pendant was discovered in stratum 3, square E13, just next to the hearth features.

To summarize, Maloyalomanskaya Cave is located around 70 km southeast of Kara-Bom, along another tributary of the Katun River. The cave has yielded evidence of Holocene human occupation in stratum 1 and Paleolithic occupation in strata 3 and 4. Human occupation seemed to be best represented in stratum 3. The Paleolithic assemblage is very small with only 61 lithic artifacts. It displays some of the technological features associated with the IUP, such as a co-existence of uni-and bidirectional laminar flaking, platform faceting and a Levallois component. More important are the two pointed blades with inverse proximal thinning almost identical to those described at Kara-Bom OH6 and UK1-1 OH5.4 and OH5.5. These are among the most diagnostic typological elements distinguishing the IUP from other UP and MP techno-complexes. A perforated Siberian elk tooth bearing a series of regular incisions was found in the vicinity of a hearth feature. The association of the pendant with the lithic material raises several issues. As noted by Goebel (2004), artifacts are reported from both strata 3 and 4 but are published as a whole. Piece provenience information is necessary in order to link the blades with proximal thinning, the pebble with ocher, and the pendant. The nature of this small assemblage is also problematic. The preservation of hearths, if confirmed, implies that human occupation in stratum 3 took place after the erosional event affecting stratum 4. In this case, it is possible that the assemblage represents two human occupations separated by a significant time span. Nevertheless, no clear evidence for EUP or UP occur in the lithic assemblage. Instead, it shows a combination of features that could reflect of IUP assemblages. The radiocarbon age produced on a piece of charcoal from the upper part of stratum 3 may then represent a minimum age for the lithic assemblages.

Ust-Kanskaya Cave

Ust-Kanskaya, is located in the western Altai, about 80 km east of the Kazakh border. The cave lies on the right bank of the Charysh River, in a Silurian limestone cliff, at an altitude of 1040 m asl. The massif is located around 4 km east of the Ust-Kan village and 160 km southeast of the Charysh cave complex. Ust-Kanskaya was excavated in 1954 (Rudenko, 1960, 1961) and known as the first site yielding MP material in north Asia. The cave consists of a single rather large chamber (16.5 x 13.5 m) facing south. Rudenko excavated a test pit of one m² and two trenches of 11 and 9 m². According to him, the paleontological and archeological material was found in a single layer of limestone debris and soft sediments.

Stratigraphy and lithological description

The layer described is 1.75 m thick and artifacts were found up to a depth of 1.5 m. Later, Tseitlin revised the stratigraphy into six strata (Tseitlin, 1979). Archeological material occurs from strata 2 to 5, with a concentration in stratum 4. Ash and charcoal lenses occur in strata 3 and 4.

Fauna

A relatively large amount of faunal remains were reported with more than 1700 specimens. Vereshagin (1956) notes the presence of large ungulates such as *Rhinoceros thicohinus* or *Equus caballus*, carnivores such as *Crocuta spelea* or *Ursus arctos,* rodents with *Marmota sp.,* and lagomorphs such as *Lepus tolai.* In addition, 12 different species of birds have been identified. The faunal material indicates the presence of species adapted to an open steppe landscape but the absence of boreal species has been interpreted as evidence for human occupation during warm conditions (Rudenko, 1961). Fish bones have been reported associated with the Mousterian leyer (Derevianko and Markin, 1992; Derevianko *et al.*, 2005), but their association with human activities is not clearly demonstrated.

Lithic assemblages

The archeological material is produced on local raw material, mainly flint pebbles, collected in the Charysh River. Originally, Rudenko (1960) described the assemblage as a combination of archaic and UP tools, noting some similarities with Central Asian Levallois Mousterian, but he also notes the occurrence of Chatelperronian points. He considers that the Ust-Kanskaya assemblage shows a high frequency of archaic elements but overlaps with the regional UP background. Anisiutkin and Astakhov (1970) are the first to clearly attribute this material to a late Levallois Mousterian. A small UP component is noted. Later, Shunkov (1990) studied the collection (N= 483) conserved at the Hermitage museum, in St-Petersburg. He notes that a great majority of material is MP (N=467) with only a minor UP component (N=16). The UP component includes blades (N=6), a flake (N=1) and tools (N=9). Shunkov (1990) notes

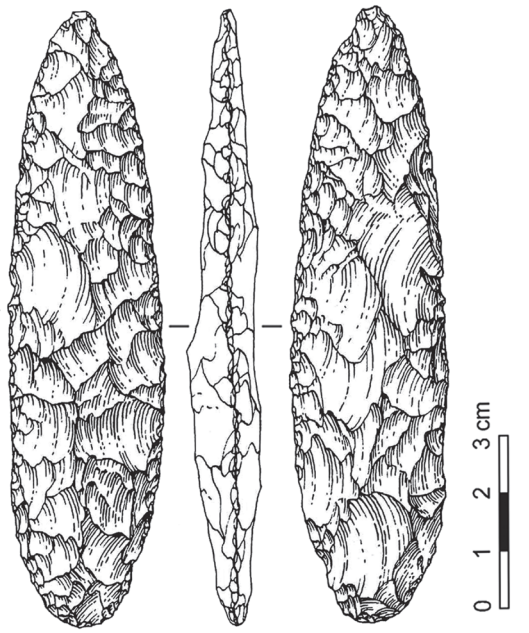


Figure 208: Ust-kanskaya, leafpoint (after Derevianko and Shunkov, 2002)

the presence of prismatic blades and the coexistence of plain and facetted platforms. The retouched toolkit includes a bifacial leaf-point in porphyria (Figure 208) and a carinated endscraper made of flint.

The MP component is described as Levallois, with the presence of blades and flakes (N=45) and points (N=6) (Derevianko *et al.*, 2001). Two Mousterian points and three transversal side-scrapers with 'semi Quina-type' retouch are reported. A single burin is noted. Following these observations, Shunkov (2005) suggests that the Ust-Kan material represents a Mousterian of Levallois tradition. According to him, the UP component might be related to a later occupation, and no evidence supporting the 'late' character of the assemblage could be observed (Derevianko, Markin, *et al.*, 2001). An additional study of the material (Yamada, 1998) describes a coexistence of Levallois and discoid technology. Unidirectional Levallois prevails and leads to the production of laminar spalls.

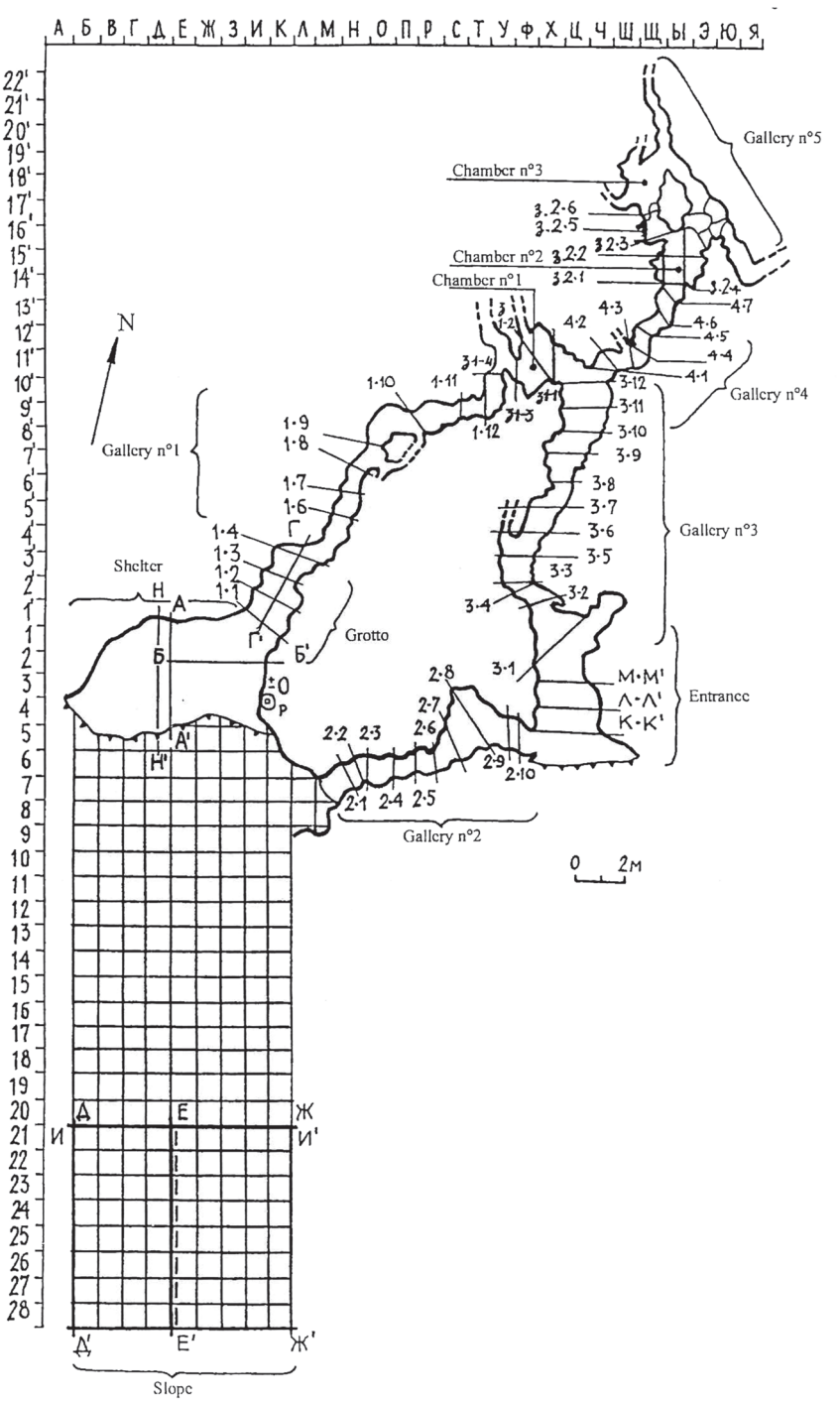


Figure 209: Okladnikov Cave, excavation map (Derevianko, Markin, *et al.*, 2001)

In 1998, new excavations were done by a team from the Institute of Archaeology and Ethnography from Novosibirsk (Derevianko and Postnov, 2004). A reassessment of the stratigraphy identified 12 lithostratigraphic strata and no less than 18 cultural layers. According to these results, all strata have yielded archeological material except strata 11 and 12. Although not fully published, the material from strata 10 to 7 is described as MP, strata 5 and 4 as transitional, and strata 3 and 2 as UP. Based on the published drawings and as stressed by Derevianko and Postnov (2004), it seems that all strata show a significant Levallois component, with laminar points and blades more pronounced in the upper strata. Derevankio and Postnov (2004) also note that the faceting index is rather high throughout the whole sequence.

Ornaments

A perforated piece of bone with two holes, some incisions on the edges and a polished surface is reported (Rudenko, 1960, 1961; Derevianko and Rybin, 2003).

To summarize, Due to the presence of a few UP elements, the Ust-Kanskaya assemblage has sometimes been interpreted as transitional (Kuzmin and Orlova, 1998). Nevertheless, most authors agree that, as the sequence was excavated as a single layer without proper geological descriptions, the assemblage likely to represents a mixture between different archeological levels (Anisutkin and Astakhov, 1970; Tseitlin, 1979; Derevianko, Shimkin, *et al.*, 1998; Goebel, 2004). New excavation appear to confirm this. An attribution of the lowermost strata to OIS6, to the strata 8 to 6 to the OIS5e, and 5 to 3 to the early OIS5-4, is based on an interpretation of the micro-mammalian fauna. If one accepts this interpretation, human occupation would start during the Middle Pleistocene.

Okladnikov Cave

The cave is located on the left bank of the Sibirychika River, not far from the Sibirychika village. The cave is of karstic origin having developed in a limestone massif and showing a complex system, including the entrance, shelters, grotto galleries and other chambers (Derevianko and Markin, 1992, 2011) (Figure 209).

Stratrigraphy and lithological description

Special attention has been paid to the stratigraphic control with combinations of longitudinal and transversal sections recorded in different parts of the cave (for more details, see Derevianko and Markin, 1992). In the shelter, archeological finds have been uncovered only in the upper strata (1-3). In the grotto, strata 1, 3, 6 and 7 have yielded artifacts. In gallery 1 and gallery 3 all strata contain archeological material, and in gallery 2, strata 3 and 7 bear evidence of human occupation. Based on the fauna and on pollen analysis, environmental reconstructions have been proposed. Most of the cultural strata (2, 3, 6 and 7) are said to have formed during warm conditions with variations in humidity. Stratum 1 would represent a cooler and more humid climate (Derevianko, Markin, *et al.*, 2001).

Chronology

Okladnikov Cave illustrates a situation in which various laboratories with various methods (see (Krause *et al.*, 2007; Wrinn, 2010). Chronological data include radiocarbon and U-series dates performed on samples collected from strata 1, 3 and 7 in the shelter, in gallery 1 and in chamber 1 (Table 113). Radiocarbon samples are exclusively on bones including one human specimen. A series of AMS dates produced by the Radio Isotope Direct Datation Laboratory (RIDDL) at Simon Fraser University, Canada, have been produced on samples from stratum 1, 2 and 3 in the shelter. Stratum 1 is dated between 32.8 and 34.2 ka ^{14}C BP, and stratum 2 between 38.5 and 37 ka ^{14}C BP (Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998). There are discrepancies between dated samples within stratum 3 with two dates ranging between 45 and 42 ka ^{14}C BP and one date indicating an age between 33 and 32 ka ^{14}C BP. A conventional date from the Novosibirsk lab (SOAN) yielded an infinite age for the shelter stratum 3. Furthermore, the shelter strata 2 and 3 have yielded human remains directly dated by AMS. The date obtained on the adult humerus from stratum 2 gives a younger age than the fauna at around 24 ka ^{14}C BP. The sample was

Layer	Context	Material	Material details	Lab code	Age	Method
1	Shelter	Fauna-bone		RIDDL-718	33,500 ± 700	^{14}C
2	Shelter	Fauna-bone		RIDDL-719	37,750 ± 750	^{14}C
2	Shelter	Human-bone	Adult humerus	KIA-27010	24,260 ± 180	^{14}C
2	Shelter	Human tooth	left lower M3	/	/	/
3	Shelter	Human bone	Sub-adult humerus (OK1)	KIA-27011	29,990 ± 500	^{14}C
				Beta-186881	34,860 ± 360	^{14}C
				OxA-15481	37,800 ± 450	^{14}C
3	Shelter	Fauna-bone		SOAN-2458	>16,210	^{14}C
3	Gallery 1	Fauna-bone		SOAN-2459	28,470 ± 1250	^{14}C
3	Shelter	Fauna-bone		RIDDL-720	43,700 +1100/-1300	^{14}C
3	Shelter	Fauna-bone		RIDDL-722	43,300 +1300/-1500	^{14}C
3	Shelter	Fauna-bone		RIDDL-721	32,400 ± 500	^{14}C
3	Chamber 1	Sediment		/	38,725 +1,435/ -1,419	U-series
3	Shelter	Human bone	Sub-adult femur (OK2)	/	/	/
3	Shelter	Human bone	Middle hand phalanx	/	/	/
3	Shelter	Human tooth	Left lower P3	/	/	/
3	Shelter	Human tooth	Left lower M1	/	/	/
3	Shelter	Human tooth	Right lower M3	/	/	/
7	Gallery 1	Sediment		/	44,600 ± 3300	U-series
7	Gallery 1	Sediment		/	44,800 ± 4000	U-series
7	Gallery 1	Human-tooth	Right lower dm2	/	/	/

Table 113: Okladnikov Cave, summary of human remains and chronological data (after Krause *et al.*, 2007). Shaded rows are directly dated human remains.

pretreated using Longin and ultrafiltration and was dated at the Leibniz Laboratory for Radiometric Dating and Isotope Research, Kiel, Germany (KIA). The C:N ratio of 3.6 is beyond the limit of the acceptable range, given that Jacobi and colleagues suggest that a well preserved Paleolithic bone should range between 3.1 and 3.4 (Jacobi *et al.*, 2006). A sub-adult humerus was dated at Kiel and at the Oxford Radiocarbon Accelerator Unit, Oxford, UK, (OxA) using Longin (1971) and ultrafiltration pretreatment (Jacobi *et al.*, 2006; Brock *et al.*, 2007). It was also sent to Beta-analytic, Florida, US, and dated with a Longin pretreatment. Although the C:N ratio for the KIA and OxA dates were acceptable, the results show a high degree of discrepancy with an age between 38.2 ka and 29.5 ka (Krause *et al.*, 2007). U-series dates have yielded an age of 38.8 ± 1.5 ka BP for chamber 1, stratum 3 and 44.6 ± 3.3 ka BP and 44.8 ± 4 ka BP gallery 1, stratum 7 (Goebel, 1994). A conventional radiocarbon date is also available for Gallery 1, but is not in agreement with the U-series dates.

Human remains

The shelter of Okladnikov Cave has yielded several human remains. Dental remains occur in stratum 2 with a left lower molar, and in stratum 3 with a left lower premolar, a left lower molar and a right lower molar. According to Viola *et al.* (2011), the Okladnikov dental remains preserve some archaic features (strongly crenulated and complex occlusal surface) but generally lack traits derived from Neandertal. Post-cranial remains are found in stratum 2, with an adult humerus, and stratum 3 with a sub-adult humerus and a hand phalanx. Morphologically, these remains are not really diagnostic of particular taxa, although the robust character and the flattened ends of the phalanx are considered archaic features. Also, the adult humerus fragment from stratum 2 is said to be more MH-like than Neandertal (Viola *et al.*, 2011). The good preservation of the collagen extracted from the phalanx, from the sub-adult humerus and femur and from the adult humerus, however, has led to the reconstruction of a mtDNA sequence (Krause *et al.*, 2007). Neandertal specific primers were sequenced in both sub-adult remains. By contrast, the adult humerus did not show any Neandertal specifics and its attribution is pending.

Lithic assemblage

The archeological material is grouped by stratum, although coming from different parts of the cave.

Stratum 7 has yielded a small assemblage (N=301). Only two cores are identified. One is on a large pebble and shows unidirectional laminar flake removals on a relatively narrow flaking surface. The other one is triangular and flat-faced with unidirectional convergent removals opposed to a cortical back (Derevianko, Markin, *et al.*, 2001). The core platform is plain, and no clear lateral preparations are observed. Blanks are mainly radial and sub-radial flakes with a low frequency of cortex. Tools (N=38) include sidescrapers (N=25), Levallois points (N=4), Levallois flakes (N=2) and Levallois blades (N=2). Only a single Levallois point is retouched. Among the various types of retouch, abrupt and scalar retouch are mentioned (Derevianko and Markin, 1992; Derevianko, Markin, *et al.*, 2001).

The stratum 6 assemblage (N=246) comes exclusively from the grotto. It includes one radial core, 16 blades and 32 tools. The main dorsal patterns are sub-radial or unidirectional parallel. The tool category includes sidescrapers (N=12), an elongated Levallois point, and a Mousterian point. Two artifacts show signs of back preparation.

The stratum 3 assemblage (N=1753) is the largest sample and includes cores or core fragments (N=13), blades (N=87) and tools (N=304). Among the cores, roughly half (N=7) illustrate a parallel reduction pattern, from one or two platforms, and the rest are radial or Levallois. The main patterning is described as orthogonal (45.8%), with a lower frequency of unidirectional (24.4%) and a fairly low frequency of bidirectional (8.4%). A low frequency of neo-cortex on dorsal faces is reported (7.3%). Various kinds of secondary treatments are applied, including retouch (scalar, abrupt), Clactonian notches, or various kind of thinning. The tool kit includes various type of sidescrapers (N=110)(including backed pieces), Levallois blades (N=29), Levallois flakes (N=7) or points (N=8), retouched Levallois points (N=7) and Mousterian points (N=8), and oval-shaped bifacial

pieces (N=4) (Derevianko and Markin, 1992; Derevianko, Markin, *et al.*, 2001).

The stratum 2 assemblage (N=1216) includes cores and core fragments (N=9), blades (N=35) and tools (N=209). Among the set, only 4 cores are informative and show a coexistence of parallel flaking and tortoise-shape Levallois cores. Blank dorsal scar patterning is mainly radial and sub-radial (45.1%) or unidirectional (N=22.8%) with an occurrence of bidirectional products (13%). Similar secondary treatments as seen in stratum 3 are observed. Tools include sidescrapers (N= 65) (including backed pieces and a Quina-type sidescraper), retouched (N=9) and unretouched (N=10) Levallois blades, Levallois flakes (N=8), Levallois points (N=8), elongated (N=5) and classic Mousterian points (N=3), endscrapers (N=6) and burins (N=4) (Derevianko and Markin, 1992; Derevianko, Markin, *et al.*, 2001).

The stratum 1 assemblage (N=395) consists of cores (N=3), blades (N=8) and tools (N=87). Cores are radial (N=2) and parallel (N=1). Blank dorsal scar patterning is mainly unidirectional (35.5%), followed by radial and sub-radial (28.8%). The secondary treatment consists almost exclusively of retouch. The toolkit includes sidescrapers (including backed pieces and a Quina-type specimen)(N=39), a Levallois blade (N=1) and flakes (N=2), and Levallois points (N=3) (Derevianko and Markin, 1992; Derevianko, Markin, *et al.*, 2001).

To summarize, the Okladnikov Cave assemblages have a low frequency of Levallois elements and a ccurrence of sidescrapers of various kinds. Cores generally occur in low frequency, and the observed specimens include classic tortoise-shape Levallois and radial cores. Although Quina side scrapers are present, they fall within the variability of the sidescrapers. Discoidal or Quina blank production is not reported. Levallois points occur in every strata, and elongated examples are not so frequent, except in stratum 7. The general reduction patterns are radial and parallel, the latter being clearly unidirectional. It is generally accepted that the Okladnikov assemblages are of Mousterian tradition, and that they represent a non-Levallois variant (Shunkov, 1990, 2005; Derevianko, Markin, *et al.*, 2001; Derevianko and Markin, 2011). It was, however, suggested that it may represent a specific functional facies (Derevianko and Shunkov, 2002; Shunkov, 2005). For example, it seems that primary reduction and blank production do not take place at the site, judging by the low frequency of cores or cortical blanks. Use-wear analysis seems to show that the toolkit was used for butchering or scraping soft material. Although some of the Levallois points were used for drilling, most of them seem to show similar use-wear as the sidescrapers. In the shelter, Mousterian stratum 3 includes human remains yielding Neandertal mtDNA and other fossils that could not be attributed to any taxa. From a general point of view, Okladnikov Cave is considered as a non-Levallois Mousterian (Shunkov, 2005) although some Levallois-like features seem more numerous in stratum 7 (Goebel, 1994).

Radiocarbon dates show significant discrepancies that may reflect differences in the method (conventional or AMS) or of bone preservation (most of the C:N ratios are not published). Beyond these specific issues, dates produced on a single bone by three different labs provided different results, although they all have an acceptable C:N value and two of them had similar pretreatment. In this situation, it is assumed here that the oldest ages for a given stratum may be the most reliable. In this case, stratum 3 is dated by radiocarbon at around 37.5 ka ^{14}C BP. U-series dates indicate older ages that would fall beyond 40 ka ^{14}C BP. This suggests that either the sub-adult bones are intrusive (from stratum 2?) and, therefore, younger than the sedimentation or that the oldest radiocarbon age has to be considered as a minimum age. Given that the age obtained by U-series for stratum 7 overlaps with the ages obtained on stratum 3, it is reasonable to consider that stratum 7-3 are roughly contemporaneous and that the human occupation of Okladnikov Cave belongs to OIS3.

Strashnaya Cave

Strashnaya Cave is located in the Charysh basin along the Ina River. The cave is 20 m long; narrow at the front, with an entrance of 2-3 m in width and 6 m in height. It enlarges at the back and opens onto a chamber. The cave was first excavated in 1969 with

a first test pit of 6 m² and 10 m deep at the entrance and a second one opened deeper in the cave, 16 m away from the drip line (Okladnikov *et al.*, 1973). The pit in the back of the cave was smaller and uncovered only the upper part of the deposits. Six lithological strata are described in the first test pit in the entrance, with archeological material occurring in the first three strata. The Paleolithic material comes from the third stratum. Derevianko and Markin (Derevianko, Shimkin, *et al.*, 1998) mention that all cultural remains have been washed out by erosional processes; therefore, fauna and pollen cannot be fully informative regarding the environment at the time of the human occupation. Generally speaking, Tseitlin (quoted from Derevianko, Shimkin, *et al.*, 1998) assigned the deposition of the main cultural stratum to the Karginian period (OIS3). Between 1989 and 1994, the site was excavated under the direction of Derevianko (Derevianko and Postnov, 2004). In 2006, the site was excavated by Zenin (Viola *et al.*, 2011). The stratigraphy was revised and includes five strata with strata 3 to 5 yielding Paleolithic material. Stratum 3 is sub-divided in 3 sub-strata, 3.1 to 3.3 and stratum 5 is divided in 5.1-5.3.

Radiocarbon dates are available for strata 5 and 6 (Table 114). Stratum 5 has yielded ages ranging between 36.5 ka and 29 ka and stratum 6 has yielded infinite ages. All dates produced in Novosibirsk (SOAN) are conventional, and dates from the Arizona AMS Facility (AA) (Tucson, US) are AMS dates. Stratum 3.1 is attributed to the Upper Paleolithic and has yielded an unpublished direct date on ornaments of 19,150 ± 80 ^{14}C BP (lab number unavailable) (Viola *et al.*, 2011).

The stratum 5 human remains were found in 1989 along the cave wall. They consist of 8 juvenile teeth likely belonging to a single MH individual of 7-8 years old (Viola *et al.*, 2011). The area where the fossils where found is said to be disturbed and to include material from the underlying strata. The association of the remains with the archeological material remains unclear.

The lithic assemblage (N=408) is generally considered as Levallois Mousterian (Goebel, 1994). The assemblage associated with stratum 3.2 is attributed to a Kara-Bom-like UP. The material is not fully published and the excavation is still ongoing; therefore, this assemblage will not be discussed in this analysis.

Chagyrskaya Cave

One of the most recently discovered caves lies along the Charysh river valley. Chagyrskaya Cave faces north and is around 25 m above the sea level. The site has been excavated by Markin since 2007 and has yielded a sequence of human occupations in layers 6.a, 6.b, 6c/1 and 6.c/2 (Derevianko, Markin, *et al.*, 2010). Although the study is still ongoing, the mate-

Layer	Material	Lab code	Age	Method
5	Bone-fauna	SOAN-3219	31,510 ± 2615	^{14}C
5	Bone-fauna	AA-30754	32,250 ± 705	^{14}C
5	Bone-fauna	AA-30755	34,780 ± 725	^{14}C
5.1	Charcoal	AA-37184	35,200 ±1300	^{14}C
6	Bone-fauna	AA-38232	>41,000	^{14}C
6	Bone-fauna	AA-38321	>41,000	^{14}C
4-6m depth	Bone-fauna	SOAN-786	>40,000-45,000	^{14}C
4-6m depth	Bone-fauna	SOAN-787	>40,000-45,000	^{14}C

Table 114: Strashnaya Cave, summary of the chronological data (after Derevianko *et al.*, 1998; Wrinn, 2010)

rial has been described as homogenous and generally comparable to the Okladnikov assemblages. So far, the assemblages are typed as non-Levallois Mousterian with aboundant sidescrapers and, at least occasionally, bifacial tools (Derevianko, Markin, *et al.*, 2009; Derevianko and Markin, 2011). Radiocarbon dates have been produced but are still unpublished and would indicate ages associated with the Ermakovo-Karginian boundary. Viola and colleagues (2011) described human fossils associated with layer 6b and 6c. Chargyrskaya 1 is a worn upper deciduous canine, and Chagyrskaya 2 is an atlas fragment. Both fossils are associated with layer 6b. Chagyrskaya 3 is an upper premolar, and Chagyrskaya 4 is a lower incisor. Both are worn and small and would fall outside the range of Neandertals. However, mtDNA was extracted and, although the results are not fully published, seem to indicate an attribution to Neandertal (Viola *et al.*, 2011).

Byka cave complex

The Byka cave complex consists of 7 caves located close to the Katun River. One the caves, Byka 1, has been described has containing Middle Paleolithic remains. The cave has yielded a sequence of 6 lithological strata. The stratum 1 assemblage is attributed to the Scythian period but also contains fragments attributed to the Afanasievo culture. Some of these fragments can be found in strata 2 and 3, testifying of admixtures (Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998; Derevianko, Markin, *et al.*, 2001; Wrinn, 2010). Stratum 4 has yielded two radiocarbon dates, 23,480 ± 300 ^{14}C BP (BIN-4980) and 37,000 ± 1000 ^{14}C BP (BIN-4981). The assemblage associated with this stratum is fairly small (circa 100 pieces), but it is described as analogous to the other strata and typed as Levallois-Mousterian. If this is the case, it would be one of the rare and late examples of this facies in a cave context.

7.1.3 SUMMARY

This overview of the open-air and cave sites from northwestern and central Altai leads to several observations. First, the regional records underline the difficulty of finding identifiable MP, IUP and EUP occupations within the same sequence.

Among the cave sites described, Denisova Cave seems to be the only one that clearly includes the three variants (Table 115). IUP diagnostic technological and typological elements occur in layer 12, 11 and 9 in the central chamber, in layer 11 in the south and east galleries, and in layers 8 and 7 in the entrance area. EUP occurs above the IUP in layer 9 in the entrance and in layers 7 and 6 in the entrance area. It is noted that both IUP and EUP techno-typological features are less clear-cut than in open air sites. In addition, the archaic component is more pronounced in cave context. Several explanations could be proposed regarding this issue. One could be the lack of taphonomic control combined with the carnivore activity (*e.g.* hyena den) that may have caused localized vertical movement of artifacts. Another explanation could be that cave sites illustrate different functional facies, or site use, than open-air sites. These differences would then reflect assemblage variability within techno-complexes. Similar problems apply to open-air sites where the two UP variants are rarely identifiable in a single sequence. At Kara-Bom, although they are traditionally attributed to UP, assemblages from OH3 to OH1 are not diagnostic. Even if it displays some of the IUP features, the OH4 attribution is still unclear. At UK1-2, the EUP seems clearly identified in stratum 9, with some diagnostic elements occurring in underlying levels 10 and 11. Taphonomic issues, however, have been raised as refits show vertical movement of artifacts between the MP strata 15-12 and the EUP strata 11-8. According to the model, at UK1-2 the expected stratigraphic position of the IUP is in the disturbed zone, somewhere between the MP and the EUP. It is noted that the morphology of some of the artifacts, such as a Levallois blade core or a BC, would fit with an IUP attribution. It is, therefore, possible that an unrecognized horizon of IUP was located roughly between strata 15 and 10. Nevertheless, this issue cannot be addressed mainly due to the cumulative effect of a small sample size and of post-depositional processes. The neighboring sequence of UK1-1 remains then the best example of chrono-stratigraphic succession where both UP variants can be identified. In this case, the MP layer seems absent. As illustrat-

	MP		IUP	EUP
	Mousterian	**Levallois-Mousterian**		
Open-air	∗ UK1-2, stratum 19?	∗ Kara-Bom, MPH2 ∗ UK1-2, stratum 18-12	∗ Kara-Bom, MPH1-OH5 ∗ Kara-Bom, OH4? ∗ UK1-1, OH5.4-5.5 ∗ Kara-Tenesh	∗ UK1-1, OH5.1-OH5.3 ∗ Anuy III, layer 12 ∗ Anuy II, OH12 to OH3 ∗ Karaturuk? ∗ *UK1-2, strata 11-8*
Cave	∗ Denisova, central chamber layer 21-12 ∗ Okladnikov strata 7-1 ∗ Chagyrskaya unit 3	∗ Denisova entrance zone, layers 10-9 ∗ *Ust-Kanskaya* ∗ *Strashnaya*	∗ *Denisova main chamber, layer 11* ∗ Denisova entrance zone, layer 8 ∗ *Denisova east gallery, layer 11* ∗ *Maloyalomen-skaya,. layers 3-4*	∗ *Denisova central chamber, layer 9* ∗ Denisova entrance zone, layers 7-6 ∗ *Denisova east gallery, layer 9*

Table 115: Summary of the reviewed assemblages and their attributions. Italic text indicates assemblages with taphonomic problems.

ed by the taphonomic analysis, the size, the nature and the stratigraphic position of the OH6.1 sample raises questions regarding its MP attribution. The UK1-1 and UK1-2 excavation areas are not physically connected, and it is, therefore, not possible to correlate the sequences. Kara-Tenesh has yielded a series of diagnostic IUP elements. The stratigraphic layer show signs of solifluction, but the frequent refits tend to indicate low energy processes. So far, the lack of spatial analysis, however, does not rule out a possible admixture with an MP component.

The MP occupations are usually described as two different variants, the Mousterian (Denisova-variant) and the Levallois-Mousterian (Kara-Bom variant). They are mainly defined based on the proportions of Levallois and Mousterian tools (Shunkov, 1990, 2005). In fact, Levallois products usually occur within the non-Levallois Mousterian component, even if the indices are rather low (Derevianko and Markin, 1995). The non-Levallois Mousterian variant occurs only in caves as opposed to the Levallois-Mousterian which is known in both caves and open-air sites. These variants have been considered as belonging to a single tradition, their variability reflecting different types of settlement or adaptative strategies (Derevianko and Shunkov, 2002; Shunkov, 2005). They have also been seen as reflecting different developmental trends influenced by exogenous population movements (Derevianko and Shunkov, 2002; Rybin, 2004; Wrinn, 2010; Derevianko, 2011a). Recent excavations in Chagyrskaya have led to the definition of a new variant, the Sibiryachikinsky culture, grouping mainly the non-levallois Mousterian from Okladnikov and Chagyrskaya assemblages (Derevianko, 2011a; Derevianko and Markin, 2011). The role of the different MP variants in the MP/UP transition scenarios is described in the forthcoming sections.

