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## 7 – Research question 2: an alternative chrono-cultural model

The second research question concerns whether there is a synchronous development of the IUP and EUP techno-complex (for more details about the dates, see Chapters 3, 4 and 6). The only open-air sequence where 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  $31,410 \pm 1160$   $^{14}\text{C}$  BP (SOAN-2515) and  $29,900 \pm 2070$   $^{14}\text{C}$  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:  $29,860 \pm 355$  (SOAN-3358),  $29,720 \pm 360$   $^{14}\text{C}$  BP (SOAN-3359) and  $33,400 \pm 1,285$   $^{14}\text{C}$  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  $35,100 \pm 2,850$  (SOAN-3259). The RTL-result of  $50 \pm 12$  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  $43,200 \pm 1,500$   $^{14}\text{C}$  BP (GX-17597) and  $43,200 \pm 1,600$   $^{14}\text{C}$  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  $32,000 \pm 600$   $^{14}\text{C}$  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  $33,800 \pm 600$   $^{14}\text{C}$  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:  $34,180 \pm 640$   $^{14}\text{C}$  BP (GX-17595) and  $33,780 \pm 570$   $^{14}\text{C}$  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  $^{14}\text{C}$  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 m<sup>2</sup>, 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 <sup>14</sup>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 *terminus ante quem* of 44 ka <sup>14</sup>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 were removed regularly during the detachment of

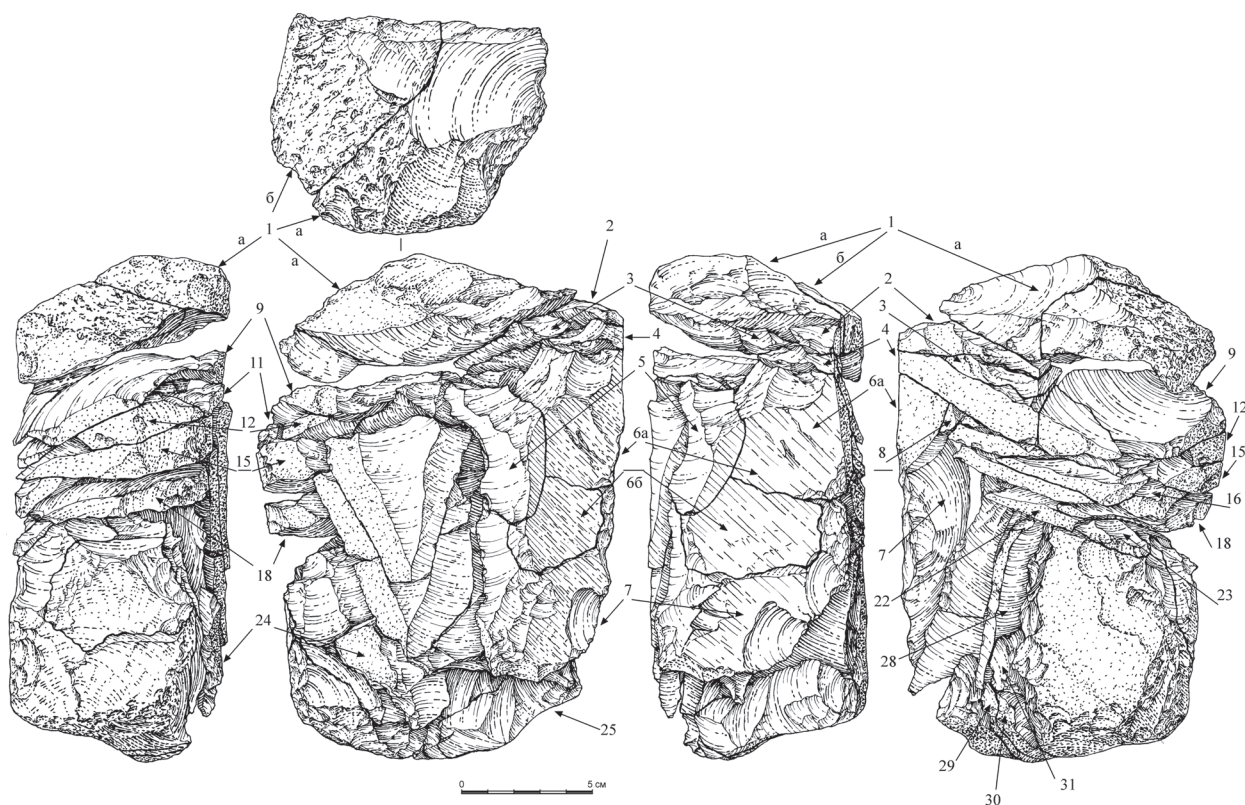


Figure 189: Kara-Bom, MPH2, refitted core (after Slavinsky and Rybin, 2007)

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-faceted 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