In terms of relative chronology, it appears that the IUP-EUP model proposed here cannot be tested properly due to the lack of reliable sequences including both UP techno-typological variants. Nevertheless, the sequence observed at Denisova Cave does not contradict the model of IUP-EUP succession observed at UK1-1. It, however, raises issues regarding how comparisons are made between open-air and

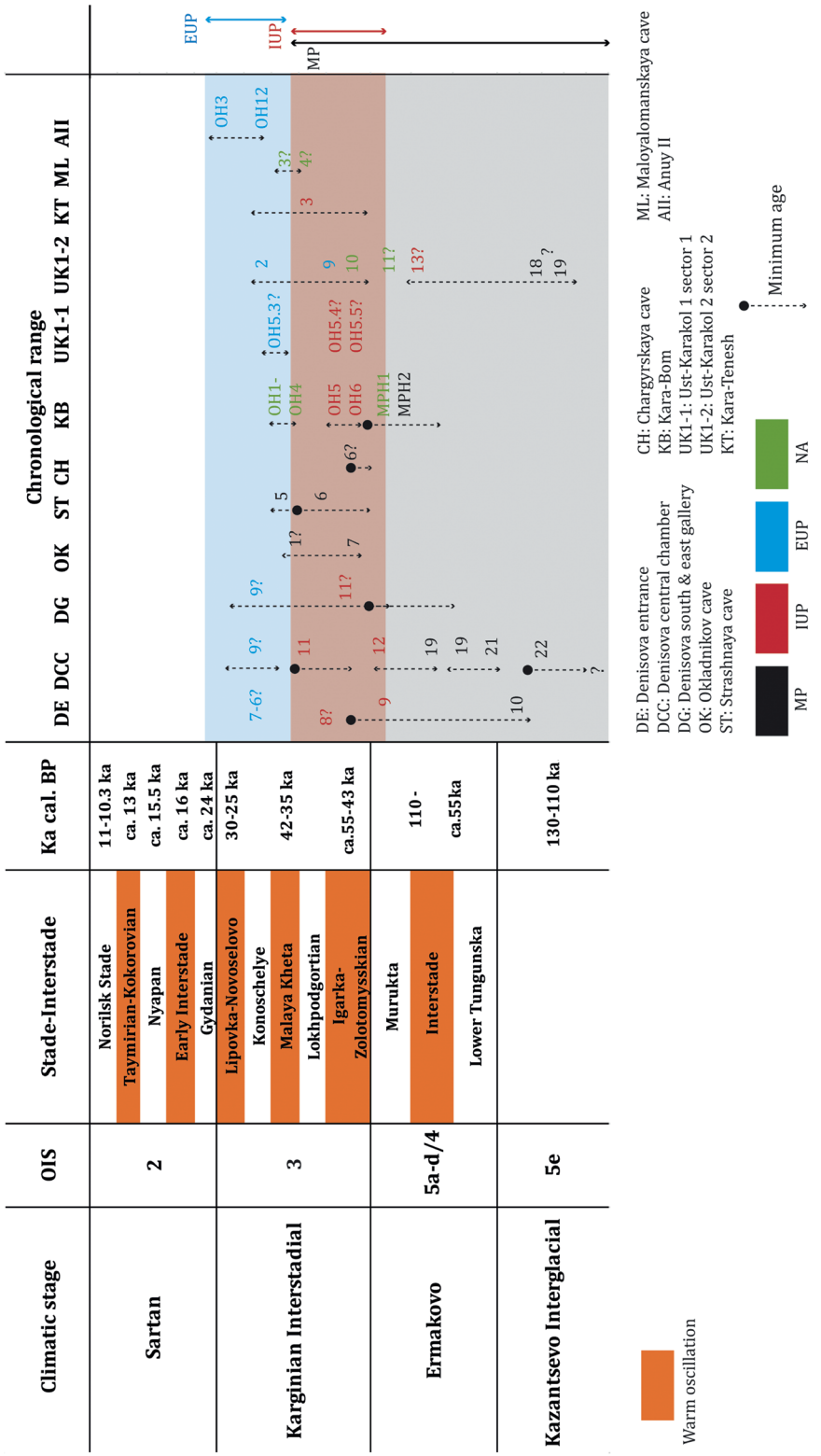


Figure 210: Summary of the regional chronological data

cave sequences. So far, MP assemblages have not been found above IUP or EUP assemblages.

Absolute chronological attributions are problematic for several reasons. First, some dating techniques such as RTL or EPR have numerous methodological uncertainties. Their agreement with some radiocarbon dates may be due to their large standard deviations. In some cases, RTL and EPR dates are, however, the only results available as the age of the dated samples falls beyond the limits of the radiocarbon technique. It is then suggested that these results should be compared with other standard ESR or TL ages obtained on the same sequences in order to evaluate the reliability of the ages obtained. Available radiocarbon dates are more numerous and provide the outline of a regional chronology that remains rather sketchy. As tested by Haesearts and colleagues (Haesaerts *et al.*, 2005), charcoal samples with similar cleaning protocols and with similar species, collected from a controlled stratigraphic environment, provide similar conventional and AMS radiocarbon ages in the Novosibirsk and Groeningen facilities. Recent methodological improvements, however, suggest that a systematic use of sample pretreatments (such as ABOX, for charcoal samples, or ultrafiltration for bone samples) associated with systematic AMS dating could lead to more constrained ages (*e.g.* Bird *et al.*, 2002; Jacobi *et al.*, 2006; Brock *et al.*, 2007; Higham *et al.*, 2009). In the case of the Altai, ultrafiltration has been applied on bone samples from Okladnikov and Denisova Cave (Krause *et al.*, 2007; Reich *et al.*, 2010). AMS-dates obtained have small standard deviations but show high degree of discrepancy. In the case of Okladnikov, the same bone dated in three different labs provided three significantly different ages even though two of the samples were pre-treated by ultrafiltration. In Denisova Cave, specific types of artifacts such as bone tools yielded younger ages than expected and the discrepancy observed is likely related to taphonomic issues. This raises questions regarding the association between the dates obtained and the archeological assemblage. In the current situation, the regional chronology is built on comparisons between different counting methods (conventional, AMS), different sample types (bone, charcoal, humic acid) and different pretreatments (*e.g.* ultrafiltration, Longin). These methodological issues suggest that the current absolute chronology is likely inaccurate, and is, therefore, interpreted here as a chronological range.

Figure 210 shows a comparison between regional climatic stages and the chronological range inferred from calibrated radiocarbon ages, magnetic inversions and RTL dates (uncalibrated results can be found in Chapters 3, 4, 5 and earlier in this chapter). As previously mentioned, the present study considers that the lower layers from the central chamber of Denisova Cave are associated with OIS5e pending some confirmation of the RTL ages. The magnetic inversions are, therefore, associated with the Blake event, as identified in the deposits from the entrance. In fact, Blake event has been recognized in the Portuguese margin sequence as two large inversions dated to 115 and 122 ka (Thouveny *et al.*, 2004). The age of the UK1-2 MP layers is inferred from the RTL results obtained on layer 18. Given the potential problems linked with this technique, the results are presented with a two sigma-range. More generally, given the problematic state of the record, Figure 210 has to be interpreted as a broad summary and does not present a fine grained chronology.

The general picture observed indicates MP occupation starting from OIS5e at Denisova layer 22 and possibly at Ust-Karakol layer 19 and 18. As suggested by Wrinn (2010), the environmental data from the Denisova cental chamber (Agadjanian and Serdyuk, 2005; Agadjanian, 2006, 2008) fits with an attribution to the Kazantsevo interglacial. During this phase the climate is described as very warm and humid. A broadleaf and coniferous forest seems to coexist with a meadow steppe. Based on the Blake magnetic reversal, the layer 10 from the Denisova Cave entrance zone indicates that the human occupation takes place during OIS5e. At UK1-2, the first MP occupation of stratum 19 is associated with OIS5e based on RTL dates. Pollen analysis indicates meadow steppe environment, which seems to be confirmed by the small mammal species. Layer 18 is said to be a redeposited clay layer divided into two sub-layers. 18B has yielded an RTL date overlapping with the Kazantsevo interglacial and 18A has yielded a date in between Kazantsevo and Ermakovo. According to Agadjanian (2006) the small mammal species il-

lustrate from layer 18B to 18A a transition to a cool but humid climate. In sub-layer 18B, forest species increase indicating a reduction of the steppe. On the contrary, steppe species increase and forest species decrease in layer 18A (Agadjanian and Serdyuk, 2005). Nevertheless, a sedimentary break is noted between layer 19 and 18 that is also reflected in the results of pollen analysis (Derevianko *et al.*, 2003; Agadjanian and Serdyuk, 2005). This gap makes the environmental data difficult to interpret. As the archeological material was recovered from both sub-layer 18B and 18A, it is, therefore, considered that the UK1-2 first occupation occurs at the end of a warm episode. This could be either during the Kazantsevo-Ermakovo transition or later during the Ermakovo oscillations.

The Ermakovo stage covers the end of OIS5 and OIS4. MP occupations occur in the Denisova Cave entrance zone layer 9 and in the central chamber 21 to 12. In the east and south gallery, radiocarbon results of > 50ka indicate that layer 11 contains elements that may belong to Ermakovo. At Kara-Bom, MPH1 has yielded radiocarbon ages of >44 ka which also provide a minimum age for MPH2. Environmental data from the small mammals at Denisova Cave suggest that layer 21 was formed in cold and humid conditions, and that layer 20 is associated with warm and dryer climates. Agadjanian and Serdyuk (2005) note that layers 19, 17 and 14 were formed after sedimentary breaks under unstable climatic conditions and marked by a spread of dark coniferous trees. In the entrance, a sedimentation break is described between layer 10 and 9. Layer 9 shows a decrease of forest and an increase of steppe environment and is associated by Agadjanian and Serdyuk (2005) to OIS5a-b, although they note a mismatch with the RTL result from the same layer. Layer 8 is formed after a sedimentary break during a cold and dry stage with deforestation (Derevianko *et al.*, 2003). Layer 8 is attributed to the final Ermakovo although it has not been dated. At UK1-2, pollen and small mammals in strata 17-14 testify to a dry and relatively warm climate with birch-pine forest and broadleaf species. It is associated with OIS5a-b (Agadjanian and Serdyuk, 2005), although it shows a slightly different picture than layer 9 of the Denisova Cave entrance zone. Strata 13-12 are associated with OIS4 and correspond to a cold and arid phase during which the forest reduces in size and the steppes expand. At Kara-Bom, the presence of *Coelodonta antiquatis* within the deposits of MPH1-MPH2 (Vasiliev, 2003; Wrinn, 2010) seems to indicate a rather cold climate, although the association of this species with the human occupation is unclear.

The Karginian interstadial period corresponds to OIS3 and is described as a cool and rather humid climate but with a succession of warmer oscillations. It is marked by the first clear appearance of the IUP that seems to disappear along with the MP at around 35 ka cal. BP. Shortly after, the first evidence of the EUP is recorded. At Denisova Cave, layer 7-6 of the entrance are not dated but are attributed to this period. Layer 11 and 9 from the central chamber and galleries are associated with the Karginian period, although, as previously mentioned, a part of the dated material from layer 11 belongs to Ermakovo. At Strashnaya, MP layers 6 and 5 are younger than 50 ka cal. BP and in Okladnikov Cave, U-series dates from layer 7 belong to OIS3. Preliminary results from Chagyrskaya Cave indicate ages that fit into this period, so too does the IUP and UP component from Kara-Bom, UK1-1, UK1-2, Maloyalomanskaya Cave, Kara-Tenesh and Anuy II.

In Denisova Cave central chamber, layer 11, the small mammals and the pollen indicate cool and humid climate but with an outburst of forest species in the middle of the layer and with the warmest signal at the top the layer (Derevianko *et al.*, 2003). The situation is similar in layer 7 of the entrance, with a dramatic increase of forest species. At UK1-2, pollen and mammals show a significant increase of forest and meadow taxa starting from stratum 11; however, cryogenic formations are observed on the northern sections starting in strata 11 and 10. Based on radiocarbon dates and pedogenic features, Dergacheva and Fedeneva interpret Kara-Bom OH6-OH4 deposition as a warm period, OH4 being the warmest episode of the sequence probably associated with the Malaya Kheta stage (Dergacheva and Fedeneva, 1998; Derevianko, Markin, *et al.*, 2001). OH3 would accumulate during similar conditions, although a little cooler. These observations could be contradicted by the presence of *Coelodonta antiquatis* among the

burned bones associated with a fireplace found at the bottom of OH6 (Derevianko and Rybin, 2003).

Based on the current data set, it appears that there is a significant chronological overlap between the MP and the IUP although no clear interstratifications have been identified yet. Most of the MP assemblages overlapping with the IUP are of the Mousterian variant, except in Strashnaya Cave. The youngest ages attributed to MP are from Okladnikov Cave and from Strashnaya Cave. At Okladnikov Cave, the chronology of the sequence shows numerous discrepancies and the age of the layer has to be confirmed. At Strashnaya Cave, the layer 3 is mentioned as a blade-based Levallois Mousterian of the Kara-Bom type but with a date on an ornament at around 19 ka (Viola *et al.*, 2011). The lithic assemblage from the recent excavations has not been published and these results have to be confirmed as Viola *et al.* (2011) mention some localized admixture of old material into the UP layer. Notable is the apparent simultaneous end of MP and IUP around 42-35 ka. The data set suggests that both techno-complexes are replaced without overlap by EUP during the Middle part of the Karginian stage. However, large standard deviations may distort the chronological picture and induce artificial overlaps.

When comparing the chronological data at hand with high resolution climatic record (*e.g.* Chlachula, 1997; Haesaerts *et al.*, 2005, 2010), a few additional observations can be proposed. Except Denisova, the three clearly identified IUP sites are located in central Altai and extend to the confluence between the Katun and the Chuya rivers. The sedimentological, paleontological and pallynological records indicate environmental differences between northwestern and central Altai (Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998; Chlachula, 2001; Fedeneva and Dergacheva, 2003; Wrinn, 2010). In the central Altai, climate was sensibly dryer during the cold periods with a steppe vegetation cover. Mountain glaciers extended from the southeast down to central Altai during OIS2 and OIS4 (Lehmkuhl *et al.*, 2004). Moraines observed in the vicinity of Kara-Bom are tentatively attributed to Ermakovo (Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998) and would testify of a periglacial environment during OIS4. Thus, it appears parsimonious to consider that IUP occupations took place during a temperate/warm phase. Based on the ^{14}C, Kara-Bom OH5 and OH6 would be associated with the Chani-1 episode. This soil is correlated with the Bohunice soil from Central Europe (Haesaerts *et al.*, 2010). It seems to disappear during the Malaya-Kheta phase, at the end of which two cold events occur successively: Heinrich 4 event and the Konoschelie cooling. The latter is marked by the presence of ice wedges between 31 and 30 ka ^{14}C BP, after the Kurtak IV warm episode. Due to the lack of reliable data, the demise of IUP and MP cannot be linked directly with the Heinrich 4 event, although the latter may appear as a chronological boundary.

The regional framework does not contradict the proposed model of chrono-stratigraphic succession, but the problematic nature of the chronological data and the scarcity of well-dated long sequences do not allow to determine with precision how fast and in which climatic phase a replacement happened. The idea of a parallel development of IUP and EUP techno-complexes, however, is not supported by the data set even if a short-term chronological overlap cannot be ruled out.

8 – Research question 3: inter-regional comparisons

Whereas the previous section provided an overview of the Gorny-Altai regional record in order to test a chrono-cultural model, the following enlarges the perspective by proposing a selective review from neighboring regions. The goal is to address the research question 3 which suggests that long distance comparisons support multi-regional scenarios of MH emergence. A special emphasis is paid to assemblages illustrating the end of the MP and the beginning of the UP and that share technological, typological or chronological similarities with the defined Altai IUP or EUP. From west to east, the overview of archeological evidence from Central Asia, western, central and eastern Siberia, and northern Mongolia proposed below will support further discussions in the next chapter.

8.1 CENTRAL ASIA

The southeast Tian-Shan and the Tajik depression are physical boundaries between Central Asia and Xinjiang, with some of the world highest mountain peaks over 7,000 m. The lowlands join the Altai through eastern Kazakhstan and, therefore, represent a possible route toward Northeast Asia. In the south, the Pamir, the Hindu-Kush and the Kunlunshan ranges extend to the Tibetan plateau, closing access to the Takla-Makan desert (Figure 211, num. 2). The following section focuses on the sites distributed along the western edge of the Tian-Shan up to the Altai foot hills.

According to Davis and Ranov (1999), the discovery of the Teshik-Tash Neandertal, in 1938, triggered a general interest in the Paleolithic of Central Asia. Okladnikov discovered remains of a juvenile Neandertal associated with a lithic assemblage attributed by F. Bordes (1955) to Quina-Ferrassie Mousterian. The site is located on the western side of the Hissar range at circa 1800 m asl and near the Uzbek town of Baisun. The cave was excavated between 1937 and 1938 by Okladnikov over a surface of 132 m². Five cultural layers were defined within a 1.5 m thick section and separated by sterile horizons. Each cultural layer contained remains of combustion features. The fauna consists of *Capra sibirica*, with an occsonal occurrence of carnivores, such as hyena and leopard. About 2,000 lithic artifacts were collected, mainly made of local silicified limestone but with the occurrence of quartz and jasper. The assemblage is dominated by flake blanks detached from discoidal and unidirectional cores whereas blade blanks are rare. The most representative tool is the Quina-type sidescraper which gives the assemblage a Mousterian character. As noted by Vishnyatsky (1999), the attribution to a more precise facies is subject to debate (*e.g.* Okladnikov, 1949; Bordes, 1955; Ranov *et al.*, 1979).

Recently, Keates (2007) suggested that a carinated endscraper originally illustrated by Okladnikov (1949) and subsequently by Movius (1953a) could represent evidence for a bladelet/microblade production. The illustrated piece displays a few sub-cortical, hinged removals and appears insufficient to support the occurrence of such technology in a Mousterian context. Other prismatic cores mentioned by Movius (1953a) (N=4) are not documented. In sum, the Teshik-Tash assemblage appears to be clearly Mousterian and similar to an MP assemblage associated with sub-prismatic cores reported at the nearby site of Amir-Tenir (Okladnikov, 1940; Movius, 1953a; Vishnyatsky, 1999).

In 2002, the cave of Anghilak was discovered in the Kashkadariya region of southeastern Uzbekistan. Five stratigraphic units were described with a small MP lithic assemblage (N=450) concentrated in two units and with depths ranging from 30-85 cm below the ground level (Glantz *et al.*, 2003). The few illustrated bladelets appear insufficient to attribute

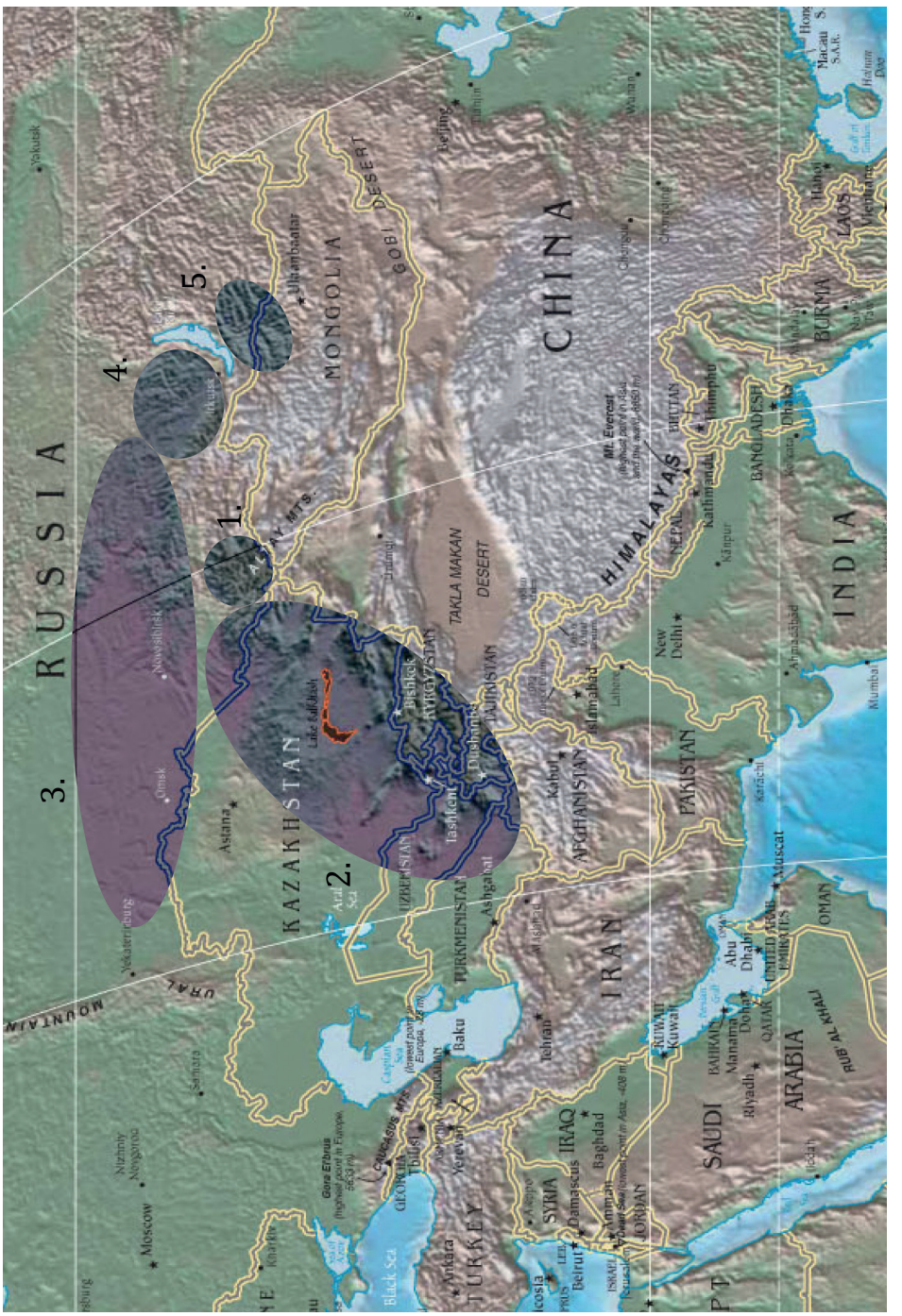


Figure 211: Map of Central and Northeast Asia. Shaded areas correspond to the main regions described in this study. 1, Altai; 2, eastern part of Central Asia; 3, western and central Siberia; 4, Cis-Baikal; 5, Trans-Baikal and northern Mongolia

a UP component to the assemblage. A fifth human metatarsal (AH-1) of an unknown taxon was discovered among the collection from the 2002 test pit. Its position and association with the lithic assemblage is not clear. Radiocarbon dates obtained on the stratum from which AH-1 is derived resulted in ages of 43,900 ± 2,000 and 38,100 ± 2,100 ^{14}C BP (Glantz *et al.*, 2008). Lab numbers are not available as chronological data are not fully published yet.

8.1.1 ZERAVSHAN BASIN

The Zeravshan river basin has yielded MP remains in open-air sites such as Kuturbulak. At this site, discoidal technology occurs along with numerous laminar blanks. Bidirectional and unidirectional cores are common, some being similar to Levallois flat-faced blade cores (*e.g.* Vishniatsky, 1999, Fig.6. num 16). At circa 18 km from Samarkhand, the Zirabulak site is said to be comparable to Kuturbulak, however, in a disturbed context (Vishnyatsky, 1996, 1999, 2004). This surface collection includes elements of bladelet reduction such as cores on flake edges and nosed and carinated endcrapers (Le Brun-Ricalens, personal comm.). The site of Sammarkandskaya is among the best known UP sites from this region and is associated with MH remains (Dzhurakulov, 1987). It has been excavated since 1939 over a surface of more than 1,000 m². Although it is mentioned by Otte (2004) as a possible Aurignacian site based on the presence of carinated endscrapers and Dufour bladelets, other scholars expressed serious doubts regarding the homogeneity of the assemblage (Vishnyatsky, 1996, 1999, 2004; Davis and Ranov, 1999).

8.1.2 AFGHANISTAN

In northern Afghanistan, the site of Kara-Kamar is located between the Turkestan plateau and the northern border of the Hindu-Kush (Ranov and Karimova, 2005). It was discovered and excavated by Coon in 1954 (Coon, 1957). Level III is composed of loessic sediments and includes two paleo-soils. Artifacts were selected during the excavation (N=87 among circa 3400 artifacts) and include a series of carinated and nosed endscrapers (N=32) and some bladelets, although the provenience of the latter is uncertain (Davis, 2004; Vinogradov, 2004). Radiocarbon dates were produced in the early stages of the technique and provided a minimum age of 25 ka ^{14}C BP for the units C12 and C13 and of 32 ka ^{14}C BP for the unit C11 (Coon and Ralph, 1955; Davis, 1978). Carinated endscrapers have been used to assign the assemblage to the Aurignacian in the context of migration models from west to east (Vinogradov and Ranov, 1985) or from east to west (Otte and Kozlowski, 2007). Other scholars rather argue for a technological convergence (Davis, 2004; Vishnyatsky, 2004).

In the Kyzyl-Kum desert, clusters of surface finds led to the identification of several sites (Kuk-Ayaz 1-3) (Sayfullayev and Cauche, 2004). Although the general aspect of the assemblages suggests a UP attribution, contextual and chronological data are lacking.

8.1.3 TAJIKISTAN

The southern part of Tajikistan is bordered by the Tian-Shan in the northeast and the by the Pamir in the southeast. The preservation of massive loess accumulations is one of the major features of this region. Successions of loess layers and paleo-soils reaching 200 m in total thickness are correlated with sections from northern China (Dodonov and Baiguzina, 1995). These two regions yielded high resolution sequences, recording Asian climatic fluctuations for a period ranging from the Miocene to the last interglacial (Dodonov and Zhou, 2008). The pedo-complexes 6 (PC6) and 5 (PC5) have yielded remains of Karatau and Lakhuti Lower Paleolithic traditions (e.g Ranov, 1995) that were first dated to 200 ka and 130 ka by TL (Dodonov, 1991). As demonstrated by Zhou and colleagues (Zhou *et al.*, 1995), the TL dates ranging from 800 ka to 20 ka widely underestimated the ages of the deposits. The early TL results obtained in the Kiev laboratory in the early 1970's (Shelkoplyas, 1974) have since been recognized as problematic. Subsequent improvements in luminescence dating have provided ages correlating PC1 with OIS5 (Zhou *et al.*, 1995). The Brunhes/Matuyama boundary corresponds to OIS19 in the marine record and is well documented in the

loess sequences in PC9. Depending of the section, it may show inconsistencies in the measured positions implying that ages may be over-estimated by a few to maximum circa 30 ka (Zhou and Shackleton, 1999). The loess sequences are now dated by correlations with paleo-climatic curves and the Karatau and Lakhuti occupations are attributed to OIS15.

The Chonako and Obi-Mazar sequences are correlated with the marine isotopic curve (ODP-667) and with the Tenaghi-Philippon pollen record (Schäfer *et al.*, 2003) (Figure 212). This suggests that the first MP occurs at Chonako 3, in PC2, and is dated circa 250 ka. The Levallois-Mousterian appears within PC2b circa 220-200 ka, followed by a Levallois-Mousterian with blades in PC2a. Refits show that post-depositional processes have affected these subunits, and assemblages from PC2a-b-c are described as a whole. Nevertheless, blades are well represented and consist of about 20% of the set (N=circa 350). The loess interstadial 2 (LI2) is associated with the laminar assemblage (N=circa 90) LI2b that includes genuine pyramidal cores (N=3). The cores are similar across levels with triangular flaking surfaces displaying unidirectional and convergent removals (Schäfer *et al.*, 1998; Ranov and Schäfer, 2000). Striking platforms are plain and the reduction is semi-turning or circular. According to Schäfer *et al.* (2003), the 'bladelet' horizon derived from LI2a occurs prior to the climatic optimum of OIS5e, about a meter below the interglacial soil. The age of LI2a is estimated at circa 150 ka (Schäfer *et al.*, 1998). The lithic material associated with LI2a consist of a small assemblage (N=25) dominated y blades and bladelets (N=11)(Schäfer *et al.*, 1998). PC1 is not well documented, but the Levallois artifacts found are not laminar and remain older than the radiocarbon dates associated with other Mousterian sites in Central Asia (Ranov and Schäfer, 2000). Objections against this chronology are raised by Ranov (Ranov and Schäfer, 2000) who mentions unpublished TL dates obtained by Vlasov and Kulikov on Chonako loess. The dates would be similar to those previously obtained by Shelkoplyas, circa 40 ka for PC1. However, there is likely confusion between TL and RTL techniques, and the latter may have some methodological issues (Kuzmin, 2000). If one accepts the long chronology, this sequence would document the oldest occurrence of volumetric laminar technology in Central Asia and would then become roughly contemporaneous with Tabun D-type or other MP laminar assemblages from the Levant (*e.g.* Bar-Yosef and Meignen, 1992; Mercier *et al.*, 1995, 2007; Meignen, 2000, 2007).

The site of Khudji is located circa 40 km from the city of Dushanbe. It was partly destroyed by the construction of a road and only the lower part of the sediment was preserved (15-50 cm thick). During the 1978 campaign, a surface of circa 230 m² was excavated (Ranov and Amosova, 1984). Three combustion features were identified in loessic-loam deposits attributed to the Dushanbe formation. The fauna is not fully published but seems to be dominated by sheep/goat (Vishnyatsky, 1999, 2004). A radiocarbon date of 38,900 ± 700 ^{14}C BP (GIN-2905) was generated from a charcoal sample. The site was re-excavated in 1997, yielding a second and distinct upper complex (Ranov and Laukhin, 1998). A date of 42,100+2,440/–1,870 ^{14}C BP (GrN-23686) was obtained on a charcoal sample collected from horizon 8 in the lowermost part of the upper complex. In addition, a deciduous human tooth was discovered during wet screening. The tooth consists of a worn crown and a broken root and is interpreted as a lateral deciduous incisor (Trinkaus *et al.*, 2000). The morphology of the root indicates that the tooth was removed mechanically, and Trinkaus *et al.* (2000) suggest that the individual died at an age ranging from 3 to 5 years old. The specimen could not be attributed to a specific taxon, but it falls into the metrical range of Late Pleistocene hominins. The lithic assemblage from the lower complex (N=7,642) includes non-diagnostic cores and a similar amount of blade (N=397) and flake (N=375) blanks. Vishnyatsky (1999) notes that more than the half of the retouched tools (N=136) are on blades, a situation that appears to be in agreement with the frequencies of blanks. Retouched blades bear continuous or bilateral retouch and are classified as sidescrapers or as points. Small asymmetric triangular points on flake blanks are also described. The lithic material from the upper complex is reported as comparable with the lower complex (Trinkaus *et al.*, 2000) and, due to its high laminar index, is attributed to the Levallois facies as defined by Ranov (1968). The high

frequency of retouched tools and the coexistence of flake and blade reduction also suggest a Levallois-Mousterian attribution as defined by the same author (Ranov and Davis, 1979). More recently, Vishnyatsky supported an MP association in a broader sense (2004).

A similar assemblage is reported from Ogzi-Kichik Cave (Ranov and Nesmeyanov, 1973; Ranov and Karimova, 2005), but no clear cultural layer has been identified and the integrity of the assemblage has been questioned (Abramova, 1984; Vishnyatsky, 1999).

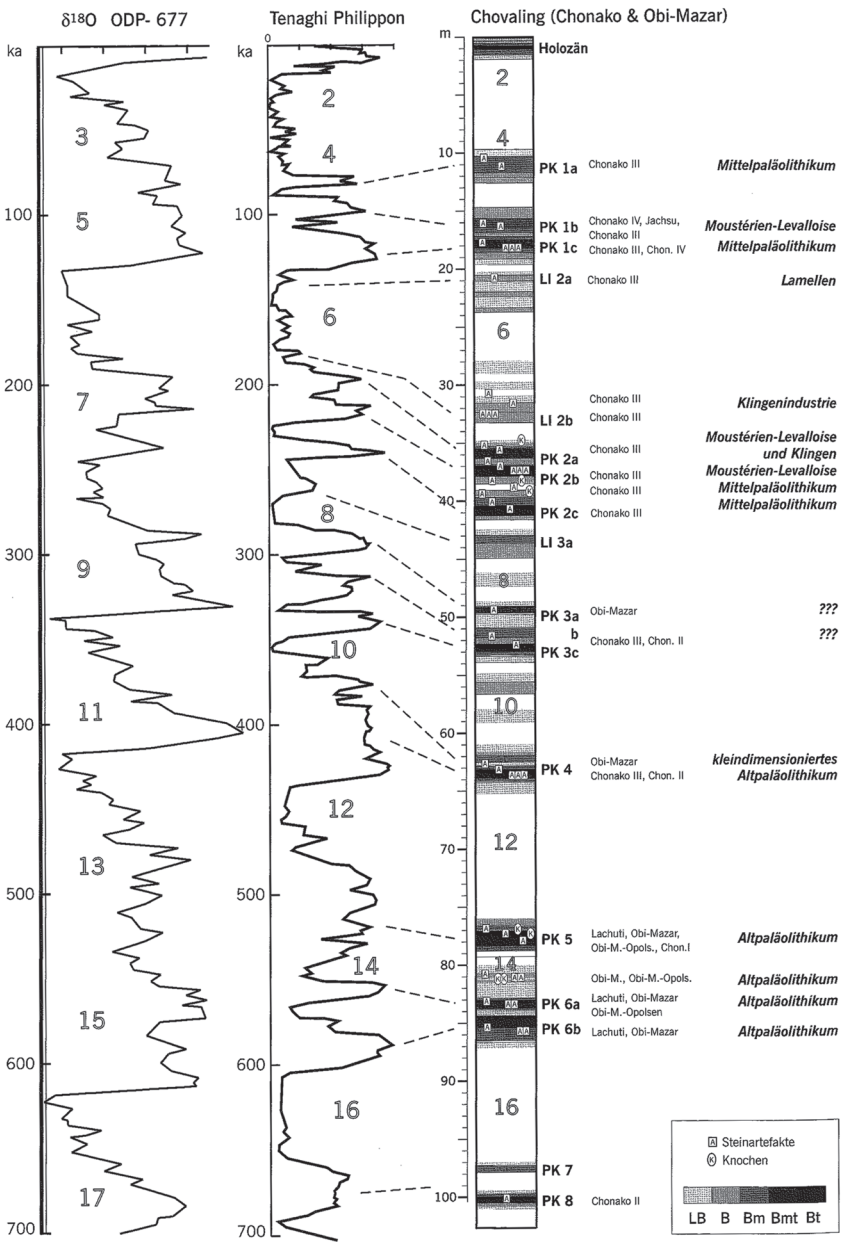


Figure 212: Chrono-climatic reconstruction from Chonako and Obi-Mazar loess sequences, Tadjikistan (after Schäfer *et al.*, 2003)

The site of Shugnou lies along the upper reaches of the Yakhsu River (Ranov and Karimova, 2005). The excavated surface yielded five cultural horizons associated with loessic sediments of the third Dushanbe terrace. Horizon 1 is dated to 10,700 ± 500 ^{14}C BP (GIN-590). Horizons 1 and 2 are attributed to the UP based on the presence of tools on blades and bladelet blanks but horizon 2 also includes discoidal and Levallois technology (Abramova, 1984). Although mentioned as UP assemblages, horizon 3 (N=300) and 4 (N=200) are described by Vishnyatsky (1999; 2004) as a Mousterian similar to the Khudji lower complex. This view is supported by other scholars (Schäfer and Ranov, 1998).

The main site located in the Fergana region is Sel-Ungur Cave (Islamov, 1990). The site is located along the Sokh River and was excavated by Islamov between 1982 and 1989. Five cultural layers have been recognized among 12 lithostratigraphic layers. The bulk of fauna from the two first layers and the pollen analysis indicate a permanent steppe landscape, and a 230Th/U date of 126 ± 5 ka (LU-936) provides a minimum age for the assemblage corresponding to the last interglacial. Humain remains have been reported (teeth, humerus and occipital bone?) and attributed to a local variant of *Homo erectus* (Islamov *et al.*, 1988; Islamov, 1990). The lithic assemblage is claimed to be Acheulean although it lacks proper handaxes. Some authors underline similarities with some of the LP pebble assemblages from Tajikistan (Ranov, 1995b; Vishnyatsky, 1999). In the Fergana, MP and UP sites are so far known only from surface collections.

8.1.4 TIAN-SHAN

The northwestern Tian-Shan is a mountainous area located west and north of the Fergana. It is an important area as recent excavations provide new data on MP-UP occupation of Central Asia. The sites of Kulbulak, Obi-Rakhmat and Dodekatym II will be presented in more detail as they are relevant points of comparison with the IUP and EUP from south Siberia.

Kulbulak

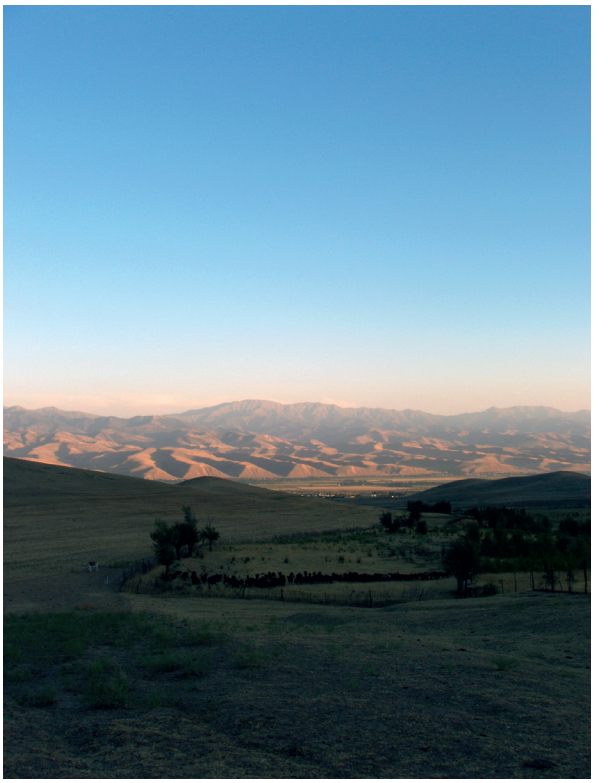


Figure 213: View on the Angren valley from the vicinity of Kulbulak (site is on the right)

The site of Kulbulak is located about 100 km northeast of Tashkent, along the western edge of the Tian-Shan range (Figure 213). Excavations in Kulbulak can be summarized in two main phases. The first phase consists of several campaigns that took place between 1964 and the early 1990s (Kasymov, 1972; Kasymov and Godin, 1984; Kasymov *et al.*, 1985; Kasymov and Grechkina, 1994; Anisutkin *et al.*, 1995). An area of circa 600 m² was excavated, including a pit of 3 m² and circa 19 m deep. During this phase, the site has yielded more than 70,000 artifacts coming from 49 archeological layers (Kasymov *et al.*, 1985; Kasymov and Grechkina, 1994). Kasymov and Godin (1984) reported that the Matuyama-Brunhes boundary has been recorded around layer 28. They attributed the bottom of the sequence to Acheulean, overlaid by MP and UP occupations. Following the publication of these results, some authors have expressed doubts regarding the integrity of the

deposits (Vishnyatsky, 1999) and regarding cultural attributions or chronological issues (Ranov, 1995b). The second phase of excavation started in 2007, under the direction of Flas and Kolobova (Derevianko, Islamov, Kolobova, *et al.*, 2008; Kolobova *et al.*, 2008; Flas *et al.*, 2010; Krivoshapkin, Kolobova, *et al.*, 2010). The excavation finished in 2010, and the analysis of the material is still on going (Flas *et al.*, 2011). The following description is based on the second phase of excavation.

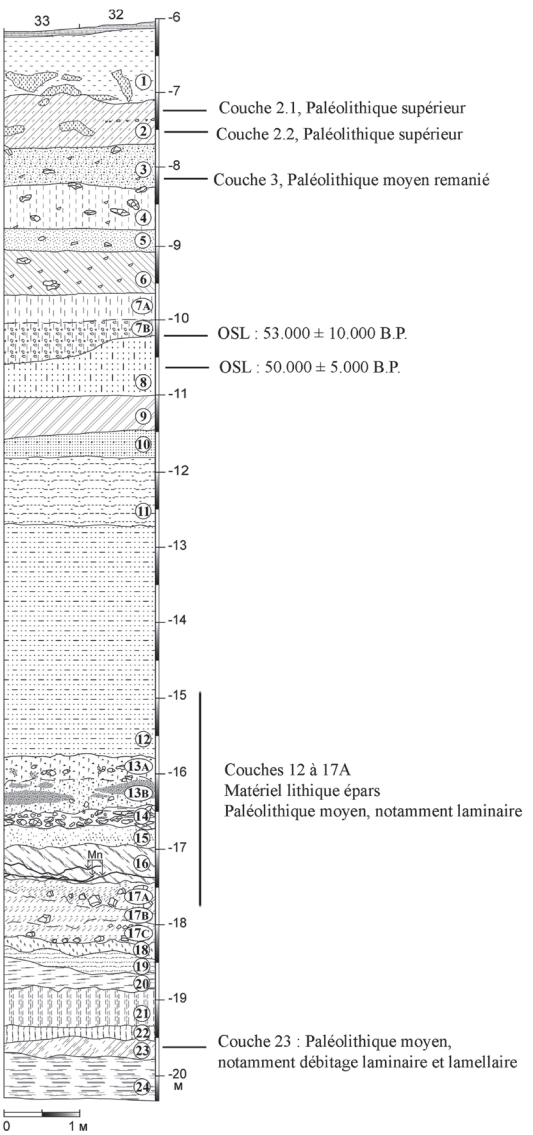


Figure 214: Kulbulak, stratigraphic log (after Flas *et al.*, 2011)

Stratigraphy

The excavation covers a total area of circa 36 m² distributed in different part of the site. The sequence is built around two main excavation areas (Figure 214). The first includes layers 1-3 and contains UP cultural layers. The second documents layers 3-24 in which MP material has been recovered. The UP levels from layer 2 were excavated in a bench of sediments left exposed by the previous investigators. The layer 2 sediment matrix consists of consolidated sandy-clay deposited near a spring, under low-energy damp conditions. During the 2007-2010 campaigns, the 19 m deep pit left by the previous excavators was reopened in order to address stratigraphic and chronological issues. 21 additional lithostratigraphic layers were described, with lithic material occurring between layers 12 and 17a and in layer 23 (Krivoshapkin, Kolobova, *et al.*, 2010; Flas *et al.*, 2011).

Chronology

No radiocarbon dates could be obtained from the sequence and the fauna is badly preserved. So far, two OSL dates have been obtained on the quartz sediment fraction from the bottom of layer 7b and from layer 8. The dates of 53 ± 10 ka (GLL-070304) and 50 ± 5 ka (GLL-070305) can be considered as minimum ages for the layers 12-17a and 23 (Flas *et al.*, 2010). A broader OSL-dating program is currently ongoing (Flas *et al.*, 2011).

Human remains

In 2009, a human tooth was found associated with the UP assemblage from layer 2.1. It has been described as an extremely worn, lower left premolar (Flas *et al.*, 2010). The fossil is currently under study.

Lithic assemblage

Two main lithic concentrations have been identified in layers 2.1 and 2.2. The collection is extremely rich (N=>40,000) and mainly illustrates primary reduction activities performed on local raw material (Kolobova *et al.*, 2008; Flas *et al.*, 2010). One of the main sources of flint is a primary outcrop located in the limestone deposit that runs along the valley. Al-

though the lithic material is still under study, some of the main features can be described. The blade production is characterized as volumetric, with mainly unidirectional and occasionally bidirectional removals (Figure 215 :1, 2). Some of the cores are semi-turning using a broad and a narrow face as a flaking surface. The opposed platform is often initialized at the end of the reduction. Platforms are generally plain and reduced in size, with frequent occurrences of macroscopic lips along the internal platform edge and traces of thin abrasion along the external edge.

A systematic wet screening of the sediments has led to the identification of a bladelet and microblade technology (Figure 216). All elements of the reduction sequence are documented. Cores have various morphologies but mainly include carinated and nosed-endscraper forms (Derevianko, Islamov, Kolobova, *et al.*, 2008; Kolobova *et al.*, 2008; Flas *et al.*, 2010). Core blanks are mainly thick flakes or by-products of the larger blank reduction. When the reduction takes place on a broad face, it tends to follow unidirectional and semi-turning patterns. Cores with the flaking surface on a narrow edge illustrate frontal reduction. The presence of fronto-lateral flakes indicates that carinated endscrapers were sometimes rejuvenated by the detachment of a deep notch flake from one extremity of the flaking surface. The notch turns the carinated endscraper into a nosed-endscraper. In other words, these two forms may correspond to different stages of reduction rather than to distinct technologies (*e.g.* Le Brun-Ricalens, 2005). The in-

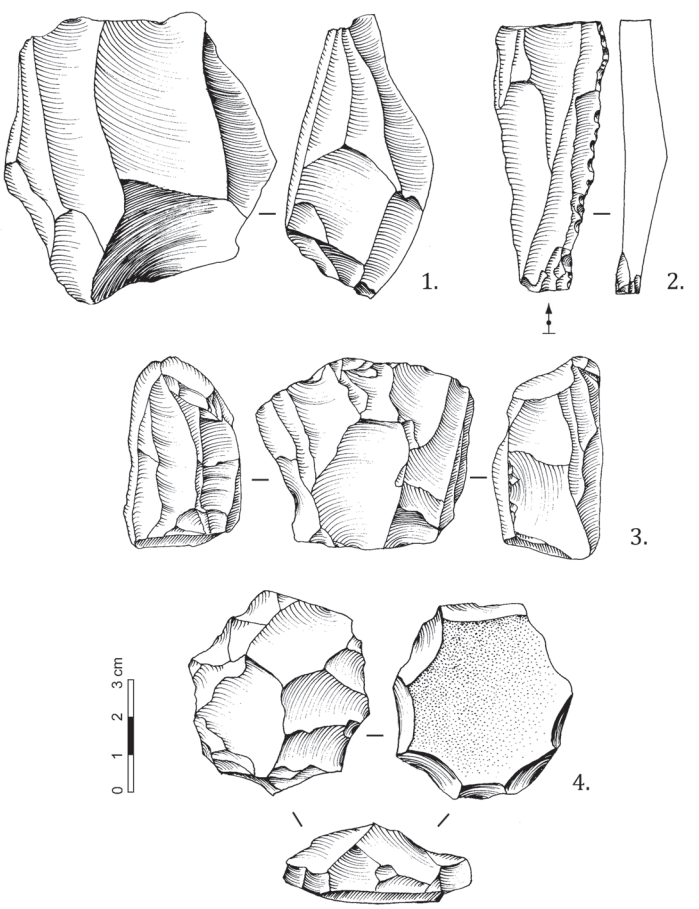


Figure 215: Kulbulak, cores from 2007 excavation. 1-2, layers 2.1 and 2.2; 3-4, layers 3 (drawings by Paquay and Zwyns)

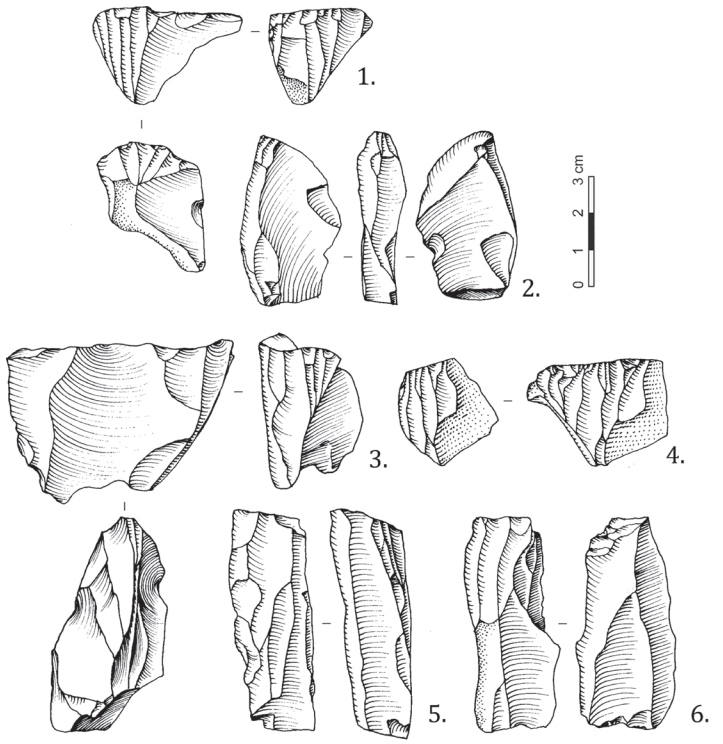


Figure 216: Kulbulak, layers 2.1 and 2.2, cores from 2007 excavation (drawings by Paquay and Zwyns)

tensity of the bladelet/microblade production is rather high judging by the frequency of core tablets and rejuvenation flakes. Cores reduced from the narrow face include bidirectional burin-like cores. Some of them are atypical BC (Figure 217: 10) produced on a small nodule also re-used as a tool *(piece esquillee)*. No systematic BC production is observed in the UP collection.

The blank width ranges from bladelet down to microblade (Figure 217: 1-9). From a general point of view, it seems that the reduction is oriented toward narrow and regular blanks. The few retouched elements identified include Dufour bladelets, some having inverse retouch along the left edge (Figure 217: 3). Other types include blanks with bilateral retouch, pointed distal ends, and proximal inverse truncations (Figure 217: 2). A first geometric microlith was found in 2007, not far from the exposed ground surface (Flas *et al.*, 2010) (Figure 217: 1). Its association with the rest the assemblage was, therefore, not secured. Since, one more was found during subsequent excavation campaigns; it seems that scalene triangles are part of the typological spectrum of the Kulbulak UP. So far, no direct date is available for these layers.

The underlying layer 3 is clearly re-deposited and has yielded an assemblage with more MP features. The lithic assemblage shows different states of patina with some of the artifacts highly weathered. A size sorting of the material is observed, with the small fraction missing. The layer 3 assemblage includes elements typical of a flake reduction, such as radial cores but also laminar elements. Flat-faced bidirectional cores with an exploitation of the narrow face also occur.

The lithic artifacts found between layers 12 and 16 seem to be in secondary position, except in layer 17a. Although the excavated area is small (circa 6 m²), a flake has been refit to a core in layer 16, and a few fragments of retouched blades have been refitted in layer 17a (Flas *et al.*, 2011). In spite of the reduced

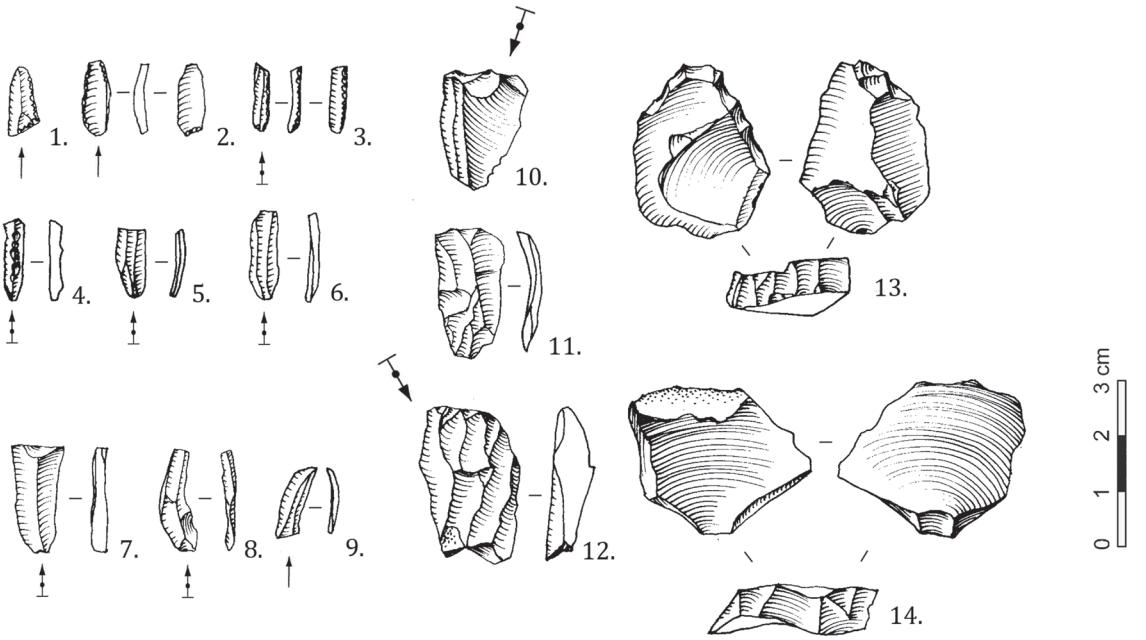


Figure 217: Kulbulak, layers 2.1 and 2.2, microblades and technological elements from 2007 excavation (drawings by Paquay and Zwyns)

sample size, evidence for bladelet technology is rather convincing. Of particular interest is the presence of a small core that is decribed as a BC, although the original blank is hard to identify (Flas *et al.*, 2010: Fig. 5, num.6).

The material from layer 23 represents the lowermost cultural level. Small and large laminar elements are reported including a refitted fragment of retouched blade (Krivoshapkin, Kolobova, *et al.*, 2010; Flas *et al.*, 2011).

In sum, new results on the Kulbulak sequence did not confirm the high number of cultural levels originally reported by Kasymovand colleagues (*e.g.* Kasymov *et al.*, 1985). In addition, there is no evidence for the presence of Acheulean assemblages (Flas *et al.*, 2010). Instead, it seems that the lower part of the Kulbulak section illustrates the presence of a blade-based MP techno-complex in the area.

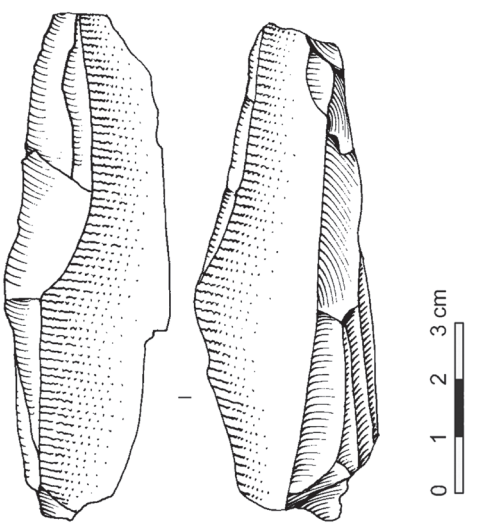


Figure 218: Kyzil-Alma II, second horizon, BC-like (undetermined blank), from 2007 excavation (drawings by Paquay and Zwyns)

Discovered by De Dapper in 2007, not far from Kulbulak, Kyzil-Alma II is a section of re-deposited loess (Derevianko *et al.*, 2008). A first cleaning of the section revealed at least three artifact horizons. The site is located along the raw material source and

may represent evidence of primary reduction. The lithic assemblage has not been described in detail yet and is under study. Among the first artifacts uncovered from the second horizon, a BC has been published. Personal observation suggests that the blank is an elongated cortical slab (Figure 218). Removals are short and fragmentary.

Obi-Rakhmat

The Obi-Rakhmat Grotto lies about 100 km northeast of Tashkent, in the western Tian-Shan range. The cave opens at the bottom of a small ravine, on the right bank of the Paltau river valley, a tributary of the Chatkal River (Figure 219). It lies at the limit of the Karatut-Bashi Mountain at an approximate elevation of 1250 m asl. The chamber is 9 m long with a maximum height of the ceiling of 11.8 m. The 20 m width entrance faces south, opening in a Paleozoic limestone massif. Following its discovery in 1962, Obi-Rakhmat was first excavated in 1964-1965 by Suleimanov under the supervision of Gerasimov and Nasretdinov (Suleimanov, 1972). Between 1966 and 1986 the site was sporadically excavated by Omanzhulov and Krakhmal. Starting in 1998, a joint research team from the Institute of Archeology and Ethnography from the Siberian Branch of the Russian Academy of Sciences and the Institute of Archeology of the Uzbekian Academy of Sciences carried out new excavations under the supervision of Derevianko (Derevianko, Islamov, Petrin, *et al.*, 1998; Derevianko, Islamov, *et al.*, 1999).

Stratigraphy

The 10 m deep stratigraphic sequence is divided into 22 strata (Figure 220). It shows alternations of pale-yellow and grey sandy loam horizons. Pale-yellow horizons are generally 50-60 cm thick and display a relatively low artifact density. Compared with the 15-25 cm thick gray horizons, they bear more lithic artifacts, bones and charcoal fragments. The strata are rather horizontal, dipping slightly to the south-



Figure 219: Obi-Rakhmat site

west in the direction of the entrance and toward the western wall of the cave. Eboulis occur in very low density in the upper part of the sequence. They are more frequent in stratum 15, with big elements up to 40cm in diameter. In highly saturated areas, the soft sediments are cemented by carbonaceous water, mainly in the vicinity of the western wall (see also Derevianko, 2004).

Based on soil micromorphology (Mallol *et al.*, 2009), Mallol and colleagues suggest that the deposition of sediments occurs in two distinct environments, namely karstic and spring systems:

- Strata 21-19.3, 19.1-15: gravitational and low-energy deposition of a sediment rich in clay in a karstic environment. Stratum 19 has a pronounced anthropogenic component, including burned bones and ashes. These elements are affected by surface water. The rate of sedimentation is hard to assess and some part of the layers might be missing due to erosion.

- Strata 19.2, 18, 16, 14-2: sedimentation linked with spring activity and with the development of wet vegetation. These layers do not have a steady sedimentation. Layers with a relatively long subaerial exposure (*e.g.* stratum 7) accumulate more detrital material. Travertine occurs in these strata.

In other words, the karstic sedimentation in the lower part of the sequence is interrupted by two layers of spring sediments. The middle and upper part of the sequence testify to a spring environment with a varying sedimentation. In general, the sedimentation reflects a low-energy autochthonous process and does not originate, as previously thought (Novikov, 2004), from the Paltau River. The only exceptions are strata 17 and 15 as the former displays some features typical of exogenous sediments and the latter represents successive roof-fall events (Mallol *et al.*, 2009).

Fauna

The main identified faunal remains (NISP=1,758 in 2004) are found in association with the archeological material. The main species (90%) are ungulates (*Capra sibirica* and *Cervus elaphus*)(Suleimanov,

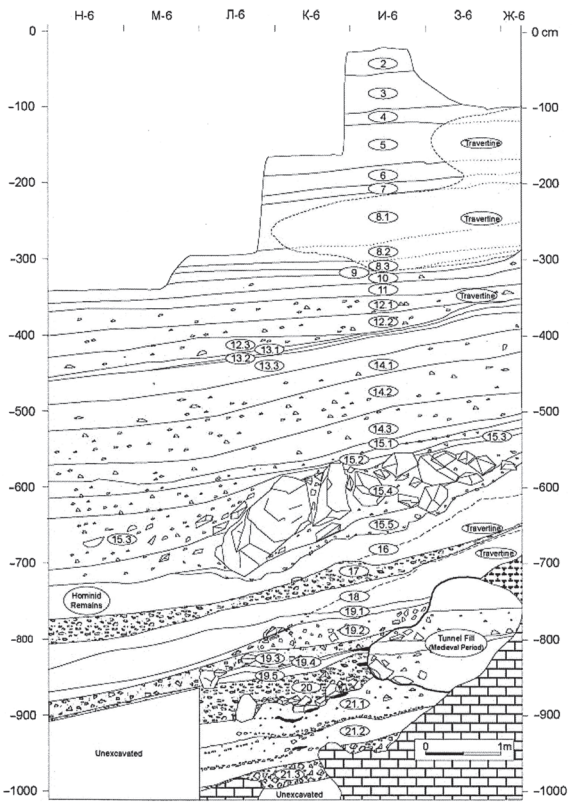


Figure 220: Obi-Rakhmat, stratigraphic column (after Mallol *et al.*, 2009)

1972; Wrinn, 2004). The infrequent occurrence of other taxa gives the spectrum an overall homogenous appearance except for the presence of roe deer in layer 16-20. Except for layer 19, the faunal assemblage is rather poor compared to the lithic artifact density. Burned specimens and bones displaying cut-marks and percussion traces occur regularly, and evidence for carnivore activity is minimal (Wrinn, 2004).

Pollen

Palynological analyses suggest that climatic conditions at the time of the deposition were similar to present day Tian-Shan. The spectrum is almost identical over the whole sequence although displaying variability in species proportions. The bad pollen conservation allows only basic identification of herbaceous species, indicating Late Pleistocene dry steppe vegetation (Kul'kova, 2004).

Chronology

A number of different methods have been applied to the sequence in order to bracket the time of its deposition, but the results do not give a coherent pictures. Radiocarbon dates obtained on charcoal samples collected in strata 7, 8.1, 8.2, 13.2, and 14.1 indicate an age between 40 ka ^{14}C BP to around 50 ka ^{14}C BP, close to the limits of the method (Krivoshapkin, Kuzmin, *et al.*, 2010). In addition, U-Series dates performed on travertine from the upper part of the sequence (strata 5-12) show significant discrepancies with the radiocarbon results, indicating roughly an age between 70-100 ka (Wrinn *et al.*, 2004). ESR dates have been performed on 8 ungulate teeth samples (*Bovidae, Cervidae* and *Capra*) collected from strata, 12.3, 13, 14.3 and 21.2. The results range between 57 ± 2 ka BP to 87 ± 4 ka BP (Skinner *et al.*, 2007; Shoer *et al.*, 2008). As suggested by infinite ages, radiocarbon dates exceeding 40 ka ^{14}C BP could reflect minimum ages (e.g stratum 14). Krivoshapkin and colleagues argue that the upper part of the sequence, starting circa stratum 14, remains in the range of radiocarbon (Krivoshapkin, Kuzmin, *et al.*, 2010). Whereas some of the outliers are rejected due to low C values, other finite radiocarbon ages are validated. The dates obtained on charcoal samples collected from strata 7 and 8 indicate an age between 45 and 50 ka cal BP. The results would then fit with the ESR results. Preliminary results of OSL dating seem to indicate overlapping ages between 52 ka and 65 ka from strata 5 to 21. These results are not fully published, but Krivoshapkin and colleagues (2010) consider that they are not conclusive (Krivoshapkin, Kuzmin, *et al.*, 2010).

Human remains

In 2003, six isolated permanent maxillary teeth and 121 cranial fragments were uncovered in stratum 16 (Glantz *et al.*, 2004, 2008; Glantz, 2010). They are assigned to a single juvenile individual, OR-1, whose age is evaluated to between 9-12 years old based on the examination of the relative root development and of the degree of dental wear (Glantz *et al.*, 2008). In the initial description and in more recent analysis, authors underlined the mosaic of morphological features observed on OR-1. As the dentition shows archaic traits, portions of the temporal regions and the left parietal were interpreted as similar to MH specimens from the same age (Glantz *et al.*, 2004, 2008). If the cranial fragments remain ambiguous, a detailed study of the dentition seems to clarify the picture. According to the authors, the comparison of discrete attributes (28 non-metric dental traits scored from Neandertals, UP, and MP Modern Humans) together with a morphometric analysis of the first upper molar strongly support the attribution of the OR-1 dental remains to Neandertal (>99 % of a posteriori probability) (Bailey *et al.*, 2008). Moreover, the left bony labyrinth and the semi-circular canal are preserved and clearly indicate Neandertal affinities (Glantz *et al.*, 2008).

Lithic assemblage

Artifacts collected in 1963, 1968-1970, 1978, 1979 and 1986 have been analyzed and published for strata 2-14 (*e.g.* Krivoshapkin and Brantingham, 2004; Krivoshapkin *et al.*, 2007). Regarding the bottom of the profile, the excavation is still on-going and only preliminary observations will be mentioned here. Most of the raw material consists of silicified limestone that occurs in natural outcrops in the west vicinity of the site and along the riverbeds (Mallol *et al.*, 2009). This material occurs as angular slabs offering natural crested edges that facilitate initial reduction. A very large number of lithic artifacts have been uncovered along the sequence (in 2004, the number of finds was >60,000) coming from a surface of circa 25 m² (Mallol *et al.*, 2009). The general character of the lithic assemblages does not vary throughout the sequence and will be summarized here as a whole. All levels testify to a developed blade technology with a usual frequency of more than 40%. Blades are produced from various types of cores (Figure 221). The core reduction is mainly unidirectional and convergent, with the occurrence of broad and narrow face cores. Some of the cores display evidence of reduction on both the narrow and flat face (Slavinsky, 2004; Krivoshapkin *et al.*, 2007). As mentioned in previous studies, burin-like cores are produced on large flakes or blades (Krivoshapkin and Brantingham, 2004). The flaking surface either follows the longitudinal axis (BC) (see also Derevianko, 2011: Fig. 44 num. 3) or is perpendicular to the blank. In-

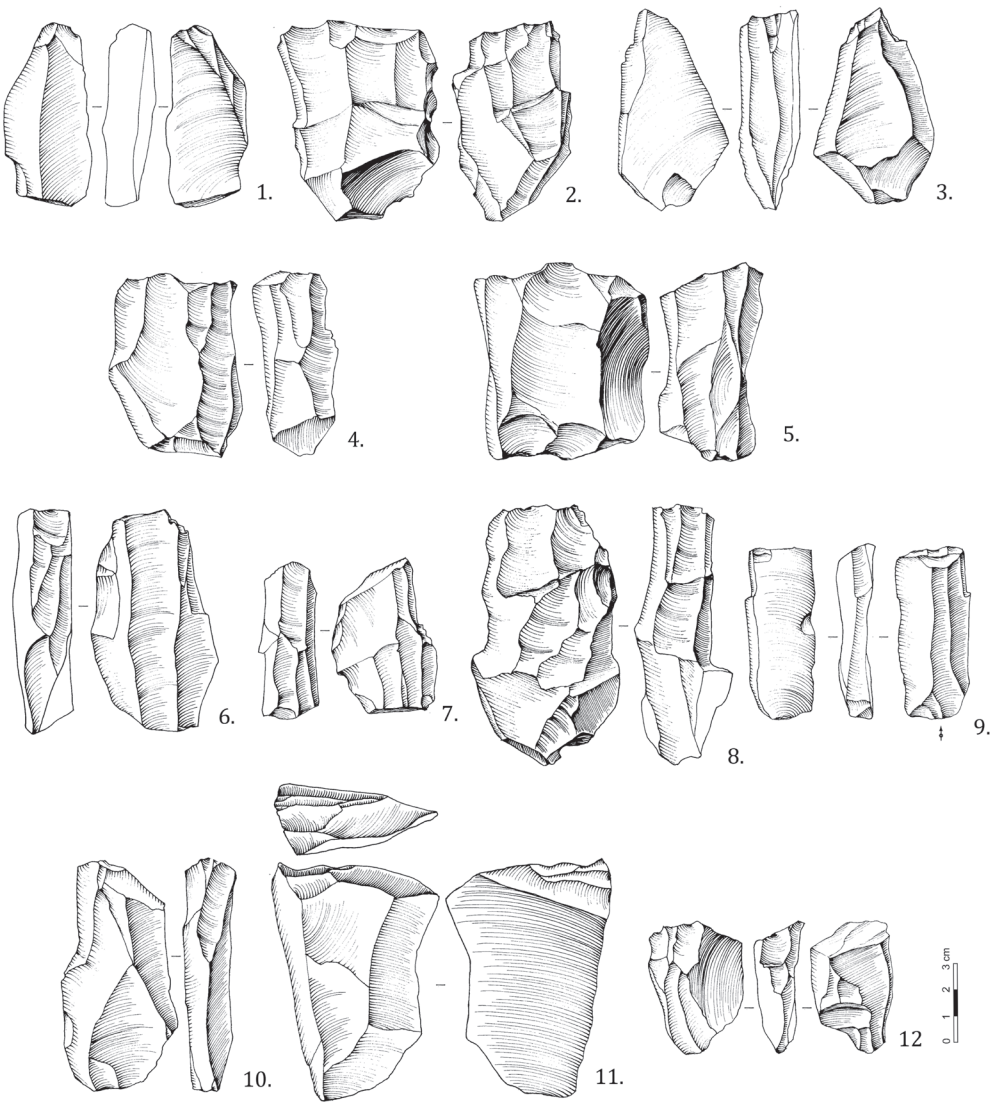


Figure 221: Obi-Rakhmat, cores. 1. stratum 7; 2, 3, 8. stratum 11; 4-7, 9. stratum 14; 10. stratum 15; 11, 12. stratum 19 (drawings by Paquay and Otte)

termediate forms are observed, such as lateral burins *(burin plan)* with a flaking surface expanding toward the ventral face of the blank. Some of the platforms are reshaped by partial tablet removals. Bidirectional removals seem to represent distal management of the core or a change of platform that follows a long unidirectional sequence.

Small volumetric bladelet cores occur starting from the lowermost part of the sequence. Large/medium laminar blanks can be classified within two main categories. Blades with parallel or sub-parallel edges show mainly unidirectional scars (Figure 222). In some cases, a short opposed removal is observed on the distal part of the blank. Orientation of the removal indicates that blanks with parallel edges are produced by a rather convergent reduction system. Platforms are usually thick (>4 mm) and plain, but facetted and dihedral types also occur. Prepared crests are not frequent.