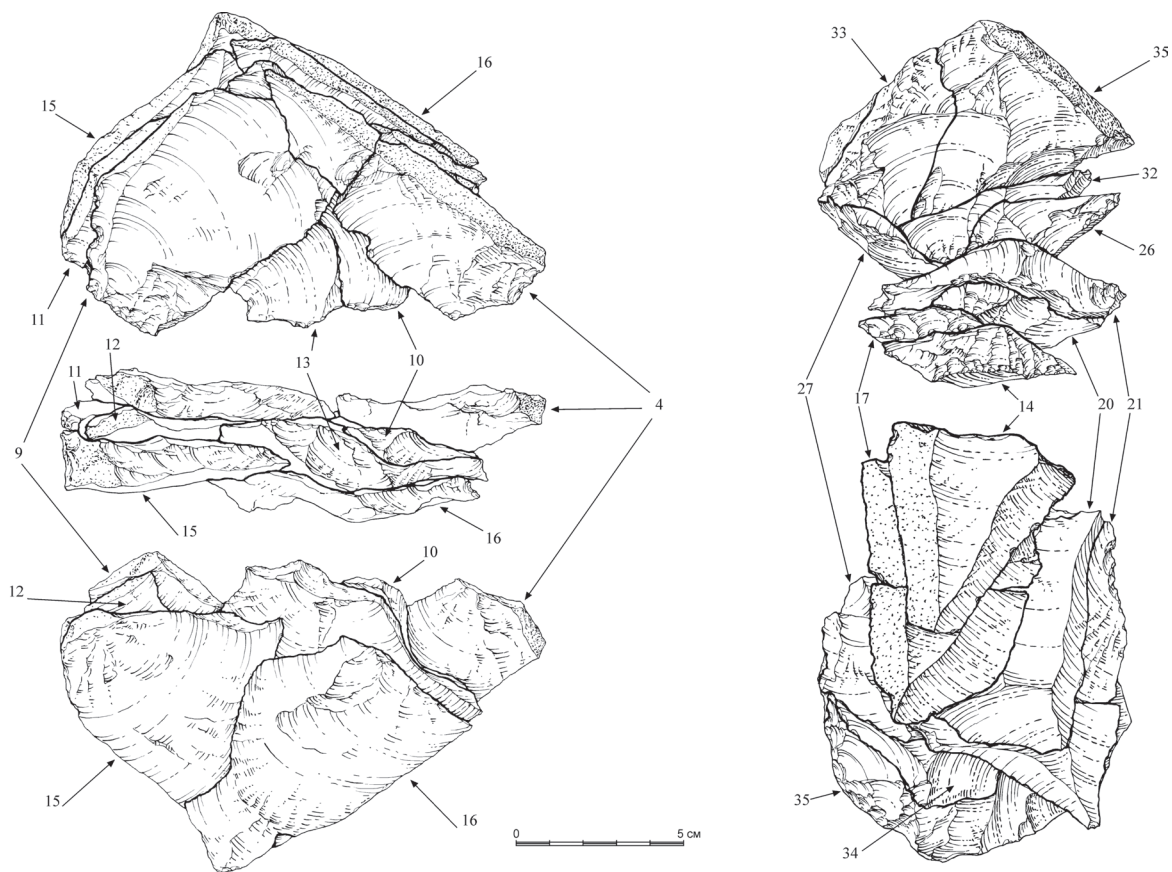


Figure 190: Kara-Bom, MPH2, isolated sequences from the refitted core of Figure 189. Left: transversal flaking; Right: pointed blanks

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 unidi-

rectional (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  $^{14}\text{C}$  BP. It is noted that the youngest date,  $30,990 \pm 460$   $^{14}\text{C}$  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  $38,080 \pm 910$   $^{14}\text{C}$  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  $^{14}\text{C}$  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  $133 \pm 33$  ka BP (RTL-661) by the RTL method applied on alluvial sediments, and stratum 18 is dated to  $100 \pm 20$  ka BP (RTL-659) and  $80 \pm 18$  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