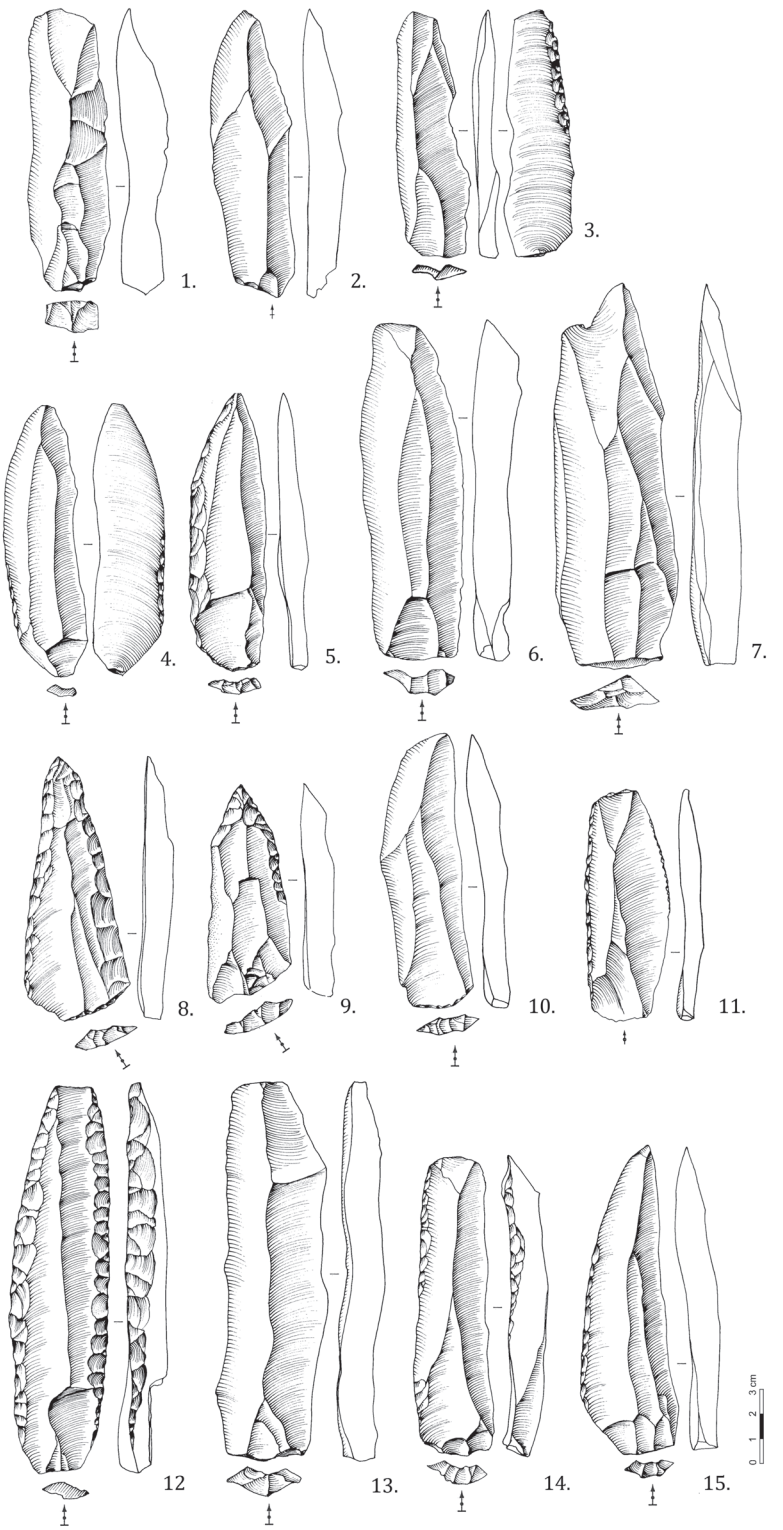


Figure 222: Obi-Rakhmat, blades. 1-3. stratum 11; 4-6. stratum 15; 7. stratum 14; 8-11. stratum 19; 12-15. stratum 20 (drawings by Paquay and Otte)

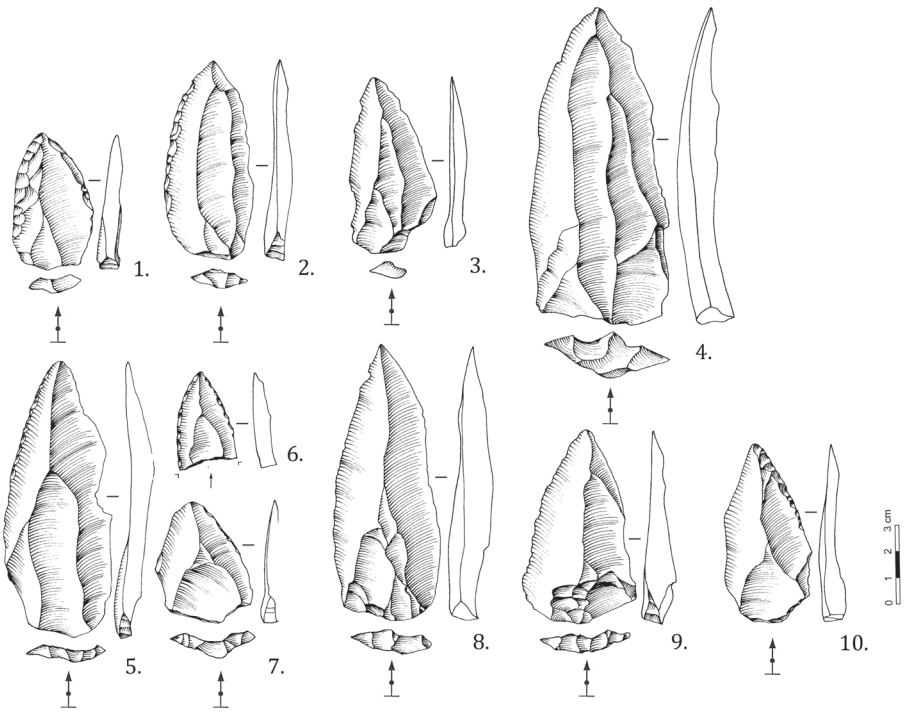


Figure 223: Obi-Rakhmat, convergent blanks. 1. stratum 2; 2. stratum 7; 3. stratum 15; 3, 4. stratum 17; 5-7. stratum 19; 8-9. stratum 21; 10. stratum 20 (drawings by Paquay and Otte)

Some retouched blades are pointed by a bilateral semi-steep, steep or scalar retouch. Other blade blanks bear marginal retouch that is sometimes thin. The second main category of blank is represented by artifacts with convergent edges (Figure 223). This category includes classic and atypical Levallois points. The dorsal patterning is usually unidirectional and convergent, although some blanks may occasionally present a distal opposed removal.

Platforms are plain, dihedral or facetted, the latter being sometimes slightly *débordant*. Some of these convergent blanks bear bilateral mesio-distal retouch; others have thin and scalar marginal retouch along one edge. When marginal retouch is thin, semi-steep and steep, it can take the form of a truncation (Figure 224). In fact, truncations are rather abundant in some strata (*e.g.* stratum 19). Some of them are similar to small Levallois blade cores and can be typed as truncated-facetted pieces, while others seem to be truncated tools on blade fragments. A few rare specimens seem to suggest a basal thinning by inverse retouch, starting in layer 21 (Derevianko, Krivoshapkin, *et al.*, 2004).

From a general point of view, blade platforms are mainly plain. Based on the definition of Nehoroshev (1999), Slavinsky (2004) underlines the lack genuine 'platform reduction' in the upper part of the sequence (stratum 14-3). It is then assumed that partial facetting is uncommon, if present at all.

During the 2008 campaign, squares M-6 to M-8 were excavated in strata 21.1, less than (60 cm from the bedrock), along the eastern profile (Krivoshapkin, in press). Among the finds uncovered, numerous elements illustrate different types of bladelet production, following distinct reduction sequences. The sample presented below only provides a preliminary view of the assemblage as the excavation is still ongoing.

Cores are of various types, including cores on flake ridge, prismatic and sub-prismatic forms. They

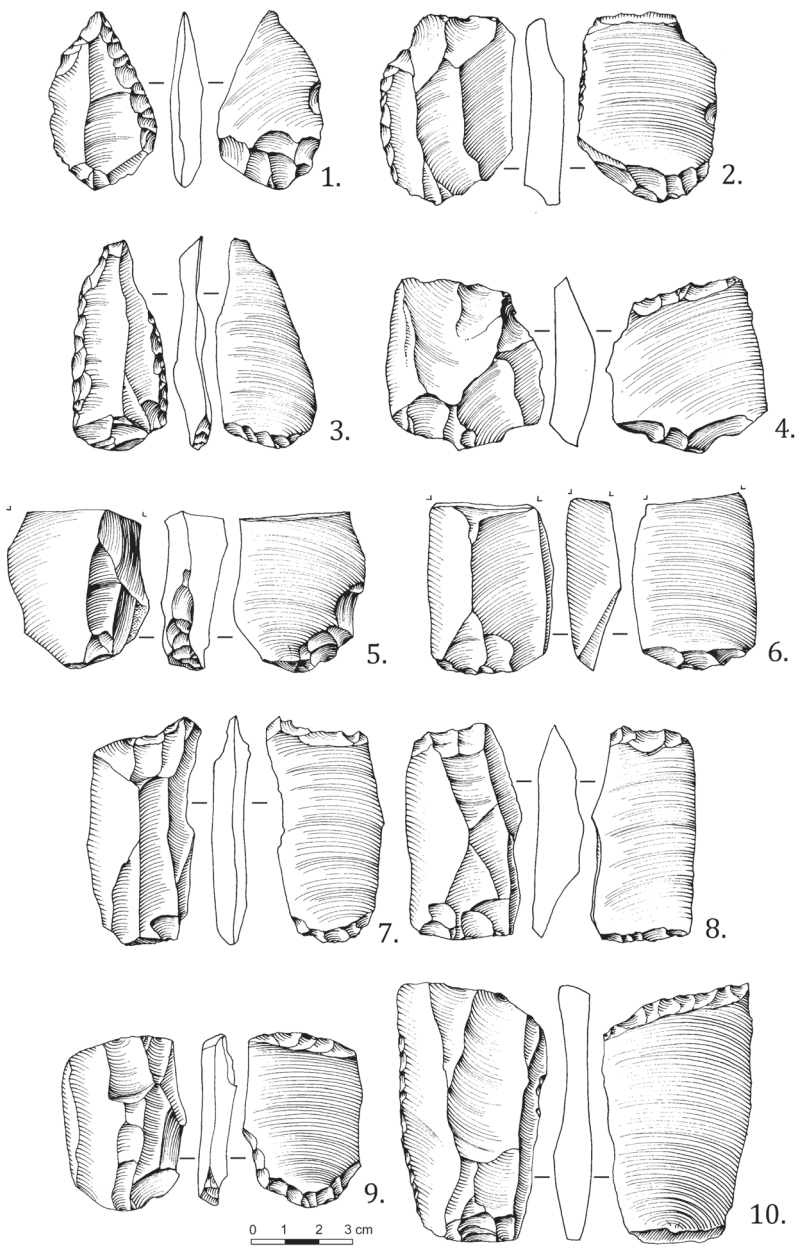


Figure 224: Obi-Rakhmat. Blanks with truncation and/or inverse retouch. 1. stratum 18; 2-4, 6, 8-10. stratum 19; 5. stratum 21; 7. stratum 17. (drawings by Paquay and Otte)

sometimes display a posterior crest or the remains of an antero-lateral crest. Some specimens clearly document volumetric and semi-turning reduction and are rather close to wedge-shape forms (Figure 225). All stages of the reduction sequence are represented, including blanks, rejuvenation blanks, overshot, and core tablets (Figure 226). Of note is the presence of a single retouched small blank, namely a backed bladelet with direct abrupt retouch along the left edge (Figure 226: 7). The retouch is continuous but

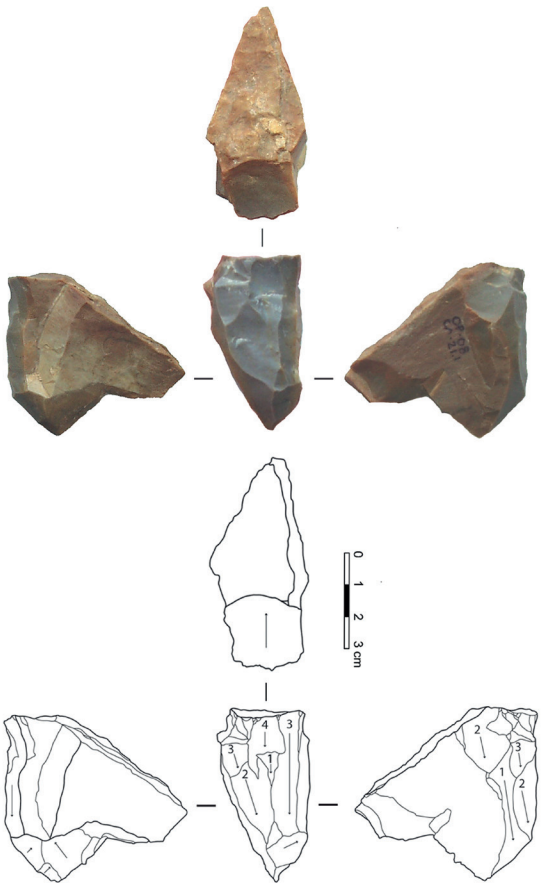


Figure 225 : Obi-Rakhmat, stratum 21, bladelet core from 2008 excavation

the proximal left end is still unretouched. Along with this technological set a small hammer stone (sandstone?) was found that displays traces of percussions on both narrow ends (Figure 226: 5). The absence of abrasion on the platform external edges does not contradict an association between hard hammer and bladelet reduction; however, platforms are mainly plain and are sometimes very small.

To summarize, the Obi-Rakhmat site is characterized by a long sequence of human occupation that probably corresponds to repeated use of the site as a hunting camp (Wrinn, 2004; Mallol *et al.*, 2009). According to previous studies, blade reduction and knapping activities took place primarily outside of the site judging by the reduced number of cores and the high frequency of retouched tools. While it has been argued that Obi-Rakhmat represents a gradual evolution toward UP technology (Derevianko, 2001; Derevianko *et al.*, 2001; Krivoshapkin and Brantingham, 2004; Krivoshapkin *et al.*, 2007), it appears that the main technological and typological features remain the same throughout the whole sequence. Some authors have suggested that it could represent laminar MP assemblage (Vishnyatsky, 2004) With respect to the sample size and to the occupation intensity, differences might be subtle and their interpretation would require a detailed technological attribute analysis. Nevertheless, the assemblage illustrates a coexistence of parallel edge and convergent blades produced mostly by unidirectional convergent reduction. Blades with parallel edges can easily be produced from narrow-faced cores and some of the Levallois laminar points may have been

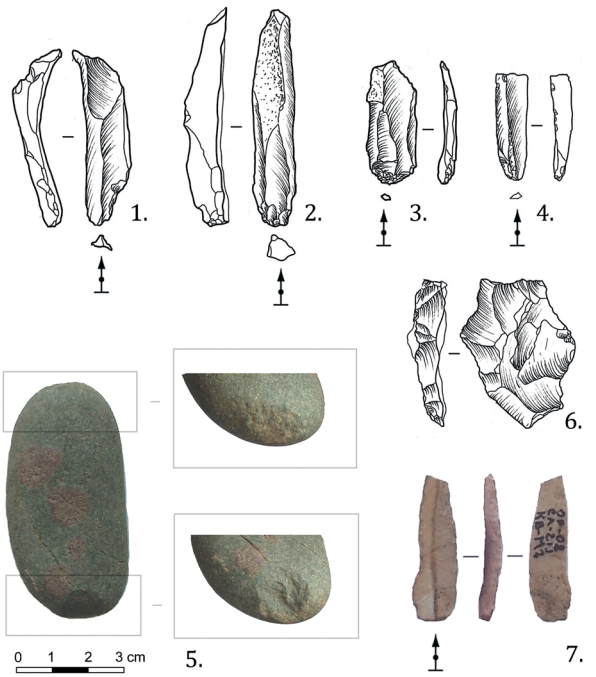


Figure 226: Obi-Rakhmat, layer 21, bladelet technology form 2008 excavation. 1, 2. Burin spall-like blanks; 3. flaking surface management flake; 5. hammer stone; 6. core tablet; 7. backed bladelet (drawings by Vavilina and Zwyns).

detached from somewhat larger flaking surfaces. Small laminar blanks are produced in various ways, including BC, burin-like cores, cores on flake edges and truncated-facetted pieces. It is noted that UP core forms occur starting in the lowermost archeological levels. The presence of all elements of the reduction sequence is exceptional and no matter whether the long or short chronology is considered, these are among the oldest examples of the kind in Central Asia and are associated with Neandertals.

Dodekatym II

The site of Dodekatym II is located along the Paltau River, circa 3 km upstream from Obi-Rakhmat. The site is located along the edge of a small plateau in a mountain depression (Figure 227).

It was excavated between 2005 and 2010 by an international team under the field direction of Krivoshapkin (Krivoshapkin *et al.*, 2005; Derevianko *et al.*,



Figure 227: Dodekatym II, view from the Paltau valley

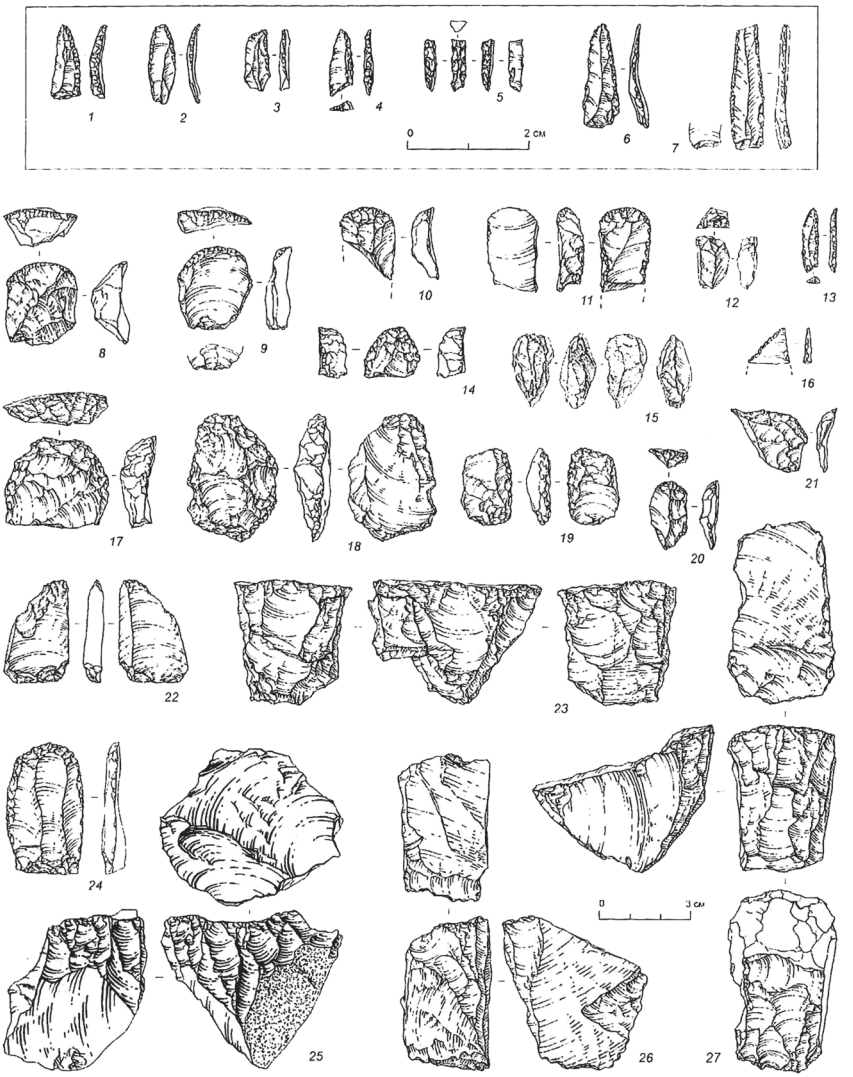


Figure 228: Dodekatym II, lithic assemblage (after Derevianko *et al.*, 2010)

2010; Kolobova *et al.*, 2011). The site has yielded a sequence of five archeological layers over an excavated surface of less than 10 m². The main concentrations are in layers 2, 4 and 5. Layer 4 has yielded AMS radiocarbon dates of 23,800 ± 190 ^{14}C BP (AA-69073) and 21,850 ± 180 ^{14}C BP (AA-69074) on charcoal and 23,600 ± 330 ^{14}C BP (AA-69075) on a bone sample. The fauna is badly preserved, and almost no identifiable bones have been recovered.

The lithic assemblages are similar across the sequence (Figure 228). Blades specimens are of medium/small size, with plain and small platforms, and unidirectional dorsal patterning. Thin abrasion is observed on the external edge of the platform, and the technique of percussion is likely organic hammer. Small wedge-shape prismatic cores testify to the production of bladelets and microblades (Zwyns and Flas, 2010). The obtained blanks have bilateral or lateral thin retouch, with some rare example of an inverse notch on the proximal end. In addition, layer

2 has yielded a series of geometric microliths with mainly scalene triangles (Derevianko *et al.*, 2010). A few of them are also reported in layer 4. Small endscrapers and splintered pieces are also typical of these assemblages. The Dodekatym II assemblages are similar to layers 2.1 and 2.2 of Kulbulak (Derevianko *et al.*, 2010).

Little is known about the north and central Tian-Shan where almost exclusively surface collections have been located (Salamat-Bulak, Tossor, Georgievsky Bugor) (Vishnyatsky, 1999).

8.1.5 KAZAKHSTAN

As noted by Vishnyatsky (1999), Kazakhstan is relatively rich in sites, but they are mainly poorly studied surface collections. In the region between the southern border of Kazakhstan and the Karatau range, small assemblages from surface collections (Borykazgan, Tanirkazgan, Akkol, Kemer I-III, Tokaly I-III) are attributed to Acheulean although they lack of genuine handaxes (Alpysbaev, 1979; Derevianko *et al.*, 1998; Vishnyatsky, 1999). MP sites are mentioned in the Chimkent province, with the Koshkurgan I and Shotkas I sites. These sites are located in a spring environment described as an artesian well surrounded by travertines. Three bone samples from Koshkurgan I dated by EPR have yielded ages of 501 ± 23 ka, 487 ± 20 ka and 427 ± 48 ka (Derevianko *et al.*, 1998). Although lithic assemblages are said to belong to the Mousterian with very few or no blades, a BC-like artifact made on what appears to be a thick laminar blank is illustrated (Artykhova, 1994, Fig. 6, num 17).

The site of Karasu is one of the few stratified sites with cultural horizons yielding flake-based assemblages, some with carinated endscrapers, and it has a direct date of 24,800 BP ± 1,100 (no lab number) for the upper layer (Taimagambetov and Aubekerov, 1996; Vishnyatsky, 1999, 2004).

In central Kazakhstan, the Tuemainak I collection is classified by Voloshin (1990) as ranging from the Mousterian to the UP, and the toolkit includes leaf-points (Voloshin, 1990; Vishnyatsky, 1999). Handaxes are reported in various locations, along the southern shore of Lake Tengiz or near Djezkazgan, in central Kazakhstan. In the northeast, LP, MP and UP artifacts are reported along the Ishim River and from the Irtish River, near Pavlodar or Ekibastuz. In the east, so-called Late Acheulean sites such as Semizbugu are mentioned along the northern and western shore of the Lake Balkash with the presence of handaxes (Derevianko *et al.*, 1993; Deom *et al.*, 2010) .

In the southeast, about 40 km from the city of Almaty, the site of Maybulak is one of the rare stratified sites attributed to UP (Taimagambetov, 2009; Deom *et al.*, 2010). Three main cultural horizons are described. The lowermost third horizon includes remains of fire and burned artifacts. The lithic assemblage (N=1,029) is characterized by the presence of microblades (N=84) and thick endscrapers are also reported (N=13). The assemblage of the second horizon (N=930) includes Levallois-like elements and prismatic cores. Thick endscrapers (N=8) and microblades (N=14) are mentioned. These assemblages show an association of Levallois elements and microblade production likely from carinated endscrapers (Taimagambetov, 2009, Fig.1 and 2). A radiocarbon date of 34,970 ± 665 has been obtained on cultural horizon 3 and of 30,062 ± 415 ^{14}C BP (?), 29,116 ± 329 ^{14}C BP (?) and 27,880 ± 280 ^{14}C BP (?) from horizon 2. A date of 24,330 ± 190 ^{14}C BP (?) was obtained on horizon 1, which presents a similar assemblage partly destroyed by a Bronze Age occupation. These dates are presumably uncalibrated ages, but the nature of the samples and the laboratory where they have been dated are not reported.

Chlachula (2010) recently reported surface finds from the Zaisan basin, in eastern Kazakhstan. Artifacts were collected from a gravel formation and attributed to eroded early Pleistocene surfaces. The Narym site would be one of the earliest evidence of human occupation. It consists of a few artifacts spotted in a colluvium deposit on the top of the Bukhtarma terrace. Artifacts are said to be flakes produced by hard-hammer percussion and bear a strong wind polish. This collection is assigned to the Middle Pleistocene (Chlachula, 2010).

Some of the surface collections found in the Kazakh steppe, such as Camp Lake site, yielded laminar artifacts. The Dzhambul and the Bere'l sites are located at the top of colluvial deposits and under a loess cover. The artifacts show UP features and are tentatively attributed to the final Paleolithic (Chlachula, 2010).

8.2 SIBERIA

A selective overview of the Paleolithic record is proposed for western and eastern Siberia. As previously stated, this summary focuses mainly on MP and UP sites that are relevant in the frame of this study. Less attention will be paid to the LP and post-LGM UP.

8.2.1 WESTERN SIBERIA

Western Siberia is a vast plain where the maximum elevation is circa 200 m asl. It is bordered by the Russian plain and the Ural range to the west, the steppe from Kazakhstan to the south, the Siberian mountain range in southeast and the Yenissei River in the east (Figure 211: 3). Starting with the discovery of the Tomskaya site in 1896, western Siberia now includes more than 30 Paleolithic localities. This number is rather small when one considers the region corresponds to an area of about 3 million km² and represents a third of Siberia.

The Byisk site is located along the Biya River in the Ob river basin. It is a stratified site and artifacts have been collected from a sandy gravel deposit underneath a succession of four loess and three paleo-soil formations. The cultural horizon is at a depth of 20 m into a 50 m thick loess section. The upper part of the loess reflects climatic fluctuations of the late Pleistocene (Evans *et al.*, 2003). These artifacts are strong evidence of human occupation prior to OIS4 (Chlachula, 2010). In the plain north of the Altai, numerous Mousterian sites (Gora Kukushka, Ust-Mashinka 3, Davidovka 1, Ust-Berezovka 3 and Ust-Boutochnyi 2) are reported (Kungurov, 2002), although none of them have been fully published yet.

In the Chulym basin, the Aryshevskoe 1 site is a workshop that is characterized by radial, convergent and parallel flaking with a toolkit mostly composed of sidescrapers, denticulates and notch tools. UP types are almost absent although artifacts with burin spall negatives are mentioned (Zenin, 2002). Radiocarbon dates were obtained on humic soil samples from the lowermost cultural layer and yielded minimum ages of 40 ka ^{14}C BP (SOAN-4178; SOAN-4179). A younger date of 33,630 ± 995 ^{14}C BP (SOAN-4180) was obtained on a charcoal sample collected in the upper layer. The assemblage is tentatively considered as MP (Zenin, 2002).

The Voronino-Yaya site is attributed to the Late Pleistocene, and a minimum age is provided a by a radiocarbon date of 28,450 ± 850 ^{14}C BP (SOAN-3837) obtained on a bone sample from the overlying horizon. The assemblage is composed of a few quartzite sandstone artifacts (Zenin, 2002).

The open-air site of Malaya Sya is also located in the Chulym river basin in the Krasnoyarsk krai. The site was discovered by Ovodov in 1974 and was excavated by Ovodov an Okladnikov in 1975 (Muratov and Ovodov, 1982). Subsequent excavations by Larichev are only partially published (Goebel, 1994, 2004). The stratigraphy is divided into five layers: layer 1 is the modern soil, layer 2 is a thick pack of loess with cryogenic wedges, layer 3 is laminated clay matrix with traces of re-deposited soil and layer 4 is a clear paleo-soil formed on a gley. The latter marks the top of a thick accumulation of loess from layer 5. A single archeological level is associated with the paleo-soil from layer 4. The available radiocarbon dates for this layer are 20,370 ± 340 ^{14}C BP (SOAN-1124), 34,500 ± 450 ^{14}C BP (SOAN-1286), 34, 420 ± 360 ^{14}C BP (SOAN-1287) and 29,450 ± 420 ^{14}C BP (AA-8876) (Muratov and Ovodov, 1982; Larichev *et al.*, 1988; Larichev and Khol'ushkine, 1992; Goebel, 1994, 2004). The first and the last dates (SOAN-1124, AA-8876) have been obtained on samples collected by Ovodov. The first one is from a charcoal sample from a disturbed area (Larichev *et al.*, 1988), and the second one is a bone dated by Goebel (1994, 2004). As pointed out by Goebel (1994), there is a disagreement between Larichev and other authors regarding the SOAN-1287 date as Larichev reports a date of 33,060 ± 300 ^{14}C BP (Larichev *et al.*, 1988; Larichev and Khol'ushkine, 1992). The reduction system

includes radial and Levallois flake cores and flat-faced bidirectional blade cores. According to Goebel (1994), most of the cores are simple unidirectional flake cores and most of the tools bear irregular or unidirectional dorsal patterning. The high frequency of cores and the low frequency of tools suggest rather expedient technology. Some authors, however, have interpreted the association of flake cores with blade blanks as illustrating a genuine UP technology resulting from a local transition (Larichev *et al.*, 1988; Otte and Derevianko, 1996). Bone and antler tools such as points or *retouchoir* are part of the toolkit (Goebel, 2004). Mobile art on a lithic flake or on tools is reported by Larichev *et al.*, (Larichev, 1978; Larichev *et al.*, 1988) including a fragmented stone pendant originally published by Okladnikov and Kirilov (Okladnikov and Kirilov, 1980). The objects are supposed to be shaped as animals, such as mammoth, eagle or tortoise, and some of them are also interpreted as instruments for paleo-astronomical observations. (Larichev *et al.*, 1988) These intepretations are controversial and, according to Goebel (2004), none of the described specimens are undisputable. According to the published material, Malaya Sya is difficult to characterize. It appears close to the Altai EUP but lacks many of the diagnostic technological elements, such as the microblade cores and blanks.

Most of the other sites, such as Gari, Lugovskoe, Shikaevka II, Novyi Tartas, Vengerovo 5, Mogoshino I, Chernoozerie II, Volchia Griva or Tomskaya, are attributed to the Sartan period (OIS2) (Derevianko, Shimkin, *et al.*, 1998; Zenin, 2002). A few of them are relevant for the discussion as they slightly overlap with the EUP technology from the Altai sites. Achinskaya is located near the city of Achinsk and documents a single cultural horizon containing a lithic assemblage, combustion features and fauna (horse, mammoth, saiga, wolf, polar fox and various birds). Although most of the cores are exhausted, wedge-shaped, discoidal and conical forms were recognized. Among the endscrapers, simple and double carinated forms are the most numerous (Anikovich, 1976), and Dufour bladelets are present (Abramova, 1984; Larichev *et al.*, 1988). A carved mammoth ivory baton with spiral decorations is associated with the assemblage (Larichev *et al.*, 1988). Achinskaya remains undated but it is generally assumed that it is posterior to the LGM (Larichev *et al.*, 1988; Derevianko, Shimkin, *et al.*, 1998; Zenin, 2002). From a techno-typological point of view, these asemblages seem to overlap with the Altai EUP.

The Shestakovo site is located along the Kiya River, a tributary of the Chulym River. The stratigraphy is divided into 25 lithostratigraphic layers that include 13 cultural horizons belonging to the Late Pleistocene and to the Holocene. Following Zenin description (2002), the lowest cultural layer, OH8, lies in the loess sediment of the stratum 24. Radiocarbon dates are 24,590 ± 110 ^{14}C BP (GrA-13329) on a horse bone and 25,660 ± 200 ^{14}C BP (GrA-13328) on a mammoth bone. Only two artifacts were recovered from this horizon: a reduced prismatic core and a blade with a straight back opposed to a crescent-shape edge. Horizon 7a corresponds to layer 22. Radiocarbon dates on mammoth bones are 22,400 ± 185 ^{14}C BP (SOAN-3612), 22,290 ± 125 ^{14}C BP (SOAN-1380), 22,500 ± 280 ^{14}C BP (SOAN-4177), 22,750 ± 160 ^{14}C BP (GrA-15880), 22,990 ± 170 ^{14}C BP (SOAN-1386), and 23,330 ± 110 ^{14}C BP (GrA-13325). The uppermost part of the layer has been washed out and is dated to 21,300 ± 420 ^{14}C BP (SOAN-3611). The associated artifacts (N=233) include carinated forms, a wedge-shaped core, microblades, bladelets and blades. This assemblage has been compared to the Altai EUP from UK1-2 (Zenin, 2002). The horizon 6 has yielded similar dates ranging between 23.5 and 20 ka ^{14}C BP produced on mammoth, reindeer and horse bones. A larger lithic assemblage (N=1,449) includes a series of asymmetric segments (N=49) with a retouched straight back opposed to crescent-shape edge. The distal part sometimes bears an oblique truncation (Zenin, 2002).

Although dated to circa 15 ka ^{14}C BP, the Chernoozerie II site is worth mentioning. It illustrates the association of Dufour bladelets with composite tools, such as grooved bone spear points with hafted lateral microliths. Carinated endscrapers are also mentioned although this assemblage seems more oriented toward pressure flaking (Derevianko, Shimkin, *et al.*, 1998).

8.2.2 CENTRAL SIBERIA

The Yenissei basin displays one of the richest concentrations of Paleolithic sites in Siberia (Figure 211: 4). Most of them are located along the left bank of the Yenissei River and can be grouped into three main clusters. The first group is located around the city of Krasnoyarsk. Afontova Gora (I-IV), Druzhinika, Korovii-log (I-III), and Kacha I-III belong to the Sartan period (OIS2) with the earliest dates around 23 ka ^{14}C BP (*e.g.* Kurtak IV) (Vasil'ev, 1992; Graf, 2009a) and are assigned to the final UP of Afontova Gora type. The second cluster is located to the south in the Minoussinsk depression and includes sites such as Tarachikha, Schlenka, Kokorevo-I-VI, Afanaseva Gora, Kurtak (I-VI), Novoselovo (I-XIII), etc. They mainly belong to the final UP Kokorevo tradition although some seem to predate the LGM (*e.g.* Tarachikha, Schlenka) (Larichev *et al.*, 1988; Vasil'ev, 1992; Astakhov *et al.*, 1993; Graf, 2009a, 2009b). The third group is located further south and to the north of the west Sayan range. Sites such as Oznachennoe I, Bolshoi Karak, Maininskii Lesozavod, Maina, Ui (I-II), Sizaya (I-XVI), Golubaya (I-VIII), Dzhoi, and Kantegir also belong to the Sartan period (Vasil'ev, 1992, 1993; Vasil'ev and Semenov, 1993; Vasil'ev *et al.*, 2002; Kuzmin, 2008).