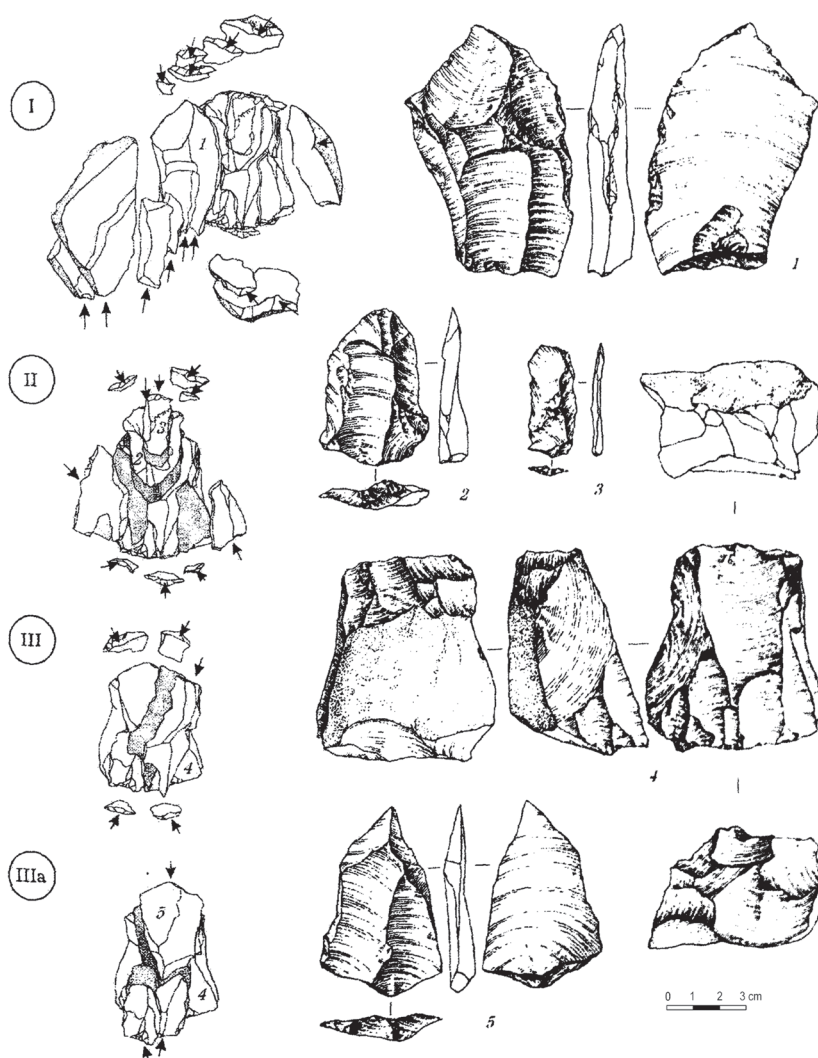


Figure 191: UK1-2, stratum 18, refitted core and reduction sequence reconstruction (after Postnov, 1999)

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 present but cores and technological el-

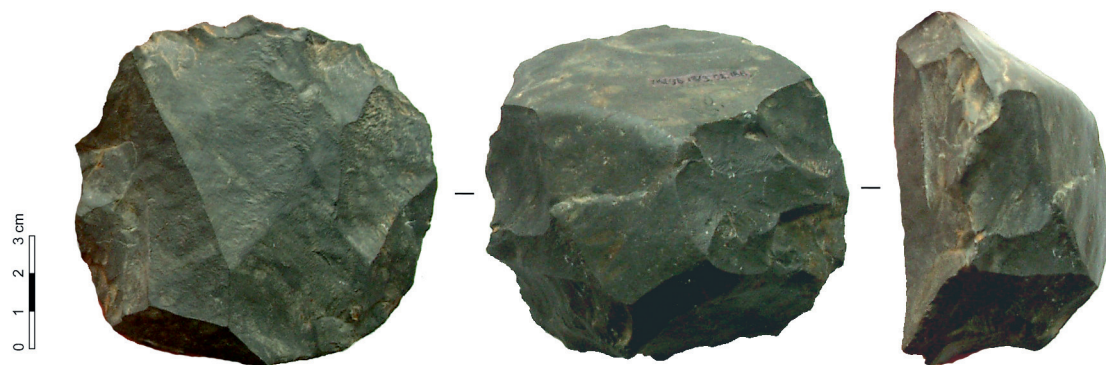


Figure 192: UK1-2, stratum 18, radial core



Figure 193: UK1-2, stratum 13, Levallois blade core

elements 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 m<sup>2</sup> (Derevianko and Zenin, 1990; Goebel, 1994). Paleolithic material was discovered over a 70 m<sup>2</sup> 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 m<sup>2</sup> 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  $54 \pm 13$  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.

#### 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 represented by sidecrappers (N=3) and knives (N=7).



Figure 194: Anuy III, stratum 18, leaf-points

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). Faceted 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 m<sup>2</sup> (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 m<sup>2</sup> test-pit made in 1981, the site was excavated in 1983 over a surface of 100 m<sup>2</sup> (Shunkov *et al.*, 1993). An additional area of 10 m<sup>2</sup> 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 Kuisi 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:  $42,165 \pm 4,170$   $^{14}\text{C}$  BP (SOAN-2485),  $34,760 \pm 1,240$   $^{14}\text{C}$  BP (SOAN-2135),  $31,400 \pm 410$   $^{14}\text{C}$  BP (SOAN-2486), and  $26,875 \pm 625$   $^{14}\text{C}$  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 rela-

tively massive, including bidirectional blade blanks. Although plain platforms are said to prevail in the set, faceted 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-