The earliest phases of human occupation are poorly known. Only a few lithics are mentioned at Kashtanka by Drozdov and Chekha (2003) from a cryoturbated and re-deposited layer with radiocarbon dates between 32 and 29 ka ^{14}C BP (Drozdov and Chekha, 2003). The Kurtak IV UP assemblage is dated to between 24-23 ka (Vasil'ev, 1993; Drozdov and Chekha, 2003; Graf, 2009a). The site of Kamennyi Log has yielded radiocarbon dates from combustion features providing an age between 34-31 ka ^{14}C BP (Drozdov and Chekha, 2003). MP artifacts with Levallois features are reported from the Kamennyi Log II (section 9-11, excavation 2-4), Berezhekovo sites (excavation 1-2) and at Verkhnyii Kamen. At Ust-Izhul (site 1), artifacts are associates with dates of >42,190 ^{14}C BP (AECV-2034C), obtained on dispersed charcoal samples, >40,050 ^{14}C BP (AECV-2033C) and >41,810 ^{14}C BP (AECV-2032C) on charcoal sample collected from two distinct combustion features, and a mammoth bone yielded a date of > 42,100 ^{14}C BP(AECV-1939c) (Drozdov *et al.*, 1999). The human occupation is bracketed by luminescence dates, with a date of 125 ± 5 ka BP obtained on the pedogenic matrix and a date of 105 ± 10 ka BP obtained on the overlying silty/clay sediments (Chlachula *et al.*, 2003). The lithic assemblage is flake-based (N=53 *in situ* finds and N=220 including the artifacts found next to the excavation area), and some of the flakes have been refitted on cobbles. The fauna display occasionally human modifications, including flaked mammoth tusk, mammoth scapula with percussion traces and fractured deer bones (Chlachula *et al.*, 2003).

Dvuglazka Cave was discovered by Abramova in 1974 and was, for a long time, the only site illustrating pre-Sartan human occupation in the region (Abramova, 1981). Located 50 km from Abakan along a tributary of the Yenissei, the cave was excavated in 1975, 1978 and 1979 over a surface of 38 m². The 8 m thick stratigraphy is divided in 8 lithostratigraphic levels, with a small sample of (N=<100) Mousterian artifacts associated with layer 5-7 (Davis, 1998; Derevianko, Shimkin, *et al.*, 1998). The assemblage is classified as Levallois Mousterian with features such as Levallois points and Levallois blade cores, discoidal cores and retouched tools such as notches and sidescrapers (Davis, 1998; Derevianko, Shimkin, *et al.*, 1998). A single radiocarbon date of 27,200 ± 800 BP (LE-4811) is associated with layer 7 underneath the MP layer (Lisitsyn and Svezhentsev, 1997; Goebel, 2004), and a date of 26, 580 ± 520 (LE-4808) was obtained on a bone samples from layer 4 associated with the UP (Lisitsyn, 2000). Three additional dates on bone sample are available, but they are without provenience and with a single lab number (single sample?) (LE-1333): 22,500 ± 600 ^{14}C BP, 20,190 ± 140 ^{14}C BP, and 19,880 ± 200 ^{14}C BP (Arslanov *et al.*, 1981; Vasil'ev *et al.*, 2002). Given these young ages, additional data on the deposition processes are needed.

Among the sites known in the Tuva region, Late UP and EUP artifacts have been reported from the Sagliy locality. Massive blades are described at Mugur, carinated endscrapers and flat-faced bidirectional cores are found associated with bone awls in Kantegir I, layer 4i. Pressure flaking microblade technology is

well documented among these assemblages. MP 'of the pebble tradition' is defined by S. N. Astakhov (1986), however, most of these sites are surface collections and none of them sites has been dated (Astakhov, 1986).

8.2.3 CIS-BAIKAL

The Cis-Baikal area corresponds to the western shore of the lake Baikal (Figure 211: 4). Numerous sites have been reported in this region, some being relevant for comparisons with the Altai material. The present review focuses on the sites of Makarovo IV and Arembovsky. Malta (Gerasimov, 1958; Cauwe *et al.*, 1996; Medvedev *et al.*, 1996) and related sites (*e.g.* Buret, Ust-Kova) belong to the Sartan period (Vasil'ev *et al.*, 2002) and will not be discussed here. It is, however, interesting to mention the presence of archaic technological features at Malta. Small and mainly unidirectional flat-faced cores, discoidal cores, or even isolated BC-like cores (mode C3 of Kimura's classification) occur in the variability of the laminar reduction (Kimura, 2003). Medvedev observed a comparable polish (see below) as on the Makarovo IV artifacts (Derevianko, Shimkin, *et al.*, 1998) and suggests that older artifacts would have been brought to the site by humans (N=48). During the 1995-1997 excavations of the Russo-Belgian collaboration (Cauwe *et al.*, 1996; Medvedev *et al.*, 1996), the lowest cultural layer has yielded dates circa 39 ka but cryogenic disturbances were observed throughout all 5 archeological layers (Cauwe, personal communication) underlining the need for further taphonomic studies.

Makarovo IV

The Makarovo complex refers to a cluster of six sites located on the Upper Lena River near the village of Kachug. This region has been studied intensively since the second half of the last century (*e.g.* Okladnikov, 1953; Aksenov, 1970, 1978; Medvedev *et al.*, 1990; Goebel, 1994, 2004; Goebel and Aksenov, 1995; Sitlivy-Escutenaire and Sitlivy, 1996). The site of Makarovo IV was discovered in 1975 by Aksenov and excavated over a surface of more than 1100 m² until 1982 (Goebel, 2004). The stratigraphy is divided into 4 sedimentary units (Vorobieva, 1987; Goebel and Aksenov, 1995) (Figure 229). The lithic assemblage (N=4,119) is derived from stratigraphic sub-unit 3a, a 5-10 cm thick horizon of sand and rock debris (Goebel and Aksenov, 1995). The underlying sub-unit 3b is composed of compact loess containing a paleo-soil in its upper part. The unit 2 is an alternation of cemented loess and sands and is crossed in some parts by deep ice-wedges. Unit 1 includes a paleo-soil that may represent the Holocene and a modern surface. Sub-unit 3a is considered as a strongly deflated surface with sediment grain-size sorting. The polish observed on artifacts and fauna is associated with sand abrasion caused by exposure to intense and strong wind (Goebel and Aksenov, 1995; Derevianko, Shimkin, *et al.*, 1998).

Unit 2 is interpreted as Sartan deposits (OIS2) and the cryogenic features are assigned to the LGM. Tseitlin (1979) and Vorobieva (1987) suggest that strong eolian processes are likely associated with a glacial phase during OIS4. According to Medvedev (*e.g.* in Derevianko, Shimkin, *et al.*, 1998), the sand blast occurs during the middle Zyriansk period, and frost-cracks from unit 2 should pre-date the Sartan period. He argues that the Makarovo 4 assemblage is circa 20 ka older than other known UP sites. Aksenov pointeds out that the unit 3 cold snap may have occurred during OIS3 (Goebel and Aksenov, 1995). Three radiocarbon dates have been obtained on bone samples collected from unit 3a, and although having a well-preserved collagen, provided a minimum age of 39 ka ^{14}C BP (Goebel and Aksenov, 1995). The fauna associated with the assemblage (N=509) includes *Coelodonta antiquitatis, Cervus elaphus,* and *Capreolus sp.* Although the presence of woolly rhino would indicate a cold phase, its association with the human presence is not clear given the taphonomy of the layer.

Vorobieva and Aksenov (1990) suggest the coexistence of radial, sub-parallel and parallel reduction and the existence of Levallois-Mousterian features. Their sample includes a large number of cores (N=133) and blanks (N=>3,000). Based on a smaller sample of tools (N=280) and cores (N=45), Goebel (1994; 2004) describes the technology as a production of

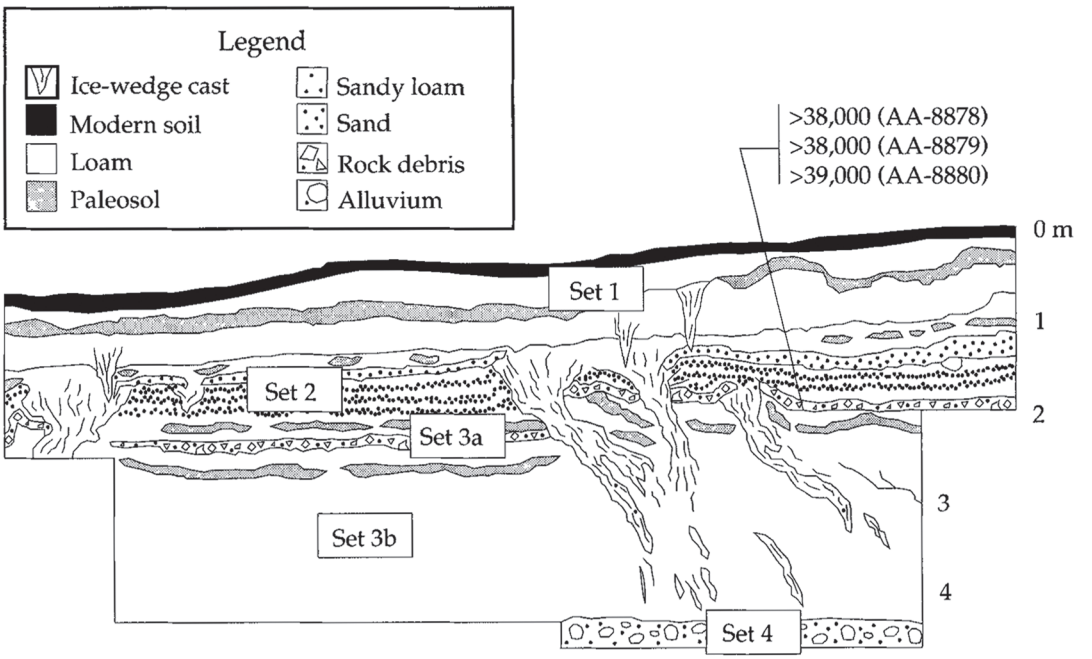


Figure 229: Makarovo IV, section and dates (after Goebel and Aksenov, 1995)

elongated spalls and blades from uni- (N=16) and bidirectional (N=14) flat-faced cores and from unidirectional sub-prismatic cores (N=6). Flake production is also represented by mono-frontal cores (N=5). Facetted and dihedral platforms co-exist with a majority of plain platforms, and it seems that unidirectional dorsal pattern dominates. Goebel (1994), however, acknowledges the difficulty of reading the direction of the scars and to identify retouch due to the sand blasted polish.

Sitlivy-Escutenaire and Sitlivy (1996) worked on large sample comparable to the one use by Vorobieva and Aksenov. They argue that the main activity taking place at the site is lithic reduction based on the low frequency of tools. They describe a coexistence of two main technological systems related to flake and blade production. For the blade production, the core performs are unidirectional and volumetric and the flaking surface is located on the narrow side of the core. As reduction continues, the flaking surface shifts to the broad face. The core reduction ends with a sub-volumetric form. They note that there was no preparation of the flaking surface prior to the reduction, the latter using the natural convexity of the pebble surface. Although crested blades are rare, some *débordant* blades are associated with a sub-volumetric approach 'close to Rocourt-type', as described by Cahen (1984), Otte (1990), Chabay and Sitlivy (1993) or Boëda (1990). It is noted that on the illustrated material, some cores show mainly removals on a single narrow face in addition to a broad one (*e.g.* Sitlivy-Escutenaire and Sitlivy, 1996, Fig. 1), suggesting the presence of a 'Roc-de-Combe method' (Boëda, 1990) analogous to the Altai IUP system. 'Microlithic cores' are reported as infrequent elements, with a flaking surface located on a narrow side of pebble blanks (Sitlivy-Escutenaire and Sitlivy, 1996). These cores have bidirectional removals and have a BC morphology (*e.g.* Sitlivy-Escutenaire and Sitlivy, 1996, Fig. 4 num. 4). The second technological system consists of slicing pebbles producing more opportunistic flakes with cortical backs ('citrus flakes'). Lateral preparation of the core is rare and may be confused with radial cores. So according to these authors, there is convincing evidence of Levallois technology although the Makorovo IV laminar technology described by Sitlivy-

Escutenaire and Sitlivy (1996) appears very similar to Altai IUP blade technology.

According to Rybin (2000), some typological markers of the Altai IUP are also present. Small points with continuous bilateral retouch or some retouched blade fragments displaying proximal inverse and direct retouch (*e.g.* Goebel and Aksenov, 1995, Fig. 3, s-t), similar to Kara-Bom, UK1-1, Kara-Tenesh, or Maloyalomenskaya Cave specimens, are present. Some appear close to the truncated-facetted type, such as in Kara-Tenesh or Kara-Bom (*e.g.* Goebel and Aksenov, 1995, Fig. 3, q).

To summarize, Makarovo IV appears technologically, typologically, and maybe chronologically analogous to the Altai IUP. Other sites of the region, such as Shishkino VIII, Sosnovyy Bor (Horizon VI), Melikithui II or Cheriomushnik are said to belong to the same tradition, known as the 'Makarovo stratum' (Derevianko, Shimkin, *et al.*, 1998).

Arembovsky

Arembovsky was discovered in 1938 by an instructor from Irkutsk who gave his name to the site. It is located in the outskirt of the city of Irkutsk, on a terrace of the Angara River and near a raw material outcrop. Between 1947-1949, material was collected from the surface until a rescue excavation was organized in 1989 (Semin *et al.*, 1990; Goebel, 1994). As described by Medvedev et and colleagues (Medvedev *et al.*, 1990), the stratigraphy includes a main cultural horizon within the first meter of sediments, in layer 2. Goebel (1994) describes it as a 'massively bedded loam' matrix. Artifacts mentioned in the underlying level 3 are presumably intrusive due to various cryogenic disturbances. Although it is attributed to the Karginian period (OIS3), no direct dates could be obtained.

Due to this problematic context, only general trends of the assemblage (N=>10,000) are considered. Vorobieva and Aksenov (1990) mention the presence of bidirectional cores with facetted platforms, convergent cores and cores with irregular removals. Goebel (2004) mentions a majority of flat-faced blade cores with radial flake cores. Blades with mainly plain platforms are produced with a tool kit rich in retouched blades (Goebel, 1994). Sitlivy-Escutenaire and Sitlivy (1996) classify the collection into three main reduction types. The first one is classic Levallois, producing irregular flakes, represented by a few cores and flakes. The second is Levallois lineal recurrent, also called 'Biache method' (Chabay and Sitlivy, 1993). What characterizes it is the radial preparation of the core that needs to be reproduced after that the recurrent removals flattened the convexities. This method is said to be used following the longitudinal axis of the core to produce blades or transversally to produce flakes. The third one is said to be similar to the so-called 'Rocourt method' (Cahen, 1984; Otte, 1990, 1994; Otte *et al.*, 1990). It is described as starting from a narrow end and extending toward the broad face, and it shows successive re-preparation and reduction (Sitlivy-Escutenaire and Sitlivy, 1996). This method is oriented toward the production of long blades. No crested blades have been found, and the authors conclude that UP technology is absent. They also acknowledge that the Biache and Rocourt methods are highly similar but that in Europe their coexistence in a given assemblage is unusual. The three described methods are also found in combinations in the Altai, in IUP context, but with frequent crested and convergent elements. Tools are not very diagnostic nor numerous, the fauna is almost absent and no combustion features have been discovered. This assemblage is interpreted as a workshop (Goebel, 2004).

Technological differences between the early and subsequent phases of UP have been underlined by Generalov and Sitlivy (1999) based on a comparison of layers VI and V from Sosnoyi Bor. The layer VI is assumed to be part of the Makarovo stratum and to represent the oldest UP in the area. The layer VI assemblage (N=488) is characterized by flake production from quartzite pebbles, by slicing, or by diagonal removals with or without platform preparations. The latter is more oriented on the removal of elongated flake blanks. Blades are fragmented and due to the absence of cores, their production is not well documented. Bifacial pieces are interpreted as either core preforms or tools. The presence of a Dufour bladelet, (Generalov and Sitlivy, 1999: Fig. 2, num 14, num.

9) and of a BC-like burin is notable (Generalov and Sitlivy, 1999: Fig. 2, num 14). The layer V assemblage appears quite different as different stages of preparation and reduction of 'cuneiform' and wedge-shaped cores are documented, along with some flat-faced Levallois-like blade cores. These two assemblages are interpreted as unique and do not find clear analogies in the region. Layer VI is reported as heavily reworked, and Tseitlin (1979) evaluates that the sedimentation took place between 19-16 ka ^{14}C BP. Other authors propose assigning layer VI to OIS4 (Vorobieva and Medvedev, 1984). As noted by Goebel (1994), the age of the lower layers remains uncertain since, they have not been directly dated. The overlying layers IIIb and 4 are dated with bone samples. A conventional date of 12,060 ± 120 ^{14}C BP (GIN-5328) (Vorobieva, 1991) was obtained for layer IIIb, and an AMS date of 12,090 ± 110 ^{14}C BP (AA-38038) is associated with layer IV (Vasil'ev *et al.*, 2002).

8.2.4 TRANS-BAIKAL

The Trans-Baikal area starts from the eastern shore of lake Baikal and extends eastward (Figure 211: 5). Sites are mainly located between the cities of Ulan-Ude and Chita, in the lower Selenga basin. The region is rich in Paleolithic sites and only some the most relevant sites, such as Tolbaga, Podzvonkaya, Varvarina Gora, and Kamenka are described in the following section.

Kamenka

The site of Kamenka is located 60 km southeast of Ulan-Ude. It is in the Selenga river basin and the Bryanka river valley. Like other UP sites in the area, it lies on a relatively high topographic relief, the Kamenka hill. Kamenka was excavated by Lbova between 1990 and 1995 (Lbova, 1996a). She divided the stratigraphy is divided in 7 layers (Lbova, 1996a, 1999), with layers 1-3 associated with Holocene and modern soil and layers 4-7 associated with the Pleistocene. Two cultural layers have been described within the lithostratigraphic layer 6, namely complexes A and B. The latter is described as a colluvial deposit composed of three sub-units, the lower one being in sandy-clay deposits with lenses of re-deposited paleo-soil, the middle one being a carbonate rich layer of clayey sand, and the upper one a brown sand with clay and gravels. Complexes A and B are associated respectively with the lower and the upper part of layer 6 and are separated by one meter of sterile sediment. Complex C was found during the 1992 campaign and is in similar stratigraphic position as complex A, although in a slightly different sand matrix (Germonpre and Lbova, 1996). Complex B conventional radiocarbon dates on bone samples are 28,815 ± 150 ^{14}C BP (SOAN-3032), 28,060 ± 475 ^{14}C BP (SOAN-2903), 28,000 ± 475 ^{14}C BP (SOAN-2903), 25,540 ± 300 ^{14}C BP (SOAN-3355) and 24,625 ± 190 ^{14}C BP (SOAN-3031). Kamenka complex A has yielded conventional dates on bone samples of 26,760 ±265 ^{14}C BP (SOAN-3353), 30,460 ± 430 ^{14}C BP (SOAN-3354), 35,845 ± 695 ^{14}C BP (SOAN-2904) and one AMS date of 40,500 ± 3,800 ^{14}C BP (AA-26743). In addition, a date 31,060 ± 530 (SOAN-3133) on a charcoal sample and a RTL date of 49,000 ± 6,000 (GN SOAN-340) are also available for the Complex A (Lbova *et al.*, 2010). Complex C has a single associated date of 30,220 ± 270 ^{14}C BP (SOAN-3052) (Lbova, 2000, 2008; Orlova *et al.*, 2005). Lbova (2000, 2008) notes that in spite of the observed discrepancy among the dates of Kamenka A-C, the expected age based on stratigraphic data is circa 35-40 ka ^{14}C BP.

The fauna as studied by Germonpre is mainly composed by Mongolian gazelles *(Procapra gutturosa)* and by horses *(Equus caballus)*. Both species bear traces of human activity and some of the bones are burned. Woolly rhinoceros fragments *(Coelodonta antiquitatis)* show a taphonomy that differs from the human accumulation with no cut-marks or breakage, suggesting that their presence is not directly linked with human activity but rather with carnivore activity. Seasonality is deduced from a few skeletal elements indicating that human occupations took place between mid-August and December in a dry steppe landscape (Germonpre and Lbova, 1996).

Although never fully published, the Kamenka A lithic assemblage (N=1328) (Buerachny and Lbova, 2000) is characterized by bidirectional mono-frontal blade

cores with some occasional sub-prismatic forms and a single Levallois flake core (Goebel, 2004). Large bidirectional blade blanks are retouched and sometimes pointed. Some pieces described as cores appear similar to BC (Lbova 2000, Fig. 17 num. 4). Neo-crested blades testify to lateral core management during the production of large blades (*e.g.* Lbova, 1999, Fig. 4, num. 6-8). Levallois-like convergent blades with facetted platforms, partial faceting or *débordant* faceting are part of the assemblage (*e.g.* Lbova, 1999, Fig. 4, num. 11,2, 4, 5, 13). Some of the convergent blanks bear bilateral direct retouch (*e.g.* Lbova, 1999, Fig. 4, num. 1, 2, 4). Bone tools have been described associated with the complex A, (Lbova, 1999) including chisels and awls, but also non-utilitarian objects (N=34) such as beads of stone and mammoth ivory and bone objects with parallel incisions (N=22) (Lbova 1999, 2000). In sum, this assemblage presents techno-typological similarities with the IUP and also includes a rich collection of bone tools and ornaments.

Podzvonkaya

The site of Podzvonkaya is located on the first terrace of the left bank of the Tamir River, a small tributary of the Selenga River. The topography of the site consists of a natural amphitheater formed by the hills and the valley. The site was excavated between 1991 and 2000 by Tashak with the collaboration of a Belgian team in 1993 (Cauwe *et al.*, 1993; Tashak, 2002, 2005). Several thousand square meters were excavated and the few publications available do not provide clear data regarding stratigraphic successions. Three main sectors were excavated. Sectors A, B and C and several units have been defined on stratigraphic basis but also on the basis of material concentrations. According to several authors, some of the artifact clusters are in secondary position, in slope deposits or in small channels (Cauwe *et al.*, 1993; Derevianko and Rybin, 2003). The oldest human occupation belongs to the so-called lower complex which has yielded radiocarbon AMS dates of 38,900 ± 3,300 ^{14}C BP (AA-26741) and >36,800 ^{14}C BP (AA-26742) on bone samples and conventional dates of 26,000 ± 1,000 ^{14}C BP (SOAN-3404) and

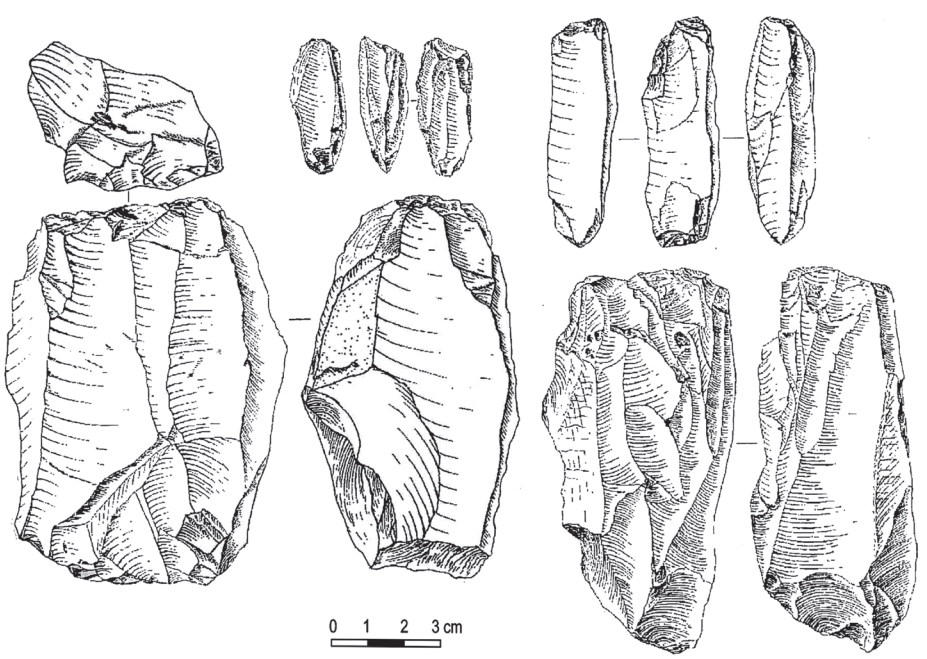


Figure 230: Podzvonkaya, cores (after Tashak, 2009)

22,675 ± 275 ^{14}C BP (SOAN-3350) on bone samples. Numerous ornaments were recovered from the eastern and southeastern units, including pendants made of ostrich eggshell (N=14), a stone pendant and a perforated mammal phalanx (Derevianko and Rybin, 2003). The raw material is relatively coarse-grained. The lithic technology is mainly oriented toward the production of wide and massive uni- and bidirectional blades from flat-faced cores, with the occasional use of crests and a high frequency of facetted platforms (Cauwe *et al.*, 1993; Tashak, 2009). The reduction likely starts from a narrow face and then expands onto a broad face. Crested and *débordant* blanks are removed from the corner between the two surfaces. Small cores are mentioned together with poorly standardized bladelets (Cauwe *et al.*, 1993; Tashak, 2007, 2009).

The illustrated material shows at least two typical BC on laminar blanks (Tashak, 2009) (Figure 230). The association of an IUP reduction system for large laminar blanks with a BC reduction system for small blade/bladelets is a technology diagnostic of the IUP. If confirmed, the available radiocarbon ages support this comparison. Taphonomic analysis and/or direct dates on the ostrich eggshells could be used to confirm the association between the ornaments and the IUP lithic assemblage.

Varvarina Gora

The site of Varvarina Gora is located along the left bank of the Bryanka River in colluvial deposits located at the foot of the Varvarina Mountain. The site was discovered in 1964 and excavated between 1973 and 1975 by Okladnikov (Okladnikov and Kirilov, 1980). The stratigraphy was revised starting in 1992 by Lbova who correlated the newly exposed profiles with the former excavations (Lbova, 1996b, 2000). The stratigraphy is 2 m thick and is described as a succession of reworked colluvial deposits (layers 2, 4) and aeolian sands and loam (layers 1, 3) (Goebel and Aksenov, 1995; Lbova, 2000; Goebel, 2004). Human occupation is associated with layer 3. Conventional radiocarbon dates of 34,900 ± 780 ^{14}C BP (SOAN-1524) and 30,600 ± 500 ^{14}C BP (SOAN-850) were obtained on bone samples associated with the human occupation during the early excavation (Bazarov *et al.*, 1982; Vasil'ev *et al.*, 2002). AMS dates were obtained on bison and wooly rhinoceros bone samples, yielding minimum ages of 35.5 ka (Goebel and Aksenov, 1995) (Figure 231). Two more conventional dates on bones are available for layers 2 and 1, with respectively 29,895 ± 1,790 ^{14}C BP (SOAN-3054) and 17,035 ± 400 ^{14}C BP (SOAN-3053) (Lbova, 1996b; Vasil'ev *et al.*, 2002).

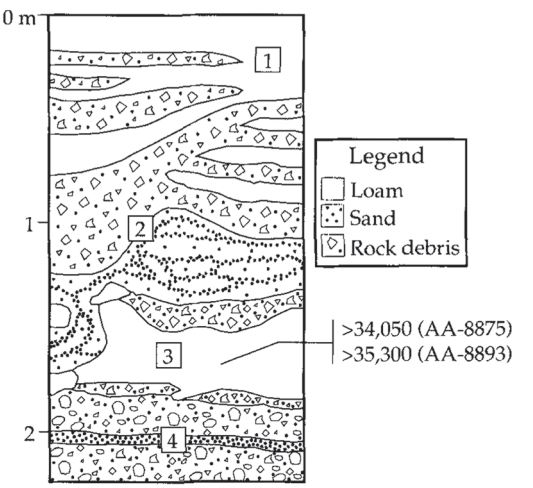


Figure 231: Varvarina Gora, section and dates (after Goebel and Aksenov, 1995)

As stressed by Goebel (*e.g.* 2004), the lithic assemblage (N=1,451) has never been published in detail. However, the main technological features described can be summarized as a coexistence of uni- or bidirectional flat-faced cores and sub-prismatic blade cores with the presence of Levallois flake cores (Lbova, 2000). Truncated-facetted pieces are present and some illustrated cores appear technologically similar to BC forms (Lbova, 2000, Fig. 35, num. 5, Fig. 34, num. 4). Formal bone tools such as awls (N=2), a *retouchoir*, and a tool made of ivory are associated with the assemblage, and a possible stone pendant is described (Goebel, 2004).

Tolbaga

The Tolbaga site is located not far from the eponymous village, on the top of hill, along the right bank of the Khilok River. The site was discovered and excavated by Konstantinov between 1972 and 1979 (624 m²) and by Vasiliev in 1985 and 1986 (340 m²). The cultural remains are associated with layer 4 and in a sandy-loam matrix. This layer is interpreted as a succession of quick slope-wash events. Bulk bone samples from the bottom of the overlying layer 3 have yielded a conventional date of 15,100 ± 520 ^{14}C BP (SOAN-810). Several unidentified bones collected during various excavations have a conventional date of 27,210 ± 300 ^{14}C BP (SOAN-1523), and a wooly rhinoceros bone from layer 4 has a conventional date of 34,860 ± 2,100 ^{14}C BP (SOAN-1522). An additional conventional date on a bone sample from stratum 4 is 26,900 ± 225 ^{14}C BP (SOAN-3078) (Sinitsyn *et al.*, 1997). Two more AMS dates 25,200 ± 260 ^{14}C BP (AA-8874) and 29,200 ± 1,000 ^{14}C BP (AA-26740), were produced on bone samples from the same layer 4 (Goebel and Waters, 2000). These dates appear inconsistent and Goebel and Waters suggest that the assemblage should be regarded as a palimpsest of occupations taking place between 35 and 25 ka ^{14}C BP.

The lithic assemblage (N=>10,000) is rich and the main technological and typological features are summarized by Goebel (1994). The lithic reduction is mainly oriented toward the production of blades and laminar flakes with a more expedient production of flakes. Blades are detached from flat-faced cores with cortical or plain platforms. Goebel also notes that cores frequently display trimming and grinding preparations. The retouch is mainly unifacial although bifaces (N=3) occasionally occur. Based on the Bazarov and colleagues sample (1982), Sitlivy-Escutenaire and Sitlivy (1996) describe two main productions. At the periphery of the main concentrations, large blades and elongated flakes with facetted platforms and with prominent bulbs are produced following a uni- or bidirectional Biache method (Chabay and Sitlivy, 1993). Within the concentrations, the methods are similar to the blade reduction from Makarovo IV but with a rare occurrence of the Rocourt method, no crest and some *débordant* blanks. In sum, the reduction is mainly flat-faced cores with radial preparation outside of the main occupation area and no preparation inside. Sitlivy-Escutenaire and Sitlivy (1996) note, however, that the Biache-type cores can be transformed into Makarovo-like cores subsequently. Vasiliev and Rybin (2008), based on a sample of lithics (N=3184), consider that the main pattern of flaking on flat-faced cores is bidirectional. By quantifying the frequency of negatives on the core surface, they suggest the dominance of one platform over the other. As the core becomes smaller, the second striking platform plays a role in flaking surface management with the removal of shorter flakes. This reduction effect has been previously identified by Pelegrin (1995) in another context. Pelegrin stressed that genuine bidirectionality is problematic in the case of small size cores and a system with the predominance of one platform over the other is used in order to avoid overshots. As opposed to Sitlivy-Escutenaire and Sitlivy (1996), Vasiliev and Rybin (2008) note the presence of crested blades (N=24).

All in all, although Tolbaga presents some similarities with the IUP, the assemblage appears technologically and chronologically to fall outside of this tradition. The composition of the assemblage with significantly high frequencies of cores, cores with cortical surfaces, and retouched tools, may represent a base-camp functional facies. This is reinforced by the composition and treatment of the fauna that includes cut-marks (N=693), fire treatment (N=82) and bone tools (N=9) (Vasiliev and Rybin, 2008). The dominance of wooly rhinoceros *(Coleodonta antiquitatis)* is unusual but in this case clearly linked with human activities. Some of the remains are transformed into bone tools (Vasiliev *et al.*, 1999; Vasiliev and Rybin, 2009). The nosed-endscrapers described by Goebel (1994) cannot be associated with a microblade production of UP type, the latter being apparently absent or not documented. The taxonomical attribution of Tolbaga remains, therefore, unclear.

Other assemblages not discussed in this section display clear technological, typological or chronological affinities with the IUP as defined in this study such as the layers 3 and 4 from Khotyk (Lbova, 2000, 2002, 2008, 2011; Lbova *et al.*, 2010), Barun-Alan I

and Suka-Padi (Tashak, 2009), Arta II layer 4 (component 4), Masterov Gora (Goebel, 1994) and Sapun (Goebel, 2004), or Kutakh (Cauwe *et al.*, 1993).

8.3 MONGOLIA

South of the Trans-Baikal, the Selenga River crosses the eastern part of the Sayan and Yablonoviyi ranges. Numerous Paleolithic sites have been discovered in the region, mainly along tributaries of the Selenga River. Sites from the Tolbor and the Dorolj river valleys are among the most recently investigated areas and will be briefly described here. The Orkhon valley has also yielded sites such Orkhon 1 and Orkhon 7, known since the 1960s. Further south, in the central Gobi desert, caves and rockshelters such Chiken-Agi and Tsagaan-Agui document IUP technology (see also Derevianko and Petrin, 1995; Gladyshev, Olsen *et al.*, 2010).

8.3.1 NORTHERN MONGOLIA

In 2002, a joint Mongolian-Russian-American team spotted not less than 19 locations along the Tolbor River. Sites, such as Toblor 15, were mainly found in sections exposed along the main road. Some others were spotted a little higher in the hills, such as Tolbor 4 (Derevianko *et al.*, 1996, 2007; Gladyshev, Olsen, *et al.*, 2010).

Tolbor 4

The site of Tolbor 4 is located about 300 km northwest of Ulaanbaatar and about 100 km from the Russian border. It lies on a hillside at the confluence between a small stream and the Tolbor River 6 km from its confluence with the Selenga River and at an altitude of 1044 m asl. This location is strategic as it lies next to a fresh-water spring and on a fine-grained riolite outcrop (Figure 232). It is exposed to the southeast and offers an open view of the entire valley. The stratigraphy was divided into 14 lithostratigraphic strata in which 6 cultural layers separated by sterile sediments were identified (Derevianko, Tseveendorj, Olsen, *et al.*, 2005; Kolomiets *et al.*, 2009). The site was excavated between 2004 and 2007, but so far, only the material from OH4, OH5 and OH6 from the 2005 excavation has been extensively published (Derevianko *et al.*, 2007; Rybin *et al.*, 2007). A single AMS radiocarbon date is available for OH6 with an age of 37,400 ± 2,600 ^{14}C BP (AA-79314). It was obtained on a bone tool that is still unpublished (Gladyshev, pers. comm.). OH5 has yielded an age of >41,050 ^{14}C BP (AA-79326) on a bone (?) sample (Gladyshev, Olsen, *et al.*, 2010). As it is often the case in the Tolbor area, the fauna are badly preserved.

OH6 and OH5 have similar techno-typological features that will be summarized here as a whole. The lithic assemblage (>12,000 from 2005 collection) (Derevianko *et al.*, 2007; personal observations) is mainly oriented toward blade blank production. Cores are mainly flat-faced sub-volumetric or volumetric, reduced by uni- or bidirectional removals (Figure 233). On flat-faced cores, the reduction starts from the corner made by two surfaces and then extends from the narrow to the broad face. Cores frequently display posterior crests prepared along a cortical narrow face. This preparation is somehow similar to the preparation of a Levallois core in the sense that it enhances the convexity of the flaking surface. The other narrow face bears negatives of removals, creating an angle between the two surfaces close to 90°. These features are typical of a sub-volumetric approach.

Thick *débordant*, naturally backed or crested blades are common and reinforce the idea of a frequent sub-volumetric and volumetric reduction. Negatives observed indicate either successions of unidirectional sequences from two opposed platforms or frequent platform switches. The assemblage also includes genuine volumetric cores with a flaking surface located on the narrow face indicating a frontal reduction. Occasionally, the back of the core is prepared by a single- or two-sided posterior crest. Platforms are shaped by the removal of large flakes, complete or partial tablets, and sometimes by faceting of the edge. Some of the cores are massive, with a length of over 20 cm and are classified by Derevianko *et al.* (2007) as ‘macro-cores’. A few cores display preparations of the back similar to Levallois blade cores.



Figure 232: Tolbor 4, raw material outcrop

Some of the cores testify to the production of small laminar blanks. The occurrence of typical BC, as defined in this study, is attested to (Figure 234: 1) (see also Derevianko *et al.*, 2007). They are on thick blade blanks with a flaking surface parallel to the core blank long axis, and they display bidirectional removal negatives with plain or facetted platforms.

Other cores are very similar, although the core blank cannot be identified (Figure 234: 2, 4). It is assumed that some of them could have been BC or flat-faced cores, but may also represent adaptive strategies related to the original narrow and elongated shape of the nodule. The preparation of posterior crest is observed, and some attempts of lateral crest removals are still visible. Large blanks are mainly blades with parallel edges and convergent blades (Figure 235). The border between these two categories is not clear-cut and naturally pointed blades are frequent, reaching circa 20% in OH6 (Derevianko *et al.*, 2007). Some are particularly massive (Derevianko *et al.*, 2007, Fig.7 num. 8).

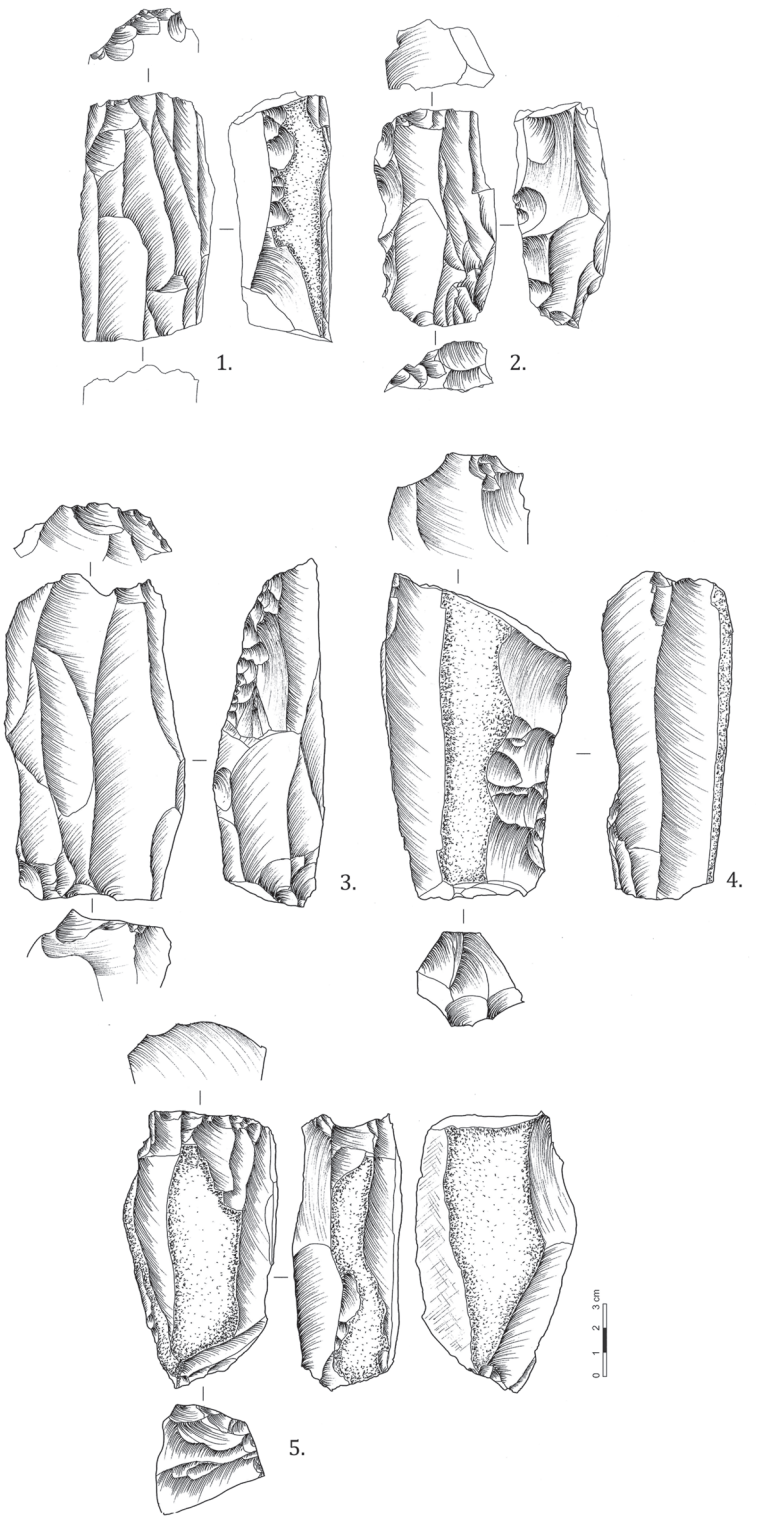


Figure 233: Tolbor 4, OH5-OH6, blade cores

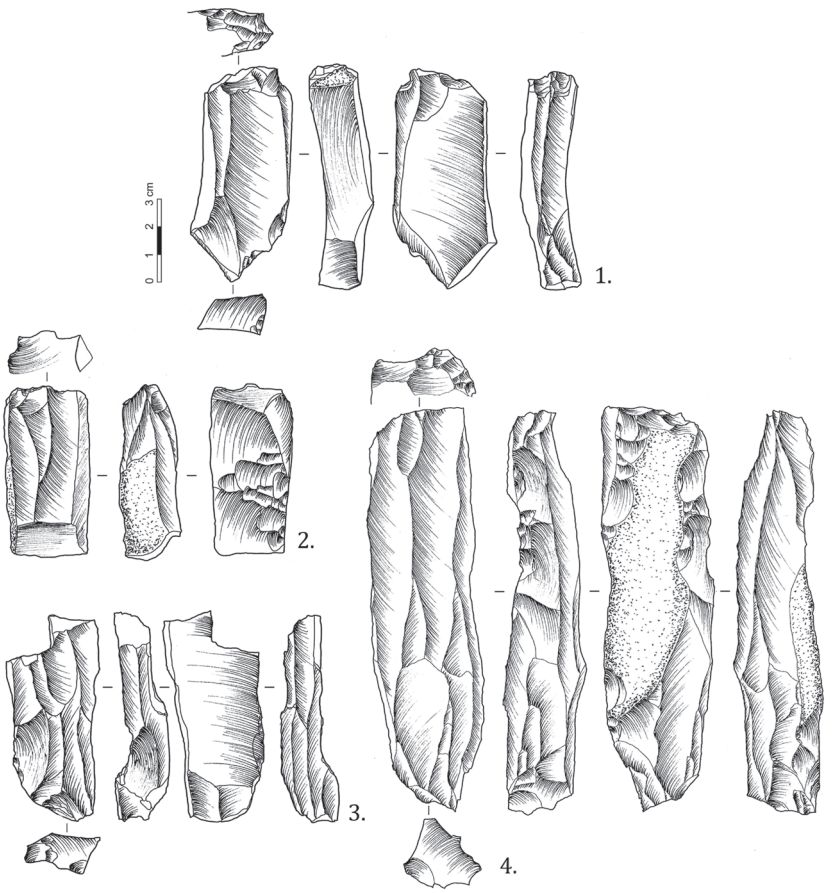


Figure 234: Tolbor 4, OH5-OH6, small blade/bladelet cores

Based on the complete artifacts, it seems that the proportions of uni- and bidirectional blanks are even (Derevianko *et al.*, 2007). As illustrated by the cores, orthogonal preparation of flat-faced cores is also reflected on the dorsal face of blanks. Crested and neocrested elements appear in various sizes testifying to regular convexity management during the reduction process. Platforms are mainly plain and dihedral but facetted specimens are well represented especially in OH6. Notable is the occurrence of *débordant* facetted platforms (Figure 235: 7) and of partial faceting, sometimes combined with a dihedral shape. The occurrence of strong and moderate abrasion of the external platform edge is also observed.

Among the retouched tools described, the presence of diagnostic elements is stressed here as they also occur in IUP assemblages from Altai. For example, according to previous reports and to personal observation blades with direct bilateral or marginal retouch are noted. Some of these may appear morphologically similar to *débordant* artifacts. This proximal retouch is also present on small pointed blades (Figure 235: 4). Bifacial tools are rare and not standardized. Points with inverse proximal retouch, considered as one of the most typical elements for the Altai IUP, are documented in the assemblage (Derevianko *et al.*, 2007). A blade with an inverse proximal truncation from OH6 was identified among the unpublished material from the 2004 excavation (Figure 235: 6). Thick endscrapers are part of the toolkit. The short removals observed on their front are not lamellar. These artifacts are, therefore, typed

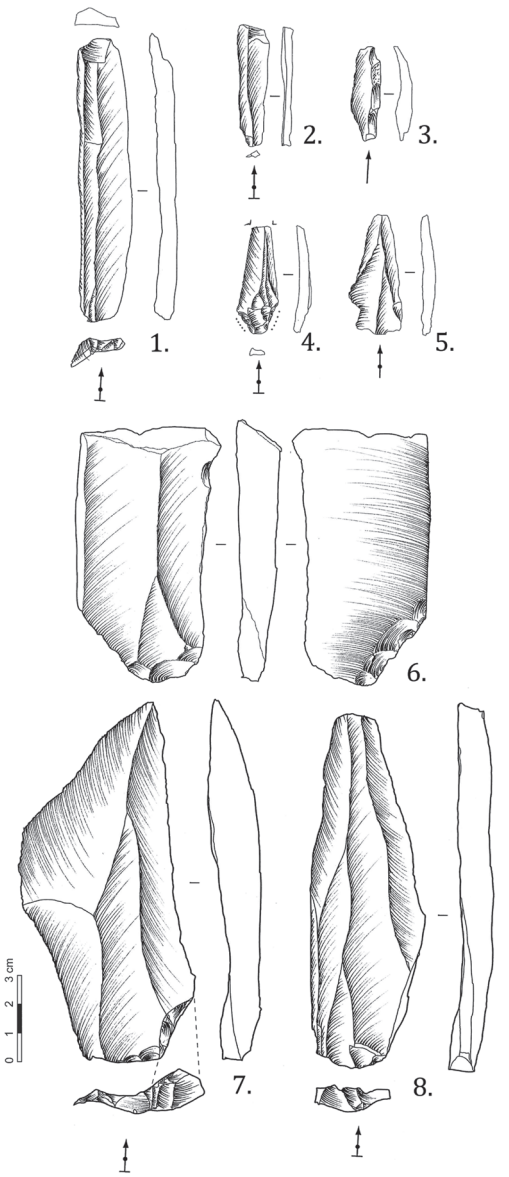


Figure 235: Tolbor 4, OH5-OH6, laminar blanks and retouched tools

as atypical carinated endscrapers (de Sonneville-Bordes and Perrot, 1954).

All in all, Tolbor 4 OH5 and OH6 show a high degree of technological and typological similarities with the Altai IUP. It also show a presence of bone tool directly dated to circa 37 ka.

The OH4 assemblage (N= 4,966 from 2005) represents a different technology. The blade reduction is less developed (Rybin *et al.*, 2007) and is almost exclusively characterized by medium/small blades produced from unidirectional flat-faced cores (Derevianko *et al.*, 2007). Blades become considerably shorter and are not naturally pointed. Microblade cores of carinated endscraper morphology are elusive in OH5-OH6 but clearly present in OH4 (Derevianko

et al., 2006, Fig. 7, num 1; Rybin *et al.*, 2007 Fig. 2 num. 1) together with small-sized wedge-shaped cores (Rybin *et al.*, 2007 fig .2 num. 19) and cores on a flake ridge (Derevianko *et al.*, 2007 Fig. 8, num 5). Small flat-faced cores are also present (Derevianko *et al.*, 2006, Fig. 7, num. 2; Rybin *et al.*, 2006, Fig. 2, num. 11). Pseudo-BC with unidirectional frontal reduction on small elongated slabs are rare (Derevianko *et al.*, 2006, Fig. 7, num. 3). Whereas most retouched blanks in OH5 and OH6 are blades, the frequency of retouched flakes and cortical blanks is higher in OH4 (Rybin *et al.*, 2007).

Tolbor 15

The assemblage of Tolbor 4 OH4 is not yet dated, so a comparison with the neighboring site of Tolbor 15 may provide insights on its the chronological position. The site of Tolbor 15 is located about 2 km upstream, along the Tolbor River (Gladyshev, Bolarbat, *et al.*, 2010). The study is still on-going and it will be briefly described here. The sequence is divided into 7 layers, each of which has yielded archeological material. The lowermost layers 6 and 7 consist of a single occupation level (Gladyshev, pers. comm.). A radiocarbon date of 29,150 ± 320 ^{14}C BP (AA-84138) was obtained on layer 7 and 28,460 ± 310 ^{14}C BP (AA-84137) was obtained on an ostrich eggshell fragment from layer 5. Layer 4 is dated to 26,700 ± 300 ^{14}C BP (AA-84135) but has also yielded younger dates such as 14,680 ± 70 ^{14}C BP (Beta-263744) and 14,820 ± 70 ^{14}C BP (Beta-263745). Layer 3, dates of 14,056 ± 81 (AA-84136) and 14,930 ± 70 ^{14}C BP (Beta-263742) (Gladyshev, Bolarbat, *et al.*, 2010; Gladyshev, Olsen, *et al.*, 2010).

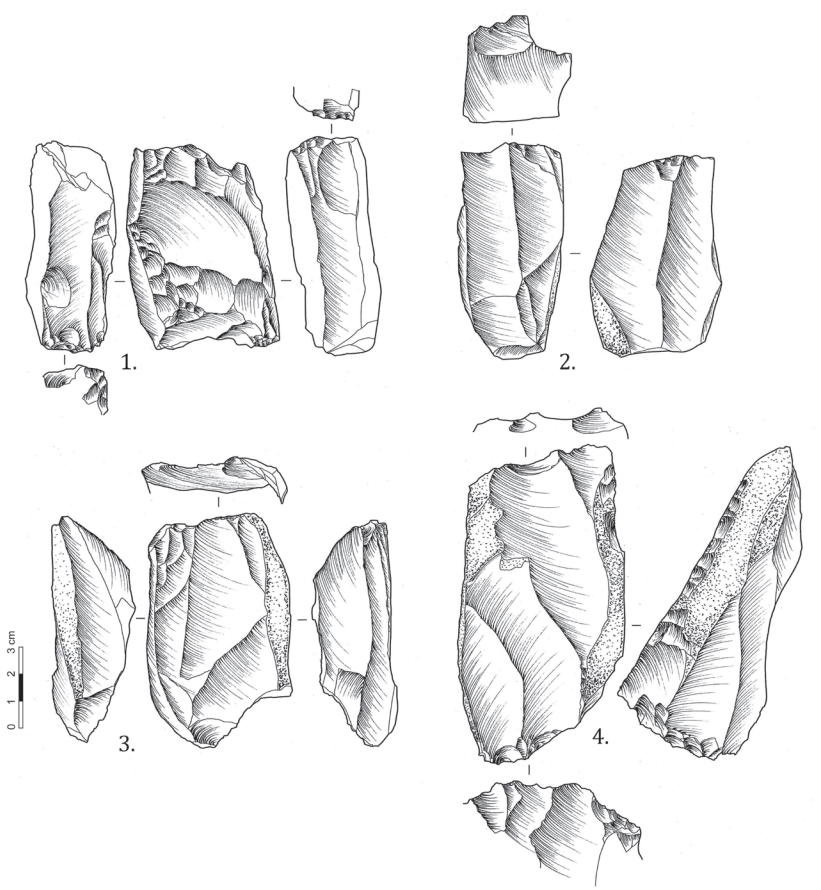


Figure 236: Tolbor 15, layers 6-7, blade cores

The following preliminary personnal observations are based on the cores and laminar blanks (N=285) from the assemblage collected through 2010. Layer 6-7 has yielded a lithic assemblage characterized by unidirectional blade reduction mainly from volumetric cores (Figure 236). Some of the cores may display sub-cortical bidirectional removals in the early stages of reduction. Platforms are mainly plain and thin (less than 4 mm thick) and the thin abrasion frequently observed on the external edge seems to suggest organic percussion. Facetted platforms are rare. Small blades, bladelets and microblades are produced from unidirectional, small flat-faced cores that sometimes resemble truncated-facetted pieces (Figure 237: 1, 2). Some flat-faced cores are flaked from a narrow face following a re-orientation of the reduction and appear as carinated endcrapers (Figure 237: 4). Genuine carinated endscrapers are also present but are rather uncommon (Figure 237: 3). Bladelet cores are produced on small slabs, blocks or thick cortical flakes and, therefore, represent a distinct reduction sequence starting from the selection of the raw material. The fronto-lateral flakes have straight profiles (Figure 238: 5-7). When slightly overshot, they may provide indirect evidence of the presence of small, prismatic cores. Microblades with pressure flaking occur in layer 5 (N=1) but are clearly documented starting from layer 4 (Gladyshev *et al.*, in press).

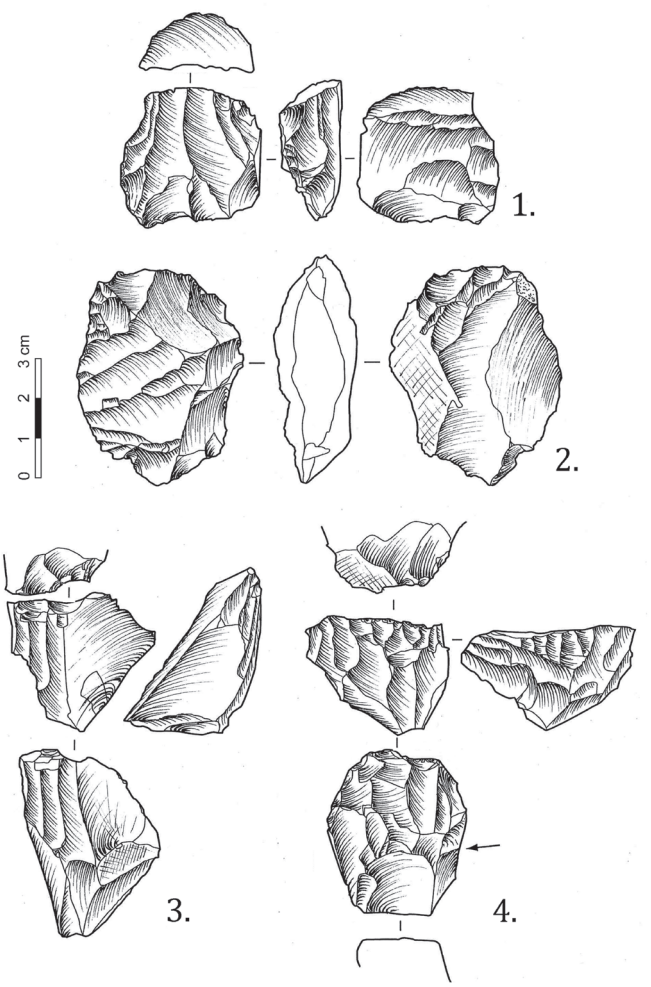


Figure 237: Tolbor 15, layers 6-7, bladelet/microblade cores

The number of bladelets observed is relatively small. The observed specimens are regular but poorly standardized and do not show signs of pressure flaking. Small blanks with trapezoidal sections are likely detached from a narrow flaking surface and are similar to burin spalls (Figure 238: 3). Among the retouched laminar blanks, some small blades display inverse lateral notches (Figure 238: 8, 9). A single Dufour bladelet has been identified (Figure 238: 4). It bears continuous, inverse, thin retouch extending along the left edge until the mesio-distal part, where a small truncation may have cause a break. The blank is cortical and shows a perpendicular removal coming from the left side.

As suggested by Gladyshev and colleagues (Gladyshev, Olsen, *et al.*, 2010), it is reasonable to consider this assemblage as analogous to the Tolbor 4 OH4 assemblage. The techno-typological and chronological information at hand would mean that both assemblages are EUP and distinct from the IUP.

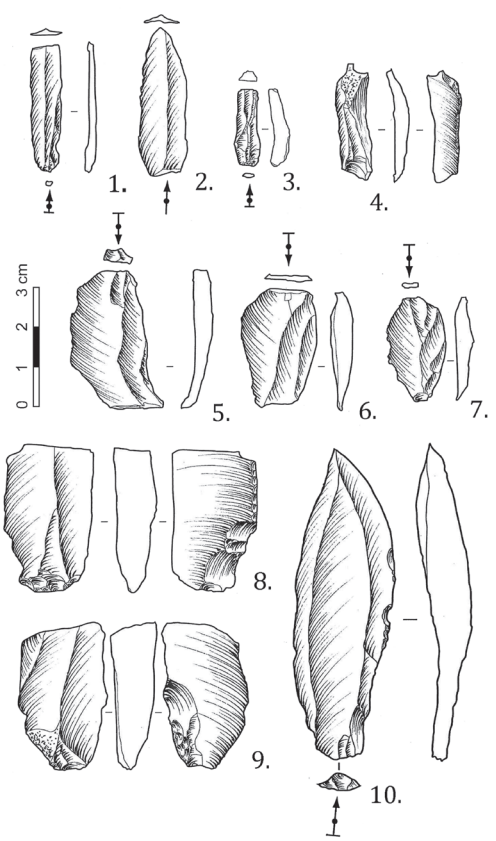


Figure 238: Tolbor 15, layers 6-7, laminar blanks and tools

Dorolj 1

Similar assemblages are documented in Dorolj 1 along the left bank of the Eg River. The site is located a few km from the confluence with the Selenga, along the east flank of the Khangai range. It was excavated between 1999 and 2001 by a Mongolian-French team at a time when the archeology of the Egin-Gol was threatened by the construction of a dam (Jaubert *et al.*, 2004). Although the sedimentary sequence is 12 m thick, it has yielded a single layer with cultural remains. It is in a colluvial deposit covered by 2-3 m of loess. The latter are disturbed by cryogenic processes and solifluction attributed to the Heinrich 2 event, circa 21 ka (Bertran *et al.*, 2003). Two AMS radiocarbon dates have been obtained on charcoal samples from combustion features with ages of 29,910 ± 310 ^{14}C BP (Gifa-99560) and 29,540 ±390 ^{14}C BP (Gifa-99561) (Betran *et al.*, 2003). Three more dates, 31,880 ± 800 ^{14}C BP (Gifa-11664), 21,820 ± 190 ^{14}C BP (Gifa-102451) and 22,030 ± 180 ^{14}C BP (Gifa-102453) have been obtained on ostrich eggshell samples. The two latter dates are younger but samples were collected from an excavation sector other than the combustion feature sector (Jaubert *et al.*, 2004). Pollen analyses have yielded inconclusive preliminary results. The fauna are badly preserved and are mainly composed of small-sized equids *(Equus sp.)*.

The lithic assemblage (N=1791) comes from an excavated surface of circa 40 m². The raw material consists of pebbles of metamorphic rocks collected in the alluvial deposits of the Eg. Levallois and discoid technologies are attested to but rare with the main reduction sequences being laminar. Blades are mostly of medium size and produced from unidirectional cores with the bidirectional blades being interpreted as a succession of two alterning unidirectional sequences. Blanks are poorly standardized, have plain platforms prepared by abrasion and likely correspond to organic hammer percussion. Large blades are present, and although they bear bidirectional removals, the dorsal patterns are said to suggest the use

of a second platform for the management of distal convexities (Jaubert *et al.*, 2004). Laminar flakes are produced using cores with two opposed platforms. The bladelet production is mainly attested to by the occurrence of cores on flakes, probably byproducts of blade production. The reduction is described as rather expedient and among the cores (N=11) a single typical carinated endscraper is mentioned (Jaubert *et al.*, 2004). The latter elements are mentioned by these authors to compare Dorolj with assemblages from the Altai such as UK1-2. Based on the present study, chronological and techno-typological analogies suggest an attribution of the Dorolj material to EUP.

Orkhon sites

In the Orkhon valley, layers 3 and 4 from the site of Orkhon 1 have yielded assemblages associated with the first occurrence of the UP. The technology is oriented toward the production of convergent laminar blanks by unidirectional and bi-directional flaking on flat-faced cores. Some of these cores are sub-volumetric (Kandyba, 2009 quoted after Gladyshev, Olsen, *et al.*, 2010) and some of the unidirectional cores are reduced without the use of natural or prepared crests (Slavinsky and Tsybankov, 2006). Orkhon 1 and 7 have yielded numerous radiocarbon and EPR dates, but these show significant problems. Due to methodological issues (Kuzmin, 2000) (see previous Chapters 3 and 5), EPR dates are not taken into account here. A recent study (Kandyba, 2009 quoted after Gladyshev, Olsen, *et al.*, 2010) retains the conventional date of 33,785 ± 300 (^{14}C BP?) (SOAN-2885) on a bone sample for the first occurrence of the UP. This date is also reported by Gladyshev and colleagues (Gladyshev, Olsen, *et al.*, 2010) but associated with layers 3 and 4 from Orkhon 7. Derevianko (Derevianko, 2011a) reports a date of 40,000 ± 700 (^{14}C BP?) (SOAN-2882) for the same layers at Orkhon 1.

These inconsistencies underline the difficulty of assessing the chronological attribution of these layers. Further confusion occurs in the published material. For example, a date of 45,100 ± 1,700 BP for earliest human occupation at the site of Orkhon 7 is associated with the layer 10 but the lab number is unknown. Similar problems occur with the reported radiocarbon age of 62,500 ± 4,500 BP which, although produced in the early 1990's, falls beyond the normal limit of the method (Astakhin *et al.*, 1993; Derevianko, 2011a). The earliest reliable age would then be associated with layer 7 with a conventional radiocarbon age of 37,100 ± 580 ^{14}C BP (SOAN-2881) on a bone sample (Orlova *et al.*, 2005), but Derevianko (2011a) associates this same date with layer 6.

Gladyshev and colleagues (Gladyshev, Olsen, *et al.*, 2010) consider the material from layers 3 and 4 from Orkhon 7 as similar to the Dorolj 1 assemblage. However, due to the above-mentioned confusion with the SOAN-2885 date, it is not clear if the description of the lithics corresponds to Orkhon 1 or Orkhon 7. Derevianko and Kandyba (2009) compare the technology and the typology of the uppermost UP layers from Orkhon 1 and Orkhon 7 to the Anuy II material. These phases would then correspond to EUP as defined in the present analysis. The earliest occupation of Orkhon 7 is attributed by Derevianko (2011a) to a Late MP, and he describes two variants of subsequent UP after a transitional phase. From a general point of view, layers 3 and 4 from Orkhon 1 show some similarities with IUP technology, and although having a crude aspect, the underlying assemblages could correspond to a similar tradition.

In sum, the Orkhon sites show techno-typological affinities with both IUP and EUP but significant problems remain regarding the chronology of the sequence.

The material from the Moltyn-Am site from 1985-1986 excavations (directed by Derevianko) is described by Derevianko and Kandyba (2009b) as two distinct assemblages attributed to Middle and Upper Paleolithic. A direct date of 20,240 ± 300 ^{14}C BP (Gif-10857) is associated with the so-called 'tongue horizon' and with an archeological assemblage (Bertran et al, 2003). It is not clear wheter this layer correspond to the assemblages described by Derevianko and Kandyba (2009b) in which case the date would be surpisingly young.

8.4 SOUTHERN MONGOLIA

Further south, sites such as Tsagaan-Agui have been mentioned as evidence of IUP in the north-central Gobi (Derevianko *et al.*, 2004, 2005). The chronology is based on radiocarbon ages and on ESR dates but shows some discrepancies (*e.g.* in layer 4). Radiocarbon dates on charcoal samples from layers 3 provide results between 34 and 31 ka ^{14}C BP. For the same layer, ESR provide results with large standard deviations, between 37 and 27 ka BP (early uptake) and between 50 and 35 ka BP (recent uptake). It seems to provide some of the youngest ages for such a technology when considering the early uranium uptake model. When considering the the recent uptake, the chronology overlap with the expected range IUP in Altai, in the Baikal and in Northern Mongolia. It is noted that the only date on bone sample provided an age of 37, 540 ± 930 ^{14}C BP (AA-31869) and is derived from the overlying layer 2. This date is, however, 10 ka older than dates on charcoal from the same layer. RTL-dates (Derevianko *et al.*, 2000) from layer 5-12 provided ages betwee 650 and 150 ka are judged too old and unreliable due to sediment transports in the cave system (Derevianko *et al.*, 2004). In other words, if IUP technology seems present in southern Mongolia, the young ages obtained are still difficult to interpret.In south-western Mongolia, surface assemblages from the Hoit Tsenker Gol terrasses and from the Takhiliin Hotgor plateau (province of Hovd) have yielded cores oriented on the bidirectional production of laminar flakes (Jaubert *et al.*, 1997) but clear evidence for systematic blade production are lacking.

8.5 SUMMARY

In Central Asia, current evidence supports a long chronology for the emergence of volumetric laminar technology. As documented in the loess from Tajikistan, prismatic and even pyramidal blade technology occurs starting from OIS7. Evidence is scarce but seems to indicate that blade assemblages last until the interglacial, with a first occurrence of small laminar elements around 150 ka. After the interglacial, this technology is not well documented. MP assemblages such as Teshik-Tash illustrate a classic Mousterian associate with laminar elements in Kuhdji. Further evidence of MP laminar technology is found in Uzbekistan. The Obi-Rakhmat sequence displays intriguing similarities with the IUP but also shows a certain degree of variability that could be related of the large size of the collection. Although sub-volumetric cores are present, it seems narrow-faced cores are particularly well represented. The chronology is problematic as the different methods do not match. For now, it is considered as younger than the Tadjik blade assemblages. Recent discoveries from Kulbulak may bring some new chronological data, as early blade technology has been identified in the sequence, with a minimum age of circa 50 ka. IUP blade technology is not yet documented in Kazakhstan or in western Siberia, but these vast territories remain only partly explored. In the eastern Altai foothills, only limited evidence of human occupation could be possibly attributed to the last interglacial. Moving further east, between the Yenissei and the Angara rivers, IUP technology is not clearly recognized. Sites such as Ust-Izhul clearly testify of a human occupation as early as OIS5e, but the small lithic assemblage is not laminar and not diagnostic. In the Cis-Baikal area, whereas assemblages such as Tolbaga remain difficult to characterize, the Makarovo group presents some clear technological, typological and possibly chronological analogies with the IUP. On the other ridge of the lake Baikal, numerous sites have yielded assemblages that show significant similarities with the Altai IUP. They are located in the Selenga river delta, and it appears that the Trans-Baikal region is likely connected with northern Mongolia since at least the beginning of OIS3. With respect to taphonomic problems and to functional and economic differences expected when comparing assemblages over a distance of more than 1000 km, technological and typological differences between IUP assemblages from Altai to Mongolia are trivial. This technology seems to be present since at least the beginning of OIS3.

EUP technology appears in Central Asia in the northeast of Afghanistan possibly circa 30-35 ka ^{14}C BP. Nearby Uzbekian sites are for the most part not dated, but new results from Kulbulak and Dodekatym indicate that bladelet and microblade technology obtained by direct percussion could be associated

in a subsequent phase with geometric microliths as early as 22-23 ka ^{14}C BP. If confirmed, these results could lead to the reassessment of numerous assemblages associated to the Mesolithic on typological basis. It would then partly fill the existing gap between MP and Holocene occupation of Central Asia. In Kazakhstan, sites such as Karasu and Maybulak could be assigned to the EUP on a technological and chronological basis. Maybulak is particularly relevant as it is located on the southeastern edge of the Altai and dated to circa 32 ka. It appears contemporaneous with the earliest phases of EUP in the Altai. In western Siberia, the EUP appears clearly at the end of OIS3 and the beginning of OIS2 and would partly overlap with the end of Altai EUP chronological range. North of the Altai, Malay Sia could also represent one of the oldest occurrences of the EUP, although no clear bladelet or microblade technology has been described yet. Between the Yenissei and the lake Baikal, bladelet and microblade technology seem to belong for the most part to the Sartan period and overlap with the first occurrence of pressure flaking. In Mongolia, EUP assemblages are attested to starting from circa 32 ka ^{14}C BP. They show technological, typological and chronological similarities with the Altai EUP.