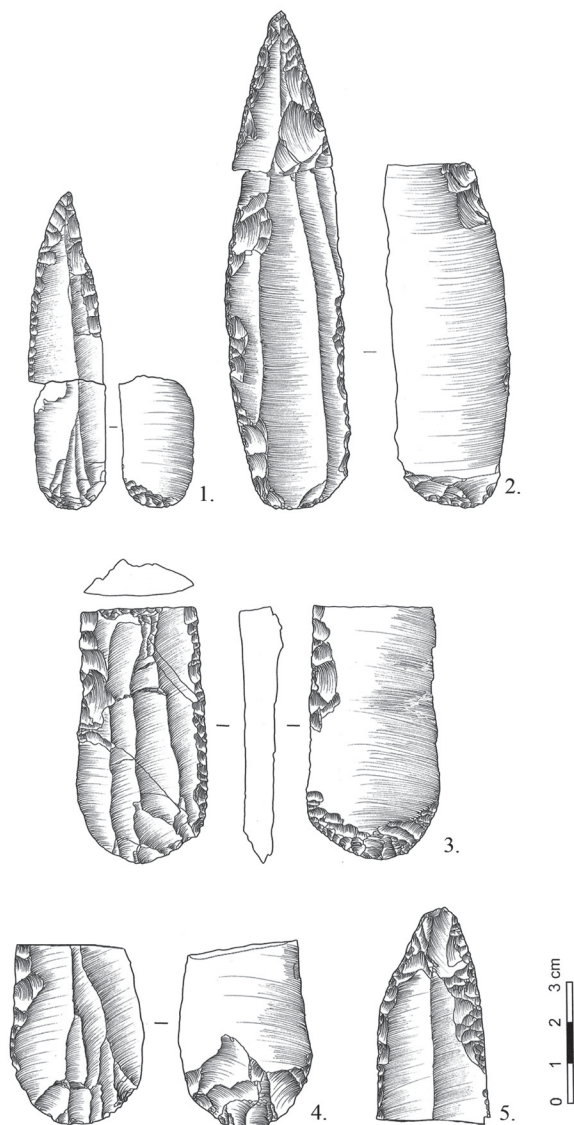


Figure 195: Kara-Tenesh, pointed blade with inverse thinning (1-2), retouched blades with inverse thinning (3-5) and pointed blade (6) (redrawn after Derevianko *et al.*, 2001)

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 intermédiaire*) 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 blank 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-faceted 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 m<sup>2</sup> each. Five lithostratigraphic strata are reported, from which cultural remains (N=223) were 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 endscrapers (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 m<sup>2</sup> 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 m<sup>2</sup> (Okladnikov and Ovodov, 1979). Excavations started in 1982 under the direction of Derevianko.



Figure 196: Denisova Cave

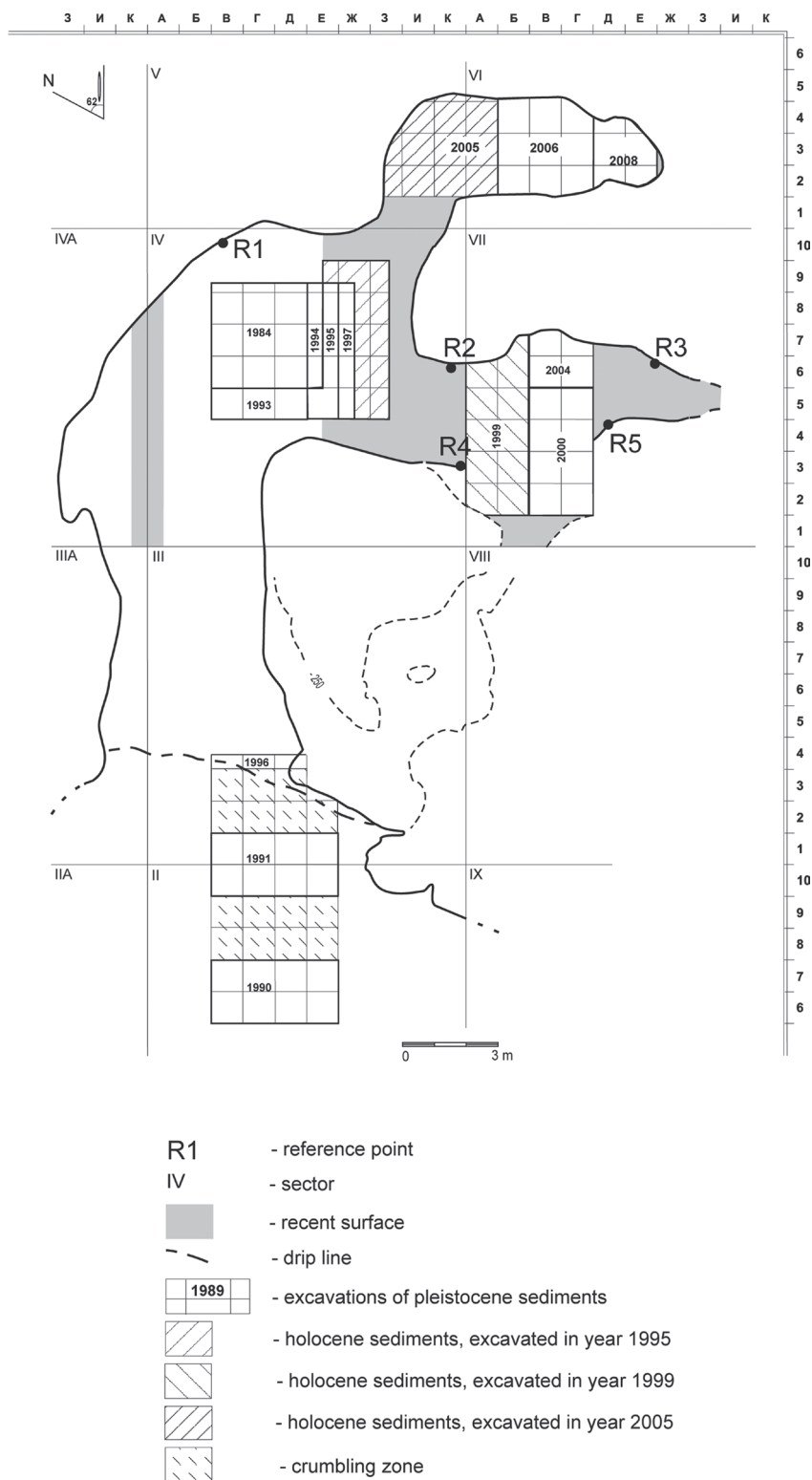


Figure 197: Denisova Cave, plan of the excavation (adapted from Derevianko *et al.*, 2003; courtesy of B. Viola)

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 m<sup>2</sup>, in the central chamber over a surface of 32 m<sup>2</sup> 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 ochre-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 var-

ious 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*, *Crocota 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

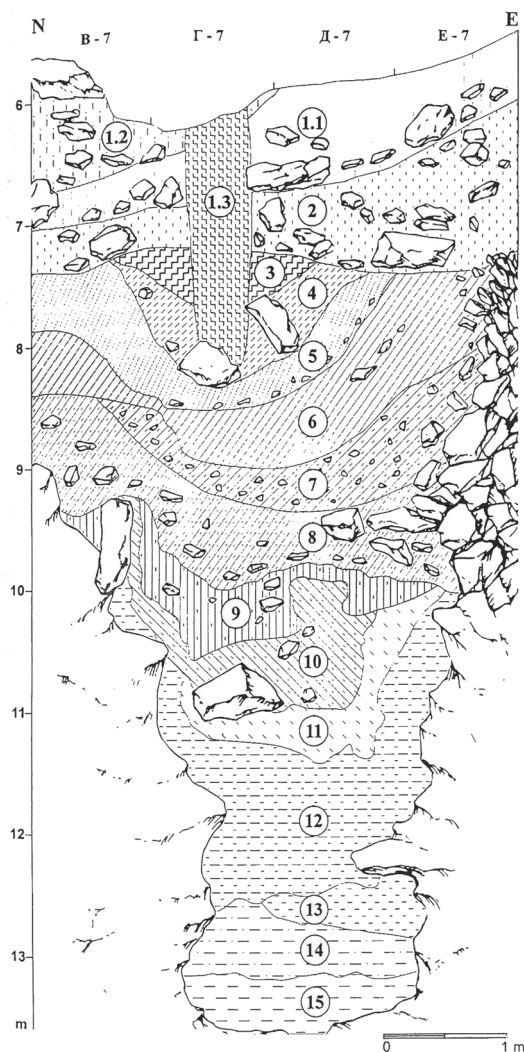


Figure 198: Denisova Cave, entrance zone, B7-E7 section (after Derevianko, Markin, *et al.*, 2001)

	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, environmental 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 steppe 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%), *Tetraoagallus altaicus*, and *Pyrhacorax pyrrhacorax*, 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 to 10) 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  $66 \pm 16$  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 micro-mammals 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  $50 \pm 12$  ka BP (RTL-608) and  $66 \pm 16$  ka BP (RTL-549). In addition, a single AMS radiocarbon date of  $46,000 \pm 2,300$  (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  $14,190 \pm 140$   $^{14}\text{C}$  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:  $10,800 \pm 40$   $^{14}\text{C}$  BP (SOAN-2865),  $10,690 \pm 65$   $^{14}\text{C}$  BP (SOAN-2866) and  $9,890 \pm 40$   $^{14}\text{C}$  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 southeastern 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 eversmannii*, *Ursus rossica*, *Crocota 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 *Cricetulus 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 par-

ticularly numerous in layers 22 and 21 (*Clethrionomys*) with a notable change in layer 20 where steppe 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 <sup>14</sup>C BP (SOAN-2488) and 39,930 ± 1,310 <sup>14</sup>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 Neanderthal 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 <sup>14</sup> 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	Char-coal	/	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
<b>Late UP</b>	5			
<b>Early UP</b>	6-7	9	9	9
<b>Transitional</b>	8	11	11	11
<b>MP</b>	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 faceted 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 faceted 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 faceted (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 area or 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).