When addressing the research question 3, clear inter-regional similarities emerge from the present overview. As developed in the next chapter, it is suggested that the available body of data does not support scenarios of human development in isolation. Instead, the data set strongly suggests long distance population movements starting from the earliest phases of OIS3.

9 – Discussion, conclusion and perspectives

In the previous chapters, three main research questions were addressed. In addition, a regional chrono-cultural model was proposed. The first section of this chapter summarizes the questions and issues tackled in this study, the results obtained and an interpretation of these results. Comparisons with the regional records and with the neighboring regions were presented in the previous chapters. In this discussion, broader technological analogies with the European and the Levantine records are briefly discussed in order to underline the defining characters of the assemblages. Keeping in mind that the current archeological record appears to be rather fragmentary given the size of the area considered, implications for MH dispersal scenarios in Asia are discussed. Following the conclusions, future directions of research are briefly suggested.

9.1 DISCUSSION

9.1.1 IUP: DEFINING THE DISTINGUISHING FEATURES

IUP human groups selected relatively large blocks or pebbles with a tabular form and produced massive and elongated pointed blanks or blades. The reduction starts following a minimum of preparations as the selected block already has a suitable shape. Blocks are heavily reduced using a standardized method. This method is similar to what Pelegrin (1990, 1995) described for the Chatelperronian and to what Boëda (1990) has defined as the 'Roc-de-Combe layer 8' reduction system. Two flaking surfaces are interconnected in order to create convexities as described by Boëda (1995) in the 'Hummal type Volumetric Construction'. The reduction starts and is resumed from one of the narrow faces of the block, but some of the cores show transversal removals from the opposed narrow edge that indicate the shaping of a posterolateral crest. Roussel (2011) recently underlined that in a Chatelperronian context the narrow face of the core is not only involved in the management of convexities but also in the production of blanks. This latter point could not be observed here in an IUP context, in other words, the IUP reduction is not a surface conception and does not fall in Boëda's definition of Levallois technology (Boëda, 1995).

This technology differs from the Rocourt method (Cahen, 1984; Boëda, 1990; Otte, 1990) which is described in MP assemblages from Belgium (e.g Rocourt) and northern France (*e.g.* Seclin, Riencourt-les-Bapaumes) assigned to OIS5 (*e.g.* Revillon and Tuffreau, 1994; Tuffreau, 1993; Revillon, 1995; Goval and Herisson, 2006; Goval and Locht, 2009) In the Altai IUP, the section of the core is assymetrical with sometimes two flaking surfaces separated by a 90° angle. The Rocourt method implies that the broad flaking surface is reshaped by *débordant* removals from both narrow faces giving the flaking surface a dome-shape. These side removals are the only way to continue the reduction. The cores often exhibit a symmetrical section close to a semi-turning type instead of an assymetrical section with two clear-cut flaking surfaces. Analogies with the Altai IUP reduction system can be found in the Late Crimean Mousterian of Kabazi II (layer II, horizon 1-4a), although the latter is described as a Rocourt reduction method (Chabay and Sitlivy, 1993; Cabaj and Sitlivy, 1994; Chabai *et al.*, 2006; Sitlivy and Zieba, 2006). Nehorochev (2004) described similar technological features in the layer 8 of Shlyakh, in the lower Don basin, dated to between 50 and 43 ka ^{14}C BP (see also Nehoroshev and Vishnyatsky, 2000). Schlyakh has been tentatively associated with the Bohunician techno-complex (Hoffecker, 2009).

Bohunician technology as described in Stranska Skala, Czech Republic (Svoboda and Bar-Yosef,

2003; Nigst, in press), is oriented toward a production of elongated Levallois points detached from bidirectional narrow-faced cores that tend to switch to unidirectional at the end of the reduction (see also Skrdla, 2003a). The cores are prepared by a frontal initial crest, and *débordant* blade removals shape the lateral convexities as the reduction continues. Skrdla (Skrdla, 2003b) notes that the reduction starts as UP, but finishes as MP. In other words, the reduction starts from the narrow face but the exhausted cores appear as flat-faced. These combined features have been interpreted as a conceptual fusion between Levallois and volumetric approaches (Svoboda and Skrdla, 1995). *Débordant* blades are detached from both sides of the flaking surface and the cross-section appears roughly symmetrical. It has been noted that the Bohunician technology is very similar to the Kara-Bom one (Svoboda and Skrdla, 1995; Skrdla, 2003b). The initialization of the reduction, the bidirectional reduction and the morphology of the end products are indeed similar. However, it appears that the reduction method is closer to a Rocourt-type technology than to the Altai IUP. Moreover, in the Bohunician from Central Europe, blades are considered as byproducts whereas in the Altai IUP the technology is mainly oriented towards blade production. If one accepts Shlyakh as a Bohunician assemblage (*e.g.* Hoffecker, 2009), Altai IUP technology could then be considered part of the Bohunician technological variability. However, Schlyakh technological affinities are so far not clear (Sitlivy and Zieba, 2006).

Altai IUP platform preparation often includes a combination of facetted and plain forms. In addition, specific forms have been identified, such as partial faceting. This latter is defined as a faceting located along the external edge the platform. The remaining part of the platform, including the point of percussion, becomes usually more prominent and remains plain or dihedral. Similar preparation was described as a core platform reduction by Nehorochev (1999) in layer 8 of Shlyakh. The purpose of partial faceting is not clear; however, two main hypotheses can be formulated. On the one hand, this could be seen as a form of faceting to obtain thicker and/or larger blanks by increasing the platform thickness. The relationship between thick platforms and thick blanks has been repeatedly observed in flake production during controlled experiments (Dibble and Whittaker, 1981; Dibble and Pelcin, 1995; Pelcin, 1997a). The second possibility is to see partial faceting as a way to remove an overhang prior to the detachment of the blank. Although thin abrasion does not occur in Altai IUP assemblages, a strong abrasion is observed among the blanks and, according to Pelegrin (2000), could correspond to the use of a soft hammerstone. Partial faceting could be seen as a similar preparation to obtain a bevel-shaped platform that allows for the removal of a robust blank.

Small laminar elements are obtained by reusing unstandardized by-products, namely the *débordant* and crested blades, detached from the intersection of the narrow and broad flaking surface (see also Zwyns *et al.*, 2011). Core blanks are not predetermined but rather anticipated and are selected according to size attributes such as their thickness and also probably for their length. In the classic Roc-de-Combe technology, some of these thick blades with natural backs are used as blanks for Chatelperron points (Pelegrin, 1995; Roussel, 2011). The burin-cores (BC) are defined here as cores on blade blanks that are reduced by uni- and bidirectional removals along the longitudinal axis of the core blank. The technique of percussion is mostly hammerstone and hinge fractures are frequent. Similar core technology is observed in the Near-East among MP laminar assemblages such as Hayonim lower E and F (Meignen, 2007). BC also occur among OIS5e MP assemblages from northern France such as Riencourt-les Bapaumes (Tuffreau, 1993; Ameloot-Van der Heijden, 1994). Some examples from Temnata sector I and II are illustrated by Tsanova (2008) but the best known occurrence of BC during the UP is represented by the polyhedral burin-cores *(nucléus burin polyédrique)* in Late Gravettian assemblages such as Le Blot, in central France (Klaric, 2006, 2007, 2008; Klaric *et al.*, 2009) or Mainz-Linsenberg, Germany (Hahn, 1969; Klaric *et al.*, 2009). This type of core produces elongated and narrow blanks with straight profiles that are often transformed into Gravette and Micrograveette points by abrupt and semi-abrupt retouch. Although they appear identical to the IUP examples, Gravettian polyhedral burins are reduced by a succession of independent unidirectional sequences rather than by alternating bidirectional removals (Klaric, 2006).

It is noted that the emergence of BC technology reflects the appearance of sub-volumetric or volumetric blade technology. The volumetric approach, however, does not *a fortiori* imply a BC reduction. Various MP and UP technological systems produce thick crested and *débordant* blanks but only a few reuse them as cores.

Considering the BC from a blank production point of view does not rule out that some of them were used as tools; however, use-wear analysis on this type of artifact tends to suggest that it is not often the case. In a Gravettian context, a recent study has shown that artifacts classified as core-like burins (including BC forms) on technological-typological basis do not bear use-wear as opposed to burins with thin and sharp chisels that are used on soft material (de Araujo Igreja and Pesesse, 2006). At Riencourt-les Bapaume, use-wear was observed on burins produced on flakes but not on the burins on blades (including the described BC forms) (Beyries, 1993; Ameloot-Van der Heijden, 1994).

The Altai IUP toolkit is quite variable and includes both MP and UP elements. The most typical tools are pointed blades with an inverse proximal thinning. This thinning is generally unifacial, although one example from Kara-Tenesh and one from UK1-1 seem to bear some proximal direct retouch. These are highly recognizable and are not found in other technocomplexes in the Altai. Similar thinning on blades is known in northwestern Europe as Jermanowizce points. They are usually retouched on both faces, but the proximal retouch can be unifacial. They are considered typical of the Lincombian-Ranisian-Jermanowizcian (LRJ) techno-complex (Flas, 2008). Stratigraphically, the latter occurs below the Aurignacian, but chronologically it overlaps with European late Mousterian assemblages. It is roughly contemporaneous with the directly dated Neandertal remains in Belgium and in the Caucasus (Semal *et al.*, 2009; Pinhasi *et al.*, 2011) but also with the earliest known dates for the Early Aurignacian in Central Europe (Haesaerts and Teyssandier, 2003; Nigst and Haesaerts, 2011). In the Levant, Emireh points are defined as a relatively short convergent blank with a bifacial proximal thinning (Garrod, 1957; Volkman and Kaufman, 1983; Copeland, 2000). Volkman and Kaufman's definition (1983) considers that the blank should be bidirectional. Emirean occurs after the Nubian and prior to the Ahmarian technocomplexes and corresponds to the Late MP/transitional industries represented by Boker Tachtit layers 1-2 (Marks and Volkman, 1983), Tor Sadaf A-B (Fox, 2003) or other assemblages (Copeland, 2000). In Syria, sites such as Jerf-al-Ajla (Schroeder, 1969, 2007) have yielded convergent blanks with inverse truncations. The Umm-el-Tlell points differ as the thinning corresponds to convergent bladelet removals observed on the dorsal face (Boëda and Muhesen, 1993; Bourguignon, 1996, 1998).The bladelet blanks show some usewear and the process is considered as a reduction sequence (Boëda and Bonilauri, 2006) or as a preparation for removing convergent blades (Bourguignon, 1998). Artifacts similar to the Umm-el-Tlell points also occur within IUP assemblages from Kara-Bom (Figure 55) and are combined with retouch at Kara-Tenesh (Figure 195). They but do not clearly appear as standardized as a tool-type nor as a bladelet reduction sequence. Instead, Kara-Tenesh examples suggest that the lamelar thinning technique correspond to a preparation for hafting.

In Central Asia, a few examples of basal unifacial thinning on points are observed at Obi-Rakhmat in various levels. Whereas Obi-Rakhmat is a rich laminar assemblage, such artifacts are rare and produced on convergent flakes and convergent blades. It is also noted that, like in Jerf-al-Ajla (Schroeder, 2007), they occur among a broader variability of truncated pieces, such as blades with oblique truncations and truncated-facetted pieces. Further east, Makarovo IV yielded similar typological elements but on short laminar flakes with bilateral retouch, including bifacial thinning of the proximal part (Goebel, 1994, 2004; Derevianko, Shimkin, *et al.*, 1998). They seem to occasionally occur in northern Mongolia were blades with parallel edges and inverse proximal truncations are reported.

The examples of leafpoints clearly associated with the IUP are rather poorly standardized. They seem to represent infrequent elements and are seen as a typical IUP feature. Nevertheless, they differ from bifaces found in Mousterian contexts such as Chagyrskaya or Okladnikov cave (Derevianko and Markin, 2011).

Although it was attributed to the MP, the attribution of Anuy III stratum 19 is still unclear given the small size of the assemblage and the lack of chronological data. If confirmed, it would represent the only clear association of leafpoints with the MP in this region. Some peculiar tool-types, such as the sickle-like blades, could be interpreted as specific to the Altai IUP, although it could also reflect an aspect of the variability of retouched blades.

9.1.2 IUP: THE ASSIGNMENT

Although typological Levallois elements such as blades and points are associated with the IUP, evidence of strict Levallois technology is infrequent. Levallois flake cores or elongated recurrent Levallois cores occur, but the main reduction system is laminar. Although no long refit sequences could demonstrate this, it appears that a portion of the convergent blades are produced by a blade reduction from the broad face of the core. This aspect differs from the classic Roc-de-Combe technology in which convergent blanks are uncommon. Meignen (2007) notes that in the Near-East, the coexistence between Levallois and blade production appears around 220 ka with the Tabun-D assemblages. Pre-Aurignacian and Acheulo-Yabrudian include laminar systems but no Levallois component. In the Near-East IUP, at sites such as Boker Tachtit layers 1-4 (Marks and Volkman, 1983), Ksar Akil layers XXI-XXIV (Bergman, 1988; Ohnuma and Bergman, 1990), and Üçagizli layers F-H (Kuhn *et al.*, 1999, 2009), Meignen (2007) observes a higher frequency of elongated blanks and an emphasis on laminar technology at the expeFig.nse of strict Levallois reduction strategies.

The Altai IUP shows a combination of technological features that occur in various chronological contexts starting from the MP. The attribution of the Altai assemblages to the IUP as defined by Kuhn (2004) and by Marks (1990) is preferred over the term 'transitional' as it does not imply a local transition process. Moreover, it is supported by several other arguments. The definition is rather broad, as it considers assemblages with a coexistence of volumetric and parallel blade reduction and the production of convergent elements (Kuhn *et al.*, 1999; Kuhn, 2003). Strict Levallois technology is present but rather infrequent. Laminar technology chiefly dominates the assemblages and falls in the definition of the Near-East IUP (Meignen, 2007). The presence of ornament has been reported at Kara-Bom in the Altai (Derevianko and Rybin, 2003; Zwyns *et al.*, 2011), and bone technology has been found associated with similar assemblages from the Trans-Baikal region (*e.g.* Khotyk, Podzvonkaya) some of which have a single cultural component (*e.g.* Varvarina Gora)(Lbova, 1996). An unpublished bone point has been found associated with the IUP (Tolbor 4, OH6) in northern Mongolia and is directly dated to circa 38 ka. From a general point of view, stratigraphic and chronological data indicate that IUP would occur early OIS3 (Gladyshev, Olsen, *et al.*, 2010). Keeping in mind that these divisions are arbitrary (Kuhn, 2003), the IUP assignment remains so far the most appropriate. Additional chronological and taphonomic support is necessary to assess this attribution and to clarify the status of these assemblages.

9.1.3 IUP: THE ORIGINS

Derevianko (2011a) argues for a local origin of the Altai IUP which evolves from a Levallois-Mousterian background. Rybin (2004) suggested that the Altai IUP evolved locally from an intrusive Levallois-Mousterian. He notes numerous similarities between Boker-Tachtit layer 1 and the Kara-Bom Levallois-Mousterian and suggests an original migration from the Near-East. Both scenarios argue that a gradual transition from MP to IUP is illustrated by the Kara-Bom sequence. Although they appear partly contemporaneous, non-Levallois Mousterian assemblages (*e.g.* Okladnikov, Chargyrskaya) (Derevianko and Markin, 2011) differ significantly from the IUP and are not relevant for the following discussion.

According to the present analysis, the few arguments in favor of a transition at Kara-Bom are mainly technological. As described in Chapter 3, the status of the Kara-Bom MPH1 assemblage is unclear due to its small sample size. In fact, almost all technological and typological elements described can occur in the variability of IUP assemblages. A possible IUP attribution for this assemblage is, therefore, not exclud-

ed. The lowermost MP assemblage (MPH2) shows a production of short Levallois points from a reduction system that is mainly unidirectional and convergent but that also includes a surface management from the narrow face by the recurrent removal of side or crested blanks. This management of convexities stretches the definition of Levallois technology and is one of the defining characters of Northeast Asian IUP. The presence of blades is mentioned but cores are missing. MPH2 blade technology is, therefore, difficult to characterize given that some elongated blanks might be linked with the production of points. Moreover, most of the MPH2 assemblage seems *in situ,* but downslope the distinction with the overlying MPH1 is unclear (Derevianko, Petrin, *et al.*, 1998). Thus, the idea that some of the material is intrusive cannot be excluded. In this situation, the presence of BC-like forms is not interpreted as meaningful. Furthermore, significant technological differences with the IUP are observed. As opposed to the MPH2 assemblage, genuine blade technology chiefly dominates the MPH1 assemblage. The reduction is not unidirectional convergent but bidirectional parallel. Convergent blanks occur, but are mainly associated with a bidirectional reduction system. The systematic occurrence of BC technology underlines the importance of the small laminar blanks in the IUP. MPH2 and OH6-OH5 technological systems are, therefore, not only different in terms of technology but also in terms of blanks produced. This is in contrast to the few examples where a local transition is documented. In the Near-East, the transition from layer 1 to layer 4 at Boker Tachtit is technological. In other words, the blanks produced do not change (even if the retouch may vary) but the technology to produce them gradually shifts from volumetric bidirectional on a narrow face to a unidirectional semi-turning reduction system (Marks and Volkman, 1983). At Kara-Bom, the situation is reversed with MPH2 being mainly unidirectional and the IUP being bidirectional. Moreover, the technological systems are oriented toward the production of convergent flakes whereas in the IUP the main technological system produces blades. At Kara-Bom, MPH2 is characterized by a surface approach and the IUP is sub-volumetric whereas at Boker Tachtit the lowermost layer 1 cores are volumetric on narrow face.

Furthermore, chronological data are not consistent with an in-situ transition scenario that strongly relies on the assumption that human occupation in the region was continuous. The chronological data indicate a minimum age circa 44 ka for MPH1. The EPR ages are not considered reliable, but it cannot be ruled out that MPH2 is considerably older than OH6. In fact, scholars tend to assign this layer to OIS4-OIS5. Given the apparent low intensity of occupation at Kara-Bom, it is not realistic to suggest that the sequence would represent minimum 20 ka of continuous occupation. Instead, it more likely represents episodic occupation during different periods that could be separated in time by thousands of years. It cannot be excluded that IUP assemblages and MPH2 share a common Levallois-Mousterian background that originated in Central Asia or even in the Near-East. According to the present study, however, the gradual transition is not documented at Kara-Bom.

Rybin (2004) suggests that Kara-Bom Levallois Mousterian is similar to Tabun D assemblages based on a comparison with the lower assemblages from Boker Tachtit dated to circa 46 ka. According to Marks (1992), the Boker Tachtit lower levels are technologically and typologically closer to Early than to Late Levantine Mousterian assemblages. Tabun D assemblages and Hayonim lower E and F, however, have been dated in Tabun (layer IX) and elsewhere between circa 260 to 160 ka (Mercier *et al.*, 1995; Rink and Schwarcz, 1999; Mercier and Valladas, 2003; Rink *et al.*, 2003, 2004). Like for the Bohunician (Skrdla, 2003), Boker Tachtit blades are considered as byproducts of the production of points (Marks and Volkman, 1983; Demidenko and Usik, 1993). The period between 120 to circa 60-50 ka is marked by the absence of MP laminar assemblages (Meignen, 2007). But the major chronological gap between the two suggests that, in the Levant, these technocomplexes are not directly related. In Central Asia, volumetric blade reduction has been identified in PC2a of Chonako III, Tadjikistan, starting at around 220-200 ka (Schäfer *et al.*, 1998). These assemblages seem to be a relevant comparison with the Levantine Tabun D phase or with laminar assemblages such as Hayonim lower E and F (Meignen, 2000) or Rosh-ein-Mor (Marks and Monigal, 1995) which have a less pronounced Levallois component.

Like in the Near-East, blade MP assemblages seem to disappear from the Tadjik sequence prior to or during OIS5e (Schäfer *et al.*, 1998) and reappear circa 50-40 ka in Kuhdji (Ranov and Schäfer, 2000). As the first occurrence of Levallois Mousterian in the Altai is documented during OIS5e, a link between the early Central Asian blade MP and the Altai cannot be excluded. The key-sequences of Kulbulak and Obi-Rakhmat in Uzbekistan could perhaps fill this gap, but for now their precise chronology remains unclear.

While the Obi-Rakhmat assemblages appear as the clearest analogy with the IUP in Central Asia, some significant issues remain regarding the lithic technology and the chronology. Up to now, the blade technological systems have not been described in detail. The reduction systems appear mostly unidirectional and if a more detailed analysis confirms these observations, it would then appear closer to a Hayonim E type of industry rather than to the Altai IUP. Blade cores are infrequent but some appear as sub-volumetric. It will be necessary to determine if they are analogous to the sub-volumetric IUP reduction or if they represent exhausted semi-turning cores. Moreover, a systematic study of the small laminar elements should help to determine the degree of technological variability of this assemblage which seems to be higher than among IUP assemblages from Altai but also from Baikal and Mongolia. BCs have been illustrated among various types of core including UP forms such as narrow-faced cores, lateral burin or microblade cores. So far, the latter are rare or non-existent among IUP assemblages, but some have been described among the laminar MP assemblages in the Levant (Hayonim E and F) (Meignen, 2007). Depending on the methods, chronological issues are significant and the earliest occupation at Obi-Rakhmat could be assigned to OIS5-OIS4. Some authors have argued that the top of the sequence is within the range of radiocarbon dates (Krivoshapkin, Kuzmin, *et al.*, 2010), but this requires confirmation as, so far, the assemblage cannot be chronologically attributed either to the MP or the IUP.

It is suggested that the scenario of local transition in the Altai lacks support in several areas. One key point is whether the the Altai was permanently occupied during the critical time period. Based on his analysis of the fauna and on the frequency of lithics, Wrinn (2010) considered that the Altai shows a very low intensity of human occupation and was not permanently occupied during the Late Pleistocene. Instead, it appears that the Altai shows successive incursions of human groups starting from the last interglacial. Whether human occupation takes place during warm or cold intervals cannot be determined due to the lack of precise and reliable chronological or paleoenvironmental data. Starting from OIS5e, multiple incursions probably from northwestern Tian-Shan brought to the Altai region assemblages of Levallois-Mousterian type. These population movements have probably contributed to the appearance of IUP in the region. It is not clear yet if the IUP represents rapid population dispersals straight from the Near-East or if it emerged from a longer transitional process initiated in Central Asia. The timing and the nature of its development are still unknown, and if a transition toward IUP occurred in the Altai, it is not yet convincingly documented in the regional archaeological record.

9.1.4 IUP: DISPERSAL FURTHER EAST

Based on some preliminary comparisons, some assemblages from the Baikal and from northern Mongolia show a high degree of similarity with the Altai IUP. Several arguments suggest a quick dispersal of the IUP techno-complex rather than for a technological convergence. The first argument, which has been put forward by several authors, is the absence of laminar MP traditions prior to the appearance of IUP assemblages in these areas. The presence of Mousterian groups east of the Altai central plain is reported starting from OIS5e (*e.g.* Ust-Izhul) but is rather elusive (Chlachula *et al.*, 2003). Assemblages are small and technologically non-diagnostic or show some contextual (Flint Valley in Mongolia) (Derevianko *et al.*, 2000) and chronological problems (*e.g.* Dvuglazka cave; Orkhon 1 and Orkhon 7) (see also, Derevianko and Petrin, 1995). The site of Priskovoe in the Trans-Baikal region was thought to represent one of the earliest occupations of the region. Based on a recent and detailed geoarcheological study and on new radiocarbon and OSL dates, the assemblage

is now assigned to the beginning of OIS2, circa 26 ka ^{14}C BP (Buvit *et al.*, 2011). This suggests that undated lithic assemblages showing archaic features have to be dated before they can be used to argue for a MP presence in the region. In other words, there is currently no convincing evidence for a local transition in any of these regions.

The second argument is linked with the geographic distribution of the sites. Goebel (2004) notes that none of the Siberian MP sites are located north of 55° latitude. In fact, a similar observation applies to IUP sites as opposed to later OIS2 UP occupations which extend further north. Although this may be a taphonomic bias, it suggests movements/contacts following a west-east axis. Sites show similar settlement patterns and usually are found at the confluence between small tributaries of a larger river and on a prominent topographic location. When preserved, the associated fauna show similarities, with the occurrence of Mongolian gazelle, Siberian goat and horse.

The third argument is related to the chronology, which although being rather coarse-grained, suggests a simultaneous appearance of IUP assemblages. Oldest dates indicate a first appearance starting from the beginning of OIS3, circa 50-45 ka ^{14}C BP.

Finally, assemblages show a high degree of technological and typological similarity despite the distance between them. These similarities include the earliest occurrence of bone tools and ornaments reported within each of the regions. Some authors (*e.g.* Goebel, 1994, 2004, 2006; Brantingham *et al.*, 2001; Rybin, 2005) have already suggested the existence of a unified techno-complex at the beginning of the UP. The present set of evidence suggests a relatively high degree of complexity particularly expressed in terms of standardized technological procedures. From a regional point of view, it is reasonable to assume that the Altai IUP reflects a single population. Following Byrne's approach (2007), it implies that the IUP shows the required combination of intricate complexity and near ubiquity that would illustrate cultural transmission processes. If the same reasoning is extrapolated to the Baikal and Mongolian assemblages, the current evidence strongly supports the hypothesis of techno-complex dispersal through north Asia (Goebel, 1999) at the beginning of OIS3.

9.1.5 IUP: THE MAKERS

In the Altai, Neandertals are clearly associated with Mousterian assemblages at Okladnikov cave and at Chargirskaya cave. Levallois-Mousterian, IUP and EUP are not yet assigned to a hominin taxa, and the remains of the so-called Denisovans derive from a problematic stratigraphic context. Layer 11 at Denisova cave includes three distinct technological features some of which are similar to the underlying layers and represent the archaic component. IUP and EUP typical features also occur, and radiocarbon dates indicate a certain degree of sediment reworking. Moreover, carnivore activity is attested to in this part of the cave. In the absence of direct dates on the Denisovan fossils, the question of their cultural attribution remains open.

In spite of the absence of reliable fossil associations with IUP assemblages, several elements can be discussed. At Obi-Rakhmat, a lithic assemblage showing intriguing similarities with the IUP is associated with Neandertal remains. The lithic assemblage is relatively homogenous from the bottom to the top, and the fossils are found in the middle part of the sequence in direct association with archeological material. The layer was deposited in a low-energy spring environment. Considering that Neandertals were the makers of the Obi-Rakhmat assemblage would imply that in central and Northeast Asia they may have produced significantly different lithic assemblages, ranging from the classic Mousterian to a developed blade industry that includes UP technological elements but without any formal bone tools or ornament.

Attributing to Neandertals such a diverse set of behaviors underlines the difficulty of assigning a lithic assemblage to a hominin taxon in the absence of associated fossils (*e.g.* Slimak *et al.* 2011, Zwyns *et al.* 2012). This is reinforced by the fact that assemblages tentatively attributed to the first MH in India or associated with MH in Australia are not laminar and relatively simple. It has recently been proposed that MH

first spread through Europe as early as the Greenland Interstadial 12, circa 45 ka ^{14}C BP, along with the Bohunician techno-complex (Hoffecker, 2009). In Southeast Asia, the first indisputable evidence of MH is dated circa 45 ka ^{14}C BP. This chronological range matches with the first appearance of the IUP in Northeast Asia dated to circa 45 to 40 ka. Based on the available radiocarbon dates, OH6 and OH5 in Kara-Bom would fit with the Chani I or Chani II climatic events as identified in the Kurtak loess-paleosoil succession. The Chani I event has been correlated with the Bohunice soil and, therefore, could match with the chronological range of the Bohunician dispersal. In this sense, the Altai IUP could be seen as a one of the 'road signs' (Bar-Yosef and Belfer-Cohen, 2011) which would illustrate MH dispersal. The association of the IUP with MH would imply a possible chronological overlap with the Neandertals directly dated to circa 37 ka ^{14}C BP.

To summarize, given the considerable variability in lithic production that could be associated with either MH or Neandertal and given the recent identification of a third hominin in the Altai, it is currently not possible to associate the IUP with a specific hominin taxon. If confirmed, the presence of bone tool technology and ornaments associated with the IUP might suggest that an association with MH is the most parsimonious. The available chronological data could support this hypothesis which, in the absence of associate fossils, still remains speculative. The archeological data have been previously used to suggest the absence of long-range migrations and to support a model of a local emergence of MH. Using the same data set, another interpretation can be proposed in which the late Pleistocene human occupation in the Altai is seen as the result of multiple incursions from the western lowlands and from Central Asia. These population movements may have been facilitated by favorable environmental conditions (Derevianko *et al.*, 2005). At the beginning of OIS3, one of these incursions leads to the rapid dispersal of a techno-complex across the southern part of Siberia, to the Cis-Baikal area, and then to Mongolia via the Selenga river basin. As opposed to a continuous and local evolution scenario, the proposed model implies significant population movement. This model is consistent with the Out-of-Africa paradigm.

9.1.6 IUP-EUP: THE SHIFT

The disappearance of the IUP from the Altai region is problematic for two main reasons. The first reason is the difficulty of assigning assemblages such as Kara-Bom OH4 to either the IUP or to the EUP. The technological analysis suggests IUP affinities, but most of the main diagnostic elements could not be found in the sample analysed. The second major difficulty is linked with the chronological data. Sample contamination rarely ages radiocarbon dates, but it often tends to provide younger results. New pretreatment methods help minimize these problems, but they have yet to be widely applied to the Altai record. Thus, it is difficult to evaluate the reliability of young dates. From a general point of view, evidence of IUP presence after Heinrich 4 event is scarce. It seems that it overlapped with the end of the Mousterian, but due to large standard deviations and to some inconsistencies between results, the length of this overlap is difficult to evaluate. Nevertheless, Mousterian assemblages disappear prior to the Heinrich 4 event. The most reliable dates associated with the EUP indicate that this techno-complex appears shortly after the Heinrich 4 event, prior or during the Konoschelie cooling, circa 33 ka ^{14}C BP. More dates are available for the warm events of Kurtak III, circa 31-30 ka. Inter-stratifications between the two techno-complexes have not been observed and, due to the large standard deviations of some radiocarbon dates, it cannot be ruled out that the IUP and EUP are separated by a significant chronological gap. The assemblage of OH4 at Kara-Bom could represent a human occupation taking place either before or during the Heinrich 4 event. Given the current imprecision of the radiocarbon chronology and the lack of understanding of the regional environmental response to Heinrich 4 event, it is not possible to formally link climatic oscillations and shifts in human occupations. Nevertheless, the sudden appearance of a new technological tradition marks the period corresponding to the GI8.

9.1.7 EUP: LAMINAR TECHNOLOGY AND RETOUCHED TOOLS

EUP groups selected large or medium blocks for blade production of a more modest size. The method appears poorly standardized but includes genuine volumetric cores with semi-turning reduction. Slabs or small pebbles of fine-grained raw material are selected and fractured to produce bladelets and microblades. The production of blades and small laminar elements are dissociated since the earliest stages of the reduction, even if thick cortical flakes are occasionally used as core blanks.

Blade reduction seems to be less systematic than for the IUP. Although the use of crested blades is assumed, the earliest stages of reduction are not well documented. Volumetric cores are reduced mainly by unidirectional flaking and the blades obtained are generally of medium size. Crested elements occur but are not numerous. The majority of the platforms are plain and of reduced size, and facetted platforms are rare. Partial faceting is absent and regular blades have a diffuse bulb, a macroscopic lip and show traces of thin abrasion along the external edge of the platform. According to Pelegrin's definition (1995), this set of features suggests the use of softhammer, although it seems that hard hammer is occasionally used to detach crude flakes. Some cores bear removals from an opposed platform. Derevianko and Volkov (2004) suggest that this represents a management of the distal convexities of the flaking surface. In the context of Chatelperronian assemblages, Pelegrin (1995) suggests that, starting from a certain size, alternate bidirectionality combined with the use of soft hammer would increase the risk of overshot. Thus, a secondary striking platform is used to remove short flakes that shape the distal convexities with elongated blade blanks detached from the opposed primary platform. Blanks obtained may not bear clear opposed removal scars on their dorsal face making them appear as chiefly unidirectional based on the dorsal patterns. Other examples suggest that cores are reduced following relatively long unidirectional reduction sequences followed by a change of orientation with flaking surfaces being used independently.

The small laminar elements are produced from slabs following three main procedures. The first procedure starts with narrow slabs, with the reduction of narrow-faced cores displaying a flaking surface on a narrow edge. The initial flaking follows natural or prepared crest and the core is shaped by lateral preparations and/or posterior crests. The reduction suggests a continuity between small blades and bladelet blank production and appears distinct from the medium size blade reduction. The reduction is strictly unidirectional and sometimes slightly convergent, and occasional overshots combined with opposed distal preparations keep the flaking surface triangular. These cores are similar to prismatic forms described at the base of the Aurignacian sequence in Isturitz, France (Normand and Turq, 2005; Normand *et al.*, 2007), or in Proto-Aurignacian contexts like Fumane (Broglio *et al.*, 2005) or Siuren I unit G (Demidenko, 2001; Demidenko and Otte, 2001; Zwyns, in press). However, in these assemblages the reduction often tends to be semi-turning, with a relatively broad flaking surface. In the Altai EUP, the reduction seems more frontal and, except for the core management, it does not extend to the lateral sides. The keel and the triangular shape of the flaking surface are more pronounced than in the classic prismatic forms. These features are more typical of the Early Ahmarian of the Negev (*e.g.* Boker A, Nahal Nizhana XIII) and have been defined by Davidzon and Goring-Morris (2003) as narrow-fronted cores (see also Monigal, 2003; Goring-Morris and Davidzon, 2006; Belfer-Cohen and Goring-Morris, 2007). In the Zagros, the early stages of the Baradostian includes similar forms, although they show more variability (Otte *et al.*, 2007, 2011; Bordes and Shidrang, 2009; Tsanova *et al.*, 2012). Generally speaking, they represent a classic and fully developed UP technology with a volumetric approach and a frontal reduction. Blanks obtained are small blades/bladelets with straight or slightly curved profiles, and they can be naturally pointed. The strata 11-8 at UK1-2 or the OH8-12 at Anuy II also include small sized examples that may have produced microblades.