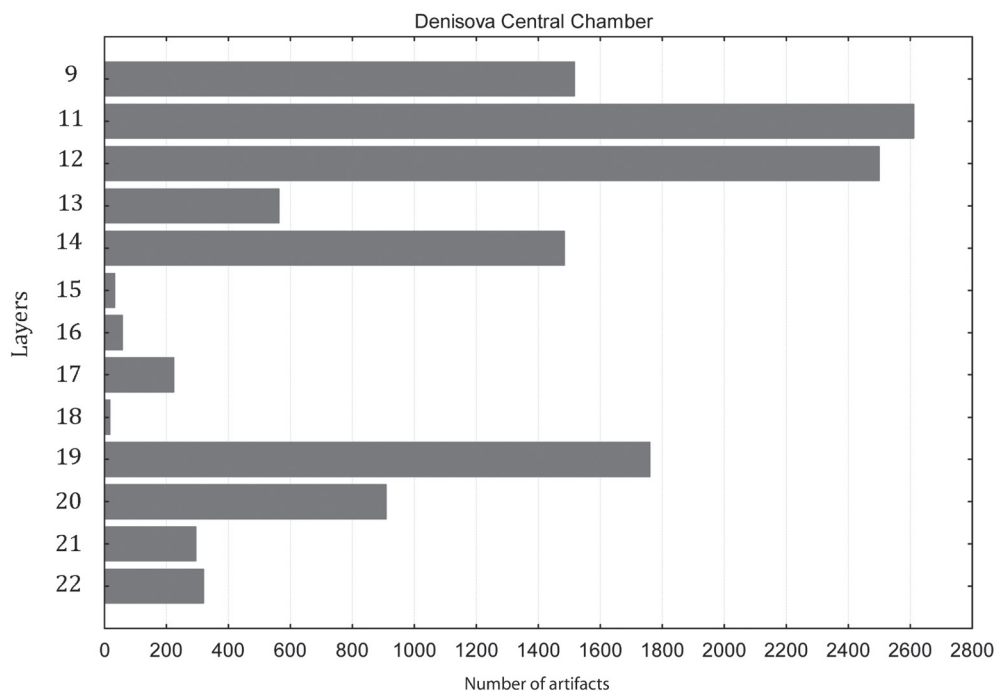


Figure 200: Denisova Cave, central chamber, number of lithic artifacts per layer (data from Derevianko, Markin *et al.*, 2001)

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 supposed 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 technological 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).

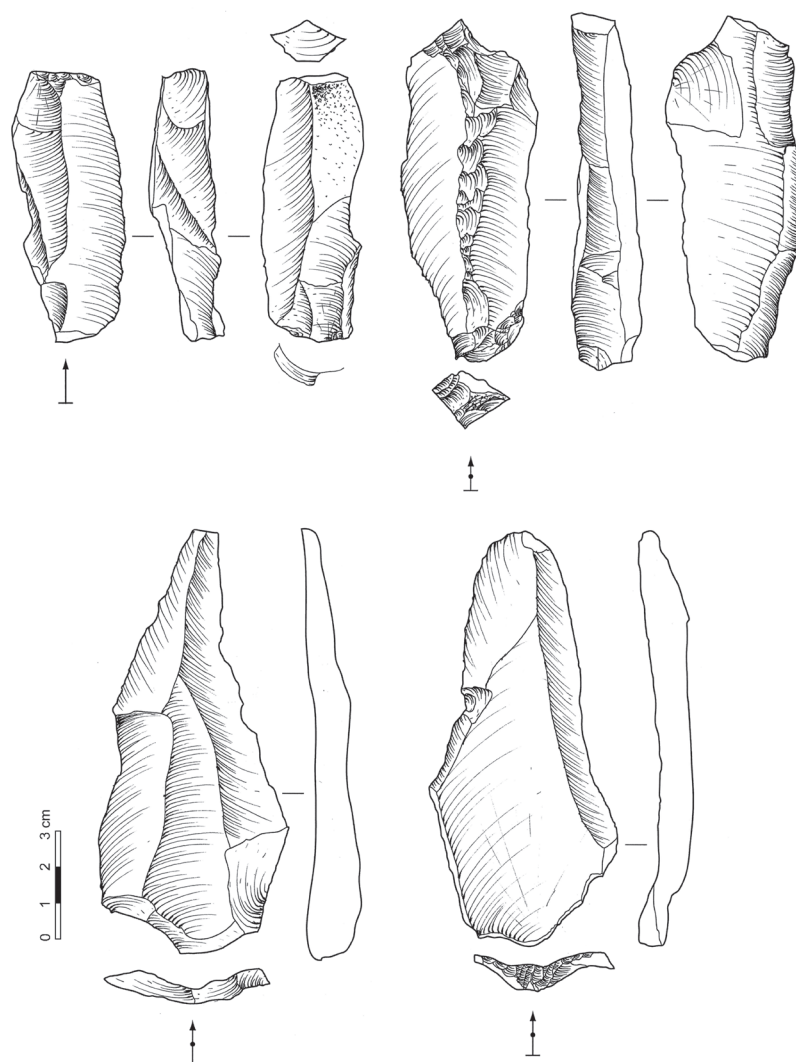


Figure 203: Denisova Cave, east gallery, layer 11.3, burin-cores (above) and Levallois laminar blanks (below)

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 cham-

ber. 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 pyrophyllite fragments and three beads made of stone (Derevianko, Markin, *et al.*, 2001).