The second procedure starts with the selection of small pebbles, thick slabs or cortical flakes. Pebbles are split in two halves, likely using a hammer and anvil technique. The reduction starts from a plain strik-

ing platform by semi-turning removals. Cores appear as carinated endscrapers with a broad flaking surface. Occasionally, the flaking surface is narrowed by the removal of fronto-lateral flakes and then turned into shouldered or nosed-endscrapers. Blocks can sometimes be reduced as carinated endscrapers. The blanks produced are bladelets or microblades. This technology is well documented in European Aurignacian contexts (*e.g.* Le Brun-Ricalens, 2005) or in the Near-East (*e.g.* Bergman, 1988; Chazan, 2001; Soriano and Ploux, 2003; Williams, 2003) but also in later assemblages. Carinated burins are quasi-absent and other burin-like cores are rare.

The third procedure represents a combination of narrow-faced cores and carinated endscrapers. In some cases, it appears that, in the first phase of reduction, the core is treated as a carinated form before being turned into a narrow-face core. Orientation changes in the course of the reduction are documented in various assemblages, such as Proto-Aurignacian, Aurignacian, Baradostian or others. From the present analysis, it is inferred that the reduction processes are relatively short. The technology, although clearly oriented to the production of bladelets or microblades, is flexible enough to adapt to the morphology of the raw material nodules.

Although only a small series of blanks is preserved, a large variability of retouched blanks is observed in the EUP. It includes Dufour bladelets and microblades, backed pieces, microblades with bilateral retouch and retouched blanks with oblique truncations. The Dufour bladelets mainly show inverse retouch and in some cases fragments show alternate retouch. The Dufour of Roc-de-Combe sub-type is absent and some of the Dufour can be assigned to the Dufour subtype Dufour (Demars and Laurent, 1992). The lack of standardization of the blanks and the position of the retouch, however, suggest that this typology may be irrelevant in the case of the Altai data set. The backed pieces are usually narrow and elongated microblades with abrupt retouch. Small bifacial pieces are infrequent. A series of small end scrapers fall outside the size range of bladelet and microblade cores. Derevianko and Volkov (2004) report the emergence of pressure flaking in these assemblages. Following Tixier *et al.*'s (1984) definition, the use of this technique could not be observed within these assemblages. Instead, the technique of percussion proposed is soft hammer.

EUP assemblages are characterized by a specific selection of raw material. Part of the observed technological variability is interpreted as a response to the raw material shape, illustrating a certain degree of technological flexibility. Some of the cores suggest continuity between blade and bladelet categories, but others show reduction sequences exclusively oriented toward microblade production.

9.1.8 EUP: THE ASSIGNEMENT

According to the available chronological data, these assemblages represent the first occurrence of a fully developed UP laminar technology in the region, with a special emphasizes on bladelets. In Europe and in the Levant, the EUP is characterized by a continuous reduction from small blade to bladelets, but also by a relative emancipation of the of the bladelet reduction strategies (*e.g.*Teyssandier *et al.*, 2010). In other words, small raw material nodules are selected to produce small blanks and the bladelet technology no longer depends exclusively on the larger blank production. Since the techno-complex in question matches this description, it seems appropriate to assign it to Early Upper Paleolithic. Moreover, the lithic assemblage from stratum 9 at UK1-2 is associated with a serpentine pendant. At Denisova cave, layer 9 from the central chamber has yielded a series of bone tools and ornaments. The layer 6 from the entrance zone is associated with bone tools and, in the eastern gallery; a rib with regular incisions associated with the layer 11 has been directly dated to 30 ka. This date falls into the EUP chronological range. These associations need to be confirmed as both of these sequences have shown some taphonomic problems. At Anuy II, the OH12-OH8 assemblages' chronological range extends to the Sartan but do not illustrate major technological changes. Technological equivalents are found in Europe and in the Near-East with a similar EUP assignment. Teyssandier and colleagues have stressed that in Europe and in the Levant, the shift from Middle to Upper Paleolithic is characterized by intensification in the production of pointed

elements (Teyssandier *et al.*, 2010). This trend would reflect a gradual technological development in projectile weaponry. In this view, the differences observed between IUP and EUP laminar reduction could be seen as the generalization of a new kind of composite projectile, perhaps including lateralized lithic implements.

9.1.9 EUP: THE ORIGINS

Based on the UK1-2 and on the Denisova sequences, Derevianko (2011a) suggests a local emergence of the EUP from the local MP background, and Derevianko and Volkov (2004) reconstruct a scenario of technological evolution based on the UK1-2 sequence (see Chapter 5). This model is based on core descriptions and argues for a gradual evolution from a unidirectional recurrent Levallois flake production dated to OIS5e (N=2 + in stratum 13 N=1) to a volumetric unidirectional blade production in stratum 11a (N=2) dated to OIS3, with intermediate forms in the undated strata 13 (N=1) and 11b (N=1). In other words, the model of gradual and local evolution is based on an assumption of continuous Late Pleistocene human occupation in the Altai and is described on the basis of seven cores. In addition, four of the cores are assigned to strata for which refits have shown mixing between MP and EUP layers. It is also noted that Derevianko and Volkov's reconstruction (2004) of the stratum 18 flake technology differs from the bidirectional flaking schema described by Postnov on the basis of refits. Some of their descriptions are not consistent with the present study. For example, a core from stratum 13 (UK-1.94.21/8.1.13) is supposed to represent the unidirectional Levallois recurrent method but is described here as a bidirectional Levallois blade core (see fig 193). Derevianko and Volkov (2004) acknowledge that bladelet and microblade cores occur starting from stratum 11 and are, therefore, not linked to the MP. The evolutionary reconstruction is also problematic as stage 1 and stage 3 occur in almost all EUP layers. Derevianko (*e.g.* 2011a) suggests that the Denisova sequence illustrates a similar gradual evolution; however, the MP layers 21 to 12 from the central chamber have been published by the same authors as a non-Levallois assemblage. Moreover, the lack of stratigraphic control and the uneven sample size combined with inconsistencies in the assemblage attributions do not support a local evolution scenario. It is, therefore, suggested that the EUP techno-complex is intrusive, probably from Central Asia. Preliminary reports from the site of Maybulak, in eastern Kazakhstan, indicate the presence of comparable assemblages in the Altai foothills circa 33-32 ka ^{14}C BP.

9.1.10 EUP: THE DISPERSAL

Kuzmin (2007) and Keates (2007) propose an emergence of microblade technology in the Altai through the examples of Ust-Karakol I and Anuy II. This leads to one of the most problematic aspects of the definition of 'microblade' and 'wedge-shaped cores'. As noted by Graf (2009), many definitions of microblades have been published but confusion remains between the flaking techniques. In the present study, microblades are defined based on metric criteria (width <6 mm). Following this definition, microblade reduction sequences first occur with the EUP starting from circa 33-30 ka ^{14}C BP. It is clearly stated here, however, that pressure flaking was not observed among these assemblages. Therefore, it is suggested that the main confusion is not due to the recognition of exhausted prismatic cores (*contra* Graf, 2009) but rather with the identification of pressure flaking techniques. Wedge-shape morphology is recognized since the earliest stages of the UP in Europe and in the Near-East, but also in Central Asia, where it occurs in the lowermost assemblage of Obi-Rakhmat (see Chapter 8). In the present study, such cores are described as narrow-faced cores and it is suggested that the wedge-shaped core definition should be restricted to artifacts clearly illustrating the pressure flaking technique. Regarding the origin of pressure flaking, it was suggested that this technique first emerged around 30 ka in the Sino-Mongolian region (Inizan, 1991). The present results, however, concur with previous studies (Goebel, 2002; Graf, 2009) suggesting the absence of such a technique in the Altai during OIS3.

The hypothesis developed by Otte (2004, 2007) is that while MH may have evolved biologically in Africa, the total absence of Aurignacian would in-

dicate that modern material culture that eventually colonizes Europe was developed elsewhere. In this context, Asia is seen as a demographic reservoir and a cultural center from which Aurignacian culture developed before moving into Europe. Otte and Derevianko (2001) propose to associate the Altai EUP with an Aurignacian techno-complex *sensu-lato*, mainly due to the presence of carinated endscrapers and Dufour bladelets. Otte and Kozlowski (2001) note that the EUP appears in the Altai without antecedent but mention elsewhere the existence of an evolution in the sequence of UK1-2 (Otte and Kozlowski, 2003). They note, however, that the lower part of the sequence is significantly older than the upper one which contains the Aurignacian-like assemblages. To the west, the main points of comparison are the assemblage C3 from Kara-Kamar, in Afghanistan, and the Baradostian from the Zagros. Vishnyatsky (2004) stressed that similar assemblages are unknown in Central Asia and in fact, until recently, most parts of this region were thought to be deserted by humans during OIS3-2 (Davis, 1990; Davis and Ranov, 1999). Recent excavations at Kulbulak and Dodekatym II, in Uzbekistan, suggest that some UP assemblages combining carinated pieces, Dufour and backed bladelets and geometric microliths are present prior to the LGM. Moreover, assemblages with carinated pieces, bladelets and microblades dated to circa 32 ka ^{14}C BP have been reported at Maybulak, in east Kazakhstan, near the southwestern edge of the Altai range.

As proposed elsewhere (Zwyns and Flas, 2010), the eastern geographic extension of the Aurignacian techno-complex *sensu strictu* can be followed to the Don River at Kostenki. The Baradostian may be derived from the Early Ahmarian but also shows clear Aurignacian features prior to the emergence of the Levantine Aurignacian. In Central Asia, evidence is still too scarce to stretch the definition of the Aurignacian. As it was shown in different contexts, carinated pieces and Dufour bladelets can occur in later UP contexts and do not imply a direct link with the Aurignacian (*e.g.* Zwyns, 2004). On the one hand, it cannot be ruled out that in Asia the emergence of such technological elements corresponds to the success of a particular kind of projectile instead of representing the spread of a well defined cultural entity (Zwyns and Flas, 2010). On the other hand, it is reasonable to consider that the Altai EUP did not develop *in situ* and may represent human incursions from Central Asia or elsewhere, that could have played a role in the spread of microblade technology in China (Bar-Yosef and Belfer-Cohen, 2011). This is consistent with the view that the generalization of the bladelet-based assemblages, and perhaps of a specific composite projectile technology, reflect socio-economical changes among hunter-gatherer societies such as an increase in group mobility (Bon, 2005).

9.1.11 EUP: THE MAKERS

For now no human fossils have been found in association with these assemblages. The MH remains from Povkovka/Mali Log, although recently mentioned as associated with the Aurignacian (Higham *et al.*, 2011) were not found in archeological context. They have been directly dated to circa 29 ka and fall within the chronological range of the EUP. In Europe, such assemblages have been clearly associated with MH (*e.g.* Bailey and Hublin, 2005; Bailey *et al.*, 2009), and the same association can be reasonably assumed for the Altai EUP. During this time, MH may have already been in Southeast Asia for at least 10 ka (Bowler *et al.*, 2003; O'Connell and Allen, 2004; Barker *et al.*, 2007).

9.1.12 EUP: THE END

The timing and the circumstances of the disappearance of the EUP from the Altai sequence is not clear. At UK1-2 radiocarbon dates are inconsistent and do not match with the paleomagnetic inversions (Derevianko *et al.*, 2003). The latest date indicates an age of 26 ka ^{14}C BP and is contemporaneous with Heinrich 3 event, which as recorded in Kurtak, indicate a major climatic degradation (Haesaerts *et al.*, 2009, 2010). At Anuy II, radiocarbon dates illustrate occupations until circa 22 ka ^{14}C BP, the end of occupation roughly corresponding with the Heinrich 2 event. At that time, the climatic degradation of OIS2 and the blockage of some river systems led to the multiplication of lakes and to the formation of giant inter-connected lakes (see Chapter 1). The dramatic

drainage of the Chuya depression glacial lake, circa 13 ka, may have destroyed evidence of human occupation along the Katun River and some scholars (*e.g.* Chlachula, 2001; Zolnikov, 2008) have suggested that similar events may have happened periodically between 26 ka to 13 ka. These climatic changes may have had a significant impact on the landscape and on the human occupation. Human groups may have moved into the lowlands of western Siberia or eastward along the Ienissei River as it is so far not clear if Siberia was occupied during the LGM.

9.2 CONCLUSIONS

Based on a taphonomic and technological analysis of the laminar material from the Upper Paleolithic open-air sites of Kara-Bom and Ust-Karakol, three main issues have been tested.

- 1 – the existence of two distinct UP variants in the region:

The results confirm the existence of two distinct techno-typological variants at the beginning of the Upper Paleolithic. The first variant (Kara-Bom variant) is assigned to an Initial Upper Paleolithic blade based industry that shows a standardized sub-volumetric and volumetric blade production but also a specific technology oriented toward the production of small laminar blanks. The latter is defined here as the burin-core technology. The second variant (Ust-Karakol variant) is assigned to Early Upper Paleolithic and is characterized by a fully developed volumetric blade technology associated with a microblade production from narrow-faced cores and carinated endscrapers.

- 2 – the chronological overlap between of these UP variants:

This hypothesis could not be confirmed. Based on a taphonomic revision of the Ust-Karakol 1 (UK1-1) (sector 1) sequence, a relative chronology has been established with an initial occurrence of the IUP followed by the EUP. Using a conservative selection of the available chronological data, a chrono-cultural model of succession between the two variants has been proposed and tested against the regional data set. However, due to the resolution of the chronological data, it could not be completely tested. Nevertheless, the model was not contradicted and suggests that the IUP occurs first at the beginning of OIS3, likely during a warm phase that corresponds to the Bohunice soil in Europe. It appears to overlap with the time range of the regional Mousterian and both techno-complexes seem to disappear from the region prior to the Heinrich 4 event. The EUP appears quickly after and does not seem to overlap significantly with Mousterian and IUP human occupations.

- 3 – the geographical distribution of the variants:

As some authors suggested the existence of an IUP techno-complex in north Asia, a series of comparisons have been proposed using the variants defined in the present study. The results support the existence of an IUP techno-complex present in the Altai, in the Cis-Baikal region, in the Trans-Baikal region and in northern Mongolia. By redefining the UP variants, the present study narrows the variability between assemblages, suggesting a quick and long-range dispersal of a homogenous techno-complex contemporaneous with the first indisputable evidence for MH in Southeast Asia. Some assemblages indicate that beside the lithic technology, bone technology and ornaments can be considered as part of the IUP behavioral package.

According to the obtained results, the current data set is not consistent with the idea of a local development for either of the UP variants. Instead, it is suggested that the human occupation in the Altai may illustrate multiple incursions of human groups during the Late Pleistocene, probably originating from Central Asia. Therefore, the proposed interpretations do not support a multi-regional model of for the origin of MH.

9.3 PERSPECTIVES

This section briefly summarizes a series of tests for the proposed models and their implications:

- Taphonomy, chronology and settlement dynamics:

The proposed chrono-cultural model is based on a small but reliable data set that needs to be confirmed by new chronological data. The available radiocarbon dates provide only a coarse-grained picture due to large standard deviations. Thus, it seems necessary to undertake a large dating program to test the model. The latter would benefit from the latest improvements in sample pre-treatment methods. Used consistently, these methods would provide more comparable results. In addition, RTL and EPR dates should be confirmed by TL or OSL methods. This cannot be achieved without a better understanding of the site formation processes using methods such as soil micro-morphology or sedimentology combined with systematic taphonomic studies. Together, these improvements should help our understanding of the meaning of the observed assemblage variability. Refining the chronology of human occupations would also facilitate comparisons with the paleo-environmental data recorded in high resolution chrono-stratigraphic sequences, thus providing a better understanding of settlement dynamics. It would also help to assess the observed overlap between the Mousterian and the IUP and to obtain more accurate data on the timing and the circumstances of the appearance and disappearance of the two UP variants. As shown by the Denisova example, the association of the IUP variant with the bone tools and ornaments should be confirmed by direct dating.

- Assemblage comparisons and dispersal model:

It is understood that the present study is based on a relatively small sample size given the area considered and mainly focuses on laminar technology. The long distance comparisons are made on the basis of preliminary qualitative observations and on the published material. Quantitative analyses on additional IUP lithic assemblages, using a unified methodology, are necessary to get a more precise picture of the variability among IUP assemblages. A study of the lithic assemblages from northern Mongolia and the Trans-Baikal is on-ongoing. Only preliminary results have been presented here. A similar study is needed on the assemblage of Obi-Rakhmat. In addition, the excavation of the newly discovered open-air site of Tolbor 16, in northern Mongolia, started in 2011 will provide new lithic and chronological data. It appears that the only way to assess questions related to the makers of the IUP is to obtain human fossils associated with the lithic assemblages. Whoever the makers of the IUP were, it would represent a major discovery as this techno-complex represents a cultural bridge, bringing blade and bone technologies from Central Asia to the gates of China.

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Dutch Summary – Kling technologie en het begin van het laat-paleolithicum in de Altai, Siberië

In de scenario's van menselijke verspreiding over Centraal en Noordoost Azië, geldt het Altai gebied als de poort naar Siberië. Het gebied heeft een groep midden- en laat-paleolithische gestratificeerde vindplaatsen opgeleverd, die recentelijk opgegraven zijn met een multi-disciplinaire benadering. Deze opeenvolgingen leverden belangrijke bewijzen op die veranderingen in de materiële cultuur illustreren die overeenkomen met de overgang van het midden- naar het laat-paleolithicum. In Europa wordt dit verschijnsel geassocieerd met de vervanging van de Neandertalers door anatomisch moderne mensen. Gebaseerd op deze dataset hebben onderzoekers verschillende scenario's voorgesteld betreffende de overgangsprocessen, lopend van hypothesen van lokale evolutie tot migraties. Het meest populaire model stelt een parallelle ontwikkeling voor van twee duidelijk verschillende laat-paleolithische tradities die beide voortkwamen uit een lokale midden-paleolithische achtergrond. Zo laten de openlucht vindplaats Kara-Bom lagen een lokaal ontwikkelde levallois-achtige laat-paleolithische traditie zien die gebaseerd is op klingen. Tegelijkertijd zou de Ust-Karakol traditie getuigen van een andere weg naar het laat-paleolithicum, met enige techno-typologische overeenkomsten met het Europese vroeg laat-paleolithicum. Bovendien zou de Sibiryachinsky traditie een binnendringende late mousterien facies zijn, die chronologisch overlapt met het eerste voorkomen van het laat-paleolithicum in het gebied.

De vraag blijft over wie was verantwoordelijk voor het maken van deze werktuig technologieën. Recente ontwikkelingen in oud DNA studies hebben laten zien dat Neandertalers aanwezig waren in het Altai gebergte rond 40.000 jaar ^{14}C BP geleden (met de Sibiryachinsky traditie). Een eerder onbekend genome werd echter verkregen dat de aanwezigheid van een ander type mensachtige in het gebied aantoont, nl. de zogenaamde 'Denisovans'. De aanwezigheid van anatomisch moderne mensen wordt in Siberië bevestigd vanaf tenminste 28.000 jaar ^{14}C BP geleden.

Drie belangrijke onderzoeksvragen zijn geformuleeerd om het model van lokale evolutie te testen:

- Zijn er twee verschillende varianten van het laat-paleolithicum in het gebied?
- Bestaat er een chronologische overlapping tussen de twee varianten?
- Wat is de geografische verspreiding van de varianten?

Ten einde deze vragen te beantwoorden, richt deze studie zich op drie niveaus op kling technologie gebaseerd op monsters van stenen werktuig materiaal van openlucht vindplaatsen. Ten eerste wordt de integriteit van het monster vastgesteld aan de hand van een taphonomische analyse. Ten tweede wordt een analyse van eigenschappen van het stenen werktuig materiaal gebruikt om technologische kenmerken en hun variabiliteit te bepalen. Deze dataset wordt gebruikt om een reconstructie van de kling afbouw volgordes, en meer algemeen van de technische systemen, te ondersteunen. Ten derde worden de technische tradities geïdentificeerd door een theoretisch raamwerk te gebruiken dat gebruikt wordt om culturele overdracht te onderscheiden van uitsluitend ecologische reacties.

De resultaten bevestigen het bestaan van twee verschillende techno-typologische varianten aan het begin van het laat-paleolithicum. De eerste variant (Kara-Bom variant) wordt toegeschreven aan een allervroegst laat-paleolithicum (Engels: Initial Upper Paleolithic = IUP) industrie die gebaseerd is op klingen die een gestandaardiseerde sub-volumetrische en volumetrische kling productie laten zien, maar ook een specifieke technologie die gericht is

op de productie van kleine stenen 'grondvormen'. De laatst-genoemde wordt hier gedefinieerd als de steker-kern technologie. De tweede variant (Ust-Karakol variant) wordt toegeschreven aan het vroeg laat-paleolithicum en wordt gekenmerkt door een volledig ontwikkelde volumetrische kling technologie die geassocieerd wordt met een micro-kling productie van kernen met een smal vlak en gekielde eindschrabbers. De chronologische overlapping tussen de varianten kon echter niet worden bevestigd. Gebaseerd op een taphonomische herziening van de Ust-Karakol 1 (UK 1-1) (sector 1) opeenvolging is een relative chronologie vastgesteld waarin het allervroegst laat-paleolithicum gevolgd wordt door het vroeg laat-paleolithicum. Het allervroegst laat-paleolithicum komt voor het eerst voor aan het begin van oxygen isotope stage 3, waarschijnlijk tijdens een warme fase die correspondeert met het glaciaal interstadiaal 12. Het lijkt te overlappen met de tijdsspanne van het regionale mousterien en beide techno-complexen lijken uit het gebied te verdwijnen voor de Heinrich 4 koude manifestatie. Het vroeg laat-paleolithicum verschijnt hierna snel en schijnt niet substantieel te overlappen met mousterien en allervroegst laat-paleolithische menselijke bewoning.

Vergelijkingen met naburige regio's onderschrijven het bestaan van een allervroegst laat-paleolithisch techno-complex in de Altai, in het Cis-Baikal gebied, in het Trans-Baikal gebied and in noord Mongolië. Door de laat-paleolithische varianten te herdefiniëren, verkleint de huidige studie de variabiliteit tussen assemblages, duidend op een snel en over een lange afstand verspreid homogeen techno-complex in tijd samenvallend met het eerste onbetwistbare bewijs voor moderne mensen in Zuidoost Azië. Enkele assemblages geven aan dat afgezien van de stenen werktuig technologie, ook been technologie en ornamenten beschouwd kunnen worden als onderdeel van het allervroegst laat-paleolithische pakket van menselijke gedrag.

Derhalve strookt, volgens de behaalde resultaten, de huidige dataset niet met het idee van een lokale ontwikkeling van beide laat-paleolithische varianten. In plaats daarvan wordt voorgesteld dat de menselijke bewoning in de Altai vele invasies van groepen mensen, waarschijnlijk afkomstig uit Centraal Azië, kan illustreren gedurende het laat-pleistoceen.

English Summary – Laminar technology and the onset of the Upper Paleolithic in the Altai, Siberia

In the scenarios of hominin dispersals across Central and Northeast Asia, the Altai region stands as the gate to Siberia. It has yielded a cluster of Middle and Upper Paleolithic stratified sites that have been recently excavated using a multidisciplinary approach. These sequences provide key-evidences illustrating changes in material culture corresponding to the transition from the Middle to the Upper Paleolithic. In Europe, this phenomenon is associated with the replacement of Neandertals by anatomically modern humans. Based on this data set, researchers have put forward different scenarios regarding the transition processes, ranging from hypotheses of local evolution to migrations. The most popular model proposes a parallel development of two distinct Upper Paleolithic traditions that both emerged from a local Middle Paleolithic background. The Upper Paleolithic strata from at the open-air site of Kara-Bom thus show a locally-developed levalloisian blade-based Upper Paleolithic tradition. Simultaneously, the Ust-Karakol tradition would testify to a different path leading to the Upper Paleolithic, with some techno-typological similarities with the European Early Upper Paleolithic. In addition, the Sibiryachinski tradition would represent an intrusive late Mousterian facies, overlapping chronologically with the first occurrence of the Upper Paleolithic in the area.

Questions remain regarding who was responsible for making these tool technologies. Recent developments in ancient DNA studies have shown that Neandertals were present in the Altai mountains around 40 ka ^{14}C BP (with the Sibiryachinsky tradition). However, a previously unknown genome was sequenced, demonstrating the presence of another type of hominin in the region, the so-called 'Denisovans'. The presence of anatomically modern humans is confirmed since at least 28 ka ^{14}C BP in Siberia.

Three main research questions are formulated in order to test the model of local evolution:

- Are there two different variant of UP in the region?
- Is there a chronological overlap between the two variants?
- What is the geographical distribution of the variants?

To address these questions, the present study focuses on laminar technology based on a sample of lithic material from open-air sites following a three-tiered approach. First, the integrity of the sample is assessed based on a taphonomic analysis. Second, an attribute analysis of the lithic material is used to quantify technological features and their variability. This data set is used to support a reconstruction of the laminar reduction sequences and more generally, of the technical systems. Third, technical traditions are identified through the use of a theoretical framework used to differentiate cultural transmission from strict ecological responses.

The results confirm the existence of two distinct techno-typological variants at the beginning of the Upper Paleolithic. The first variant (Kara-Bom variant) is assigned to an Initial Upper Paleolithic (IUP) blade based industry that shows a standardized sub-volumetric and volumetric blade production but also a specific technology oriented toward the production of small laminar blanks. The latter is defined here as the burin-core technology. The second variant (Ust-Karakol variant) is assigned to the Early Upper Paleolithic (EUP) and is characterized by a fully developed volumetric blade technology associated with a microblade production from narrow-faced cores and carinated endscrapers. The chronological overlap between the variants, however, could not be confirmed. Based on a taphonomic revision of the Ust-Karakol 1 (UK1-1) (sector 1) sequence, a relative chronology has been established with an

occurrence of the IUP followed by the EUP. The IUP occurs first at the beginning of oxygen isotope stage 3, likely during a warm phase that corresponds to the glacial interstadial 12. It appears to overlap with the time range of the regional Mousterian and both techno-complexes seem to disappear from the region prior to the Heinrich 4 cold event. The EUP appears quickly thereafter and does not seem to overlap significantly with Mousterian and IUP human occupations.

Comparisons with the neighboring regions support the existence of an IUP techno-complex present in the Altai, in the Cis-Baikal region, in the Trans-Baikal region and in northern Mongolia. By redefining the UP variants, the present study narrows the variability between assemblages, suggesting a quick and long-range dispersal of a homogenous techno-complex contemporaneous with the first indisputable evidence for MH in Southeast Asia. Some assemblages indicate that beside the lithic technology, bone technology and ornaments can be considered as part of the IUP behavioral package.

Thus, according to the obtained results, the current data set is not consistent with the idea of a local development for either of the UP variants. Instead, it is suggested that the human occupation in the Altai may illustrate multiple incursions of human groups during the Late Pleistocene, probably originating from Central Asia.

French Summary – Technologie laminaire et les débuts du Paléolithique supérieur dans l'Altaï, Sibérie

L'Altaï joue un rôle de première importance dans les modèles de dispersion des hominiinés à travers l'Asie centrale et du nord-est. Il apparaît comme la voie d'accès vers la Sibérie.

La région présente une concentration de sites stratifiés du Paléolithique moyen et supérieurs, sites qui ont fait l'objet de fouilles pluridisciplinaires récentes. Leurs séquences illustrent les changements culturels et techniques correspondant à la période de transition entre ces deux phases du Paléolithique. En Europe, ces changements sont associés à la substitution de l'homme moderne aux populations néandertaliennes. Sur base des données recueillies, de précédents travaux ont proposé différents modèles de transition, allant de l'hypothèse d'une évolution locale à celle d'une migration.

Le modèle le plus fréquemment cité suggère un développement en parallèle de deux traditions distinctes au début du Paléolithique supérieur, dans la continuité du Paléolithique moyen local. Les niveaux paléolithiques supérieur du site de plein air de Kara-Bom présentent une industrie laminaire levalloisienne. De manière simultanée, se serait développée la tradition d'Ust-Karakol, laquelle témoigne d'un processus de transition différent, montrant des similitudes techno-typologiques avec le Paléolithique supérieur ancien européen. De plus, la tradition de Sibiryachinsky pourrait être le fait de l'intrusion tardive d'un faciès moustérien pauvre en éléments levalloisiens, et qui chevaucherait chronologiquement la première apparition d'un Paléolithique supérieur dans la région.

De nombreuses questions demeurent quant à une association de ces ensembles archéologiques avec les types d'hominiinés présents dans la région. Les développements de l'étude de l'ADN ancien ont pu y démontrer la présence de populations néandertaliennes associées avec le Moustérien de type Sibiryachinsky, aux alentours de 40 000 ^{14}C BP. Cependant, le séquençage d'un génome jusqu'alors inconnu a fait apparaître la présence d'un autre type d'hominiinés: Le «Denisovien».

Celle de l'homme moderne en Sibérie, est quant à elle, attestée dés 28 000 ^{14}C BP.

Sur base de ces données, trois questions principales se posent quant à tester le modèle d'évolution locale:

- Y a-t-il eu dans la région deux traditions distinctes dés le début du Paléolithique supérieur?
- Ces variantes se recouvrent-elles chronologiquement?
- Quelles sont les aires de répartition géographiques de ces deux variantes?

Pour tenter de répondre à ces questions, la présente étude se concentre sur une analyse technologique des productions laminaires, à partir d'échantillons prélevés sur des gisements de plein air, en adoptant une approche tripartite. Premièrement, l'intégrité des échantillons analysés est testée selon une approche taphonomique. Deuxièmement, une analyse par attribut doit permettre de quantifier l'information technologique, et d'évaluer sa variabilité. Les données obtenues servent de base pour la reconstruction des schémas de production laminaire, et de manière plus générale, des systèmes techniques. Troisièmement, les traditions techniques sont identifiées par une approche théorique, permettant une différenciation des processus de transmission culturelle, par opposition à une vision strictement écologique de la variabilité technologique.

Les résultats obtenus confirment l'existence de deux variantes techno-typologiques distinctes durant les phases anciennes du Paléolithique supérieur. Une

première variante laminaire (de type Kara-Bom) qui est attribuée à un Paléolithique supérieur initial (PSI, en anglais Initial Upper Paleolitic), montre d'une part, une production standardisée de lames de grandes dimensions, selon des approches sub-volumétrique et volumétrique, et d'autre part une technologie spécifique à la production de petites lames et lamelles. Cette dernière est définie comme une technologie sur burin-nucléus. Une deuxième variante (variante d'Ust-Karakol) est attribuée à un Paléolithique supérieur ancien (PSA). Elle est caractérisée par le développement d'un débitage laminaire volumétrique, et par une production indépendante de lamelles et micro-lamelles à partir de nucléi sur faces étroites et de grattoirs carénés.

Le recouvrement chronologique entre ces deux variantes n'a cependant pas pu être confirmé. Une chronologie relative peut être établie sur base d'une révision taphonomique de la séquence d'Ust-Karakol (secteur 1), montrant la présence du PSI, suivie par celle du PSA. Le PSI semble d'une part, apparaître dès le début du stade isotopique 3, vraisemblablement durant une phase tempérée contemporaine de l'interstade glaciaire 12 (GI12), et d'autre part recouvrir chronologiquement la fin de l'occupation moustérienne dans la région. Ces deux techno-complexes disparaissent avant la phase froide d'Heinrich 4 et l'apparition soudaine, peu après, du PSA.

Les comparaisons effectuées avec l'enregistrement archéologique des régions avoisinantes, suggèrent l'existence d'un techno-complexe unifié présent dans l'Altaï, dans les régions du Cis-Baïkal, du Trans-Baïkal, jusque dans le Nord de la Mongolie.

En redéfinissant les deux variantes du Paléolithique supérieur, la présente étude reconsidère la variabilité des ensembles lithiques, suggérant une dispersion rapide, et sur de longues distances, d'un techno-complexe homogène, durant une période correspondant à la première apparition indiscutable de l'homme moderne en Asie du sud-est. Par ailleurs, certains ensembles montrent l'existence de parures et d'une technologie osseuse, éléments qui d'habitude sont associés à des comportements dits modernes.

Considérant les résultats obtenus, les données disponibles ne permettent pas d'étayer l'hypothèse d'une apparition locale de ces deux variantes du Paléolithique supérieur. Au contraire, de nombreux indices suggèrent plutôt une certaine discontinuité dans l'enregistrement archéologique, témoignant sans doute de multiples incursions de groupes humains dans l'Altaï, venant probablement d'Asie centrale, durant le Pléistocène supérieur.

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Curriculum vitae

Nicolas Zwyns graduated from the University of Liège, Belgium, in 2004 with a degree in Art History and Archeology. His thesis was entitled *Les steppes nord-pontiques durant le Pléniglaciaire supérieur: Réflexions sur la variabilité des industries et sur la problématique des ensembles aurignacoïdes* and was supervised by Prof. Marcel Otte. In 2006, he successfully completed a Master of Arts in Archeology at University College of London, England, with a thesis entitled *Bladelet production during the Middle-Upper Palaeolithic transition in the Altai region (Siberia): Critical, theoretical and methodological reflections on the contribution of technological analyses* under the supervision of Ignacio de la Torre. In 2007, he received a fellowship from the Department of Human Evolution at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany. During this period, he continued his studies as a PhD researcher under the supervision of Jean-Jacques Hublin and Shannon P. McPherron. His main interest is in the processes that led to the expansion of modern humans into central and eastern Eurasia in the late Pleistocene. He submitted his PhD dissertation in December, 2011. It was supervised by Jean-Jacques Hublin and Shannon McPherron and this book is the outcome of this PhD research.

Since January, 2012, Nicolas has been a post-doctoral researcher at UMR 5608-TRACES – *travaux et recherches archeologiques sur les cultures, les espaces et les societes*, at the University of Toulouse-le-Mirail in Toulouse, France.

As a field archeologist, Nicolas Zwyns participated in numerous Paleolithic excavations from Western Europe to the Tian-shan, including sites in western Russia, in Iran and in Uzbekistan. Since 2011, he has been co-director of an international team excavating the Paleolithic site of Tolbor 16, in northern Mongolia. He has participated in international conferences and published on the beginning of the Upper Paleolithic in Western and Eastern Europe and in Central and North-east Asia. He also participated in studies of the Neolithic/Mesolithic shift in Belgium and collaborated with specialists from other scientific fields, such as ancient DNA. His research is grounded in a multi-disciplinary approach that integrates the results of paleogenetics and of physical anthropology and that views these late Pleistocene hominins as mobile hunter-gatherers responding to a complex and changing physical geography and paleoenvironment.