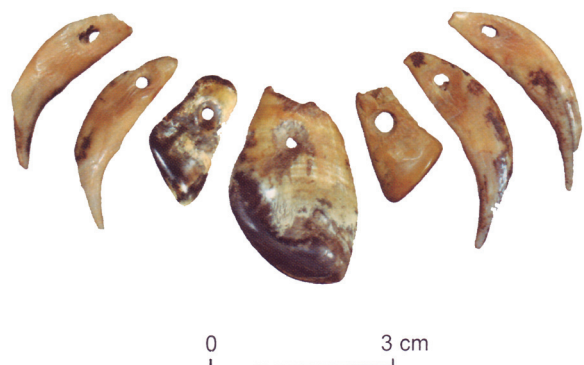


Figure 204: Denisova Cave, central chamber, ornaments (Derevianko and Shunkov, 2005)

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 associated 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 pyrophyllite 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 in 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 be 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 m<sup>2</sup> 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-

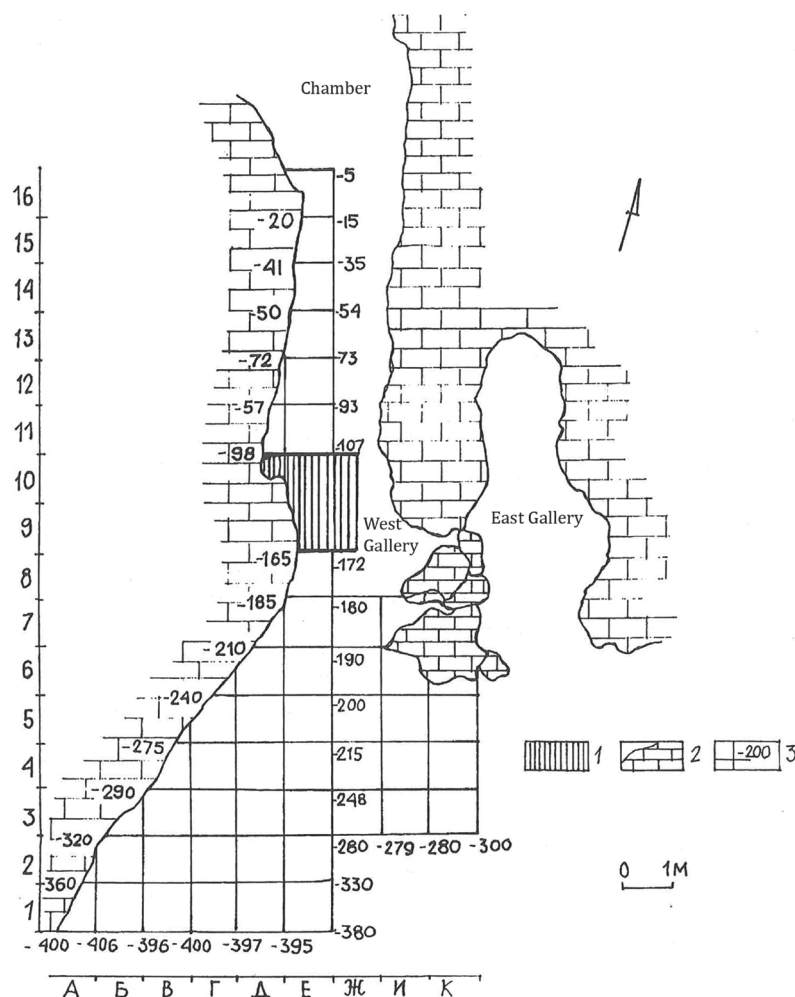


Figure 205: Maloyalomanskaya Cave, excavation plan (Derevianko, Markin, *et al.*, 2001)

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).

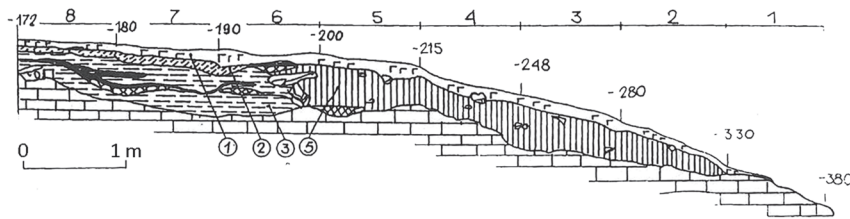
According to (Derevianko, Markin, *et al.*, 2001), blue spots are visible and interpreted as possible 'organic admixture'. The lower sub-stratum is a circa 20 cm thick brownish gray loam saturated with limestone debris and slabs. Small pieces of bone and 'ellipsoid organic inclusions' (?) are noted. 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

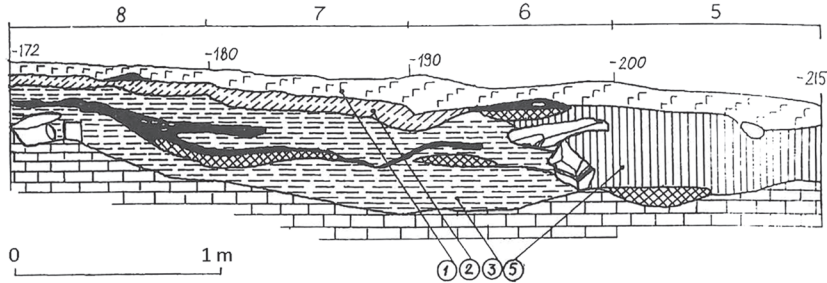
western bedrock wall. This erosional event is noted by Derevianko and colleagues (Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998) and may be prior or roughly contemporaneous with the deposition of the stratum 3.

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

1988 E/8-1 section



1988 E/8-5 section



1983 test pit: Northern wall

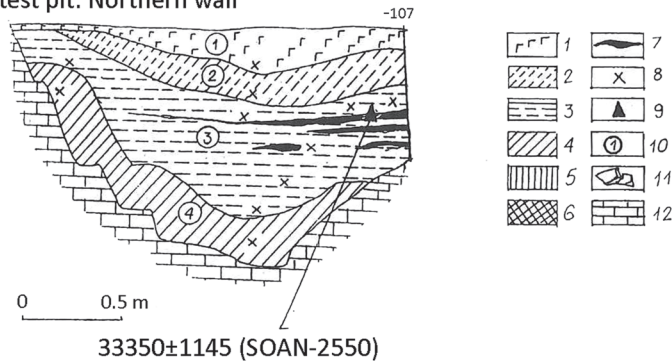


Figure 206: Maloyalomanskaya Cave, sections (after Derevianko, Markin *et al.*, 2001)

to the Holocene (Afanasiovo 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 baibacina*, *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*, *Crocota spelea*, *Uncia 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  $33,350 \pm 1,145$   $^{14}\text{C}$  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

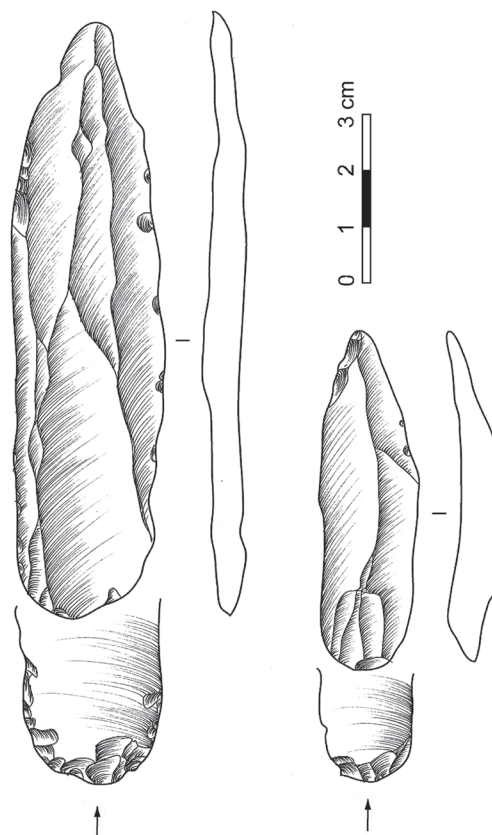


Figure 207: Maloyalomanskaya Cave, blade with inverse thinning (redrawn after Derevianko, Agadjanian, Baryshnikov, *et al.*, 1998)

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 faceted 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 technologi-

cal 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 ochre, 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 m<sup>2</sup> and two trenches of 11 and 9 m<sup>2</sup>. 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 layer (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

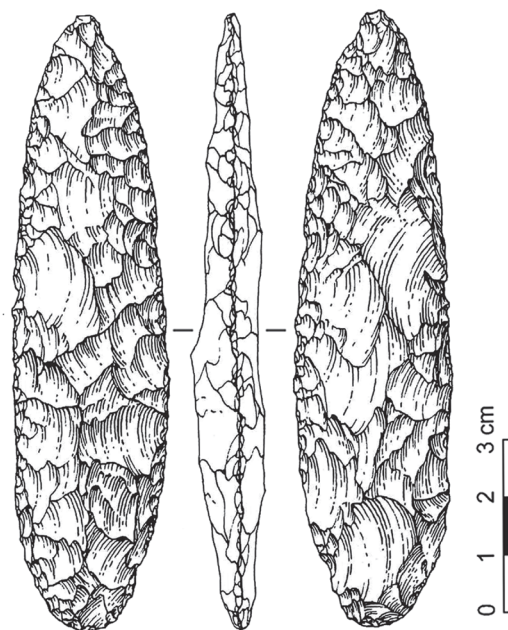


Figure 208: Ust-kanskaya, leafpoint (after Derevianko and Shunkov, 2002)

the presence of prismatic blades and the coexistence of plain and faceted 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.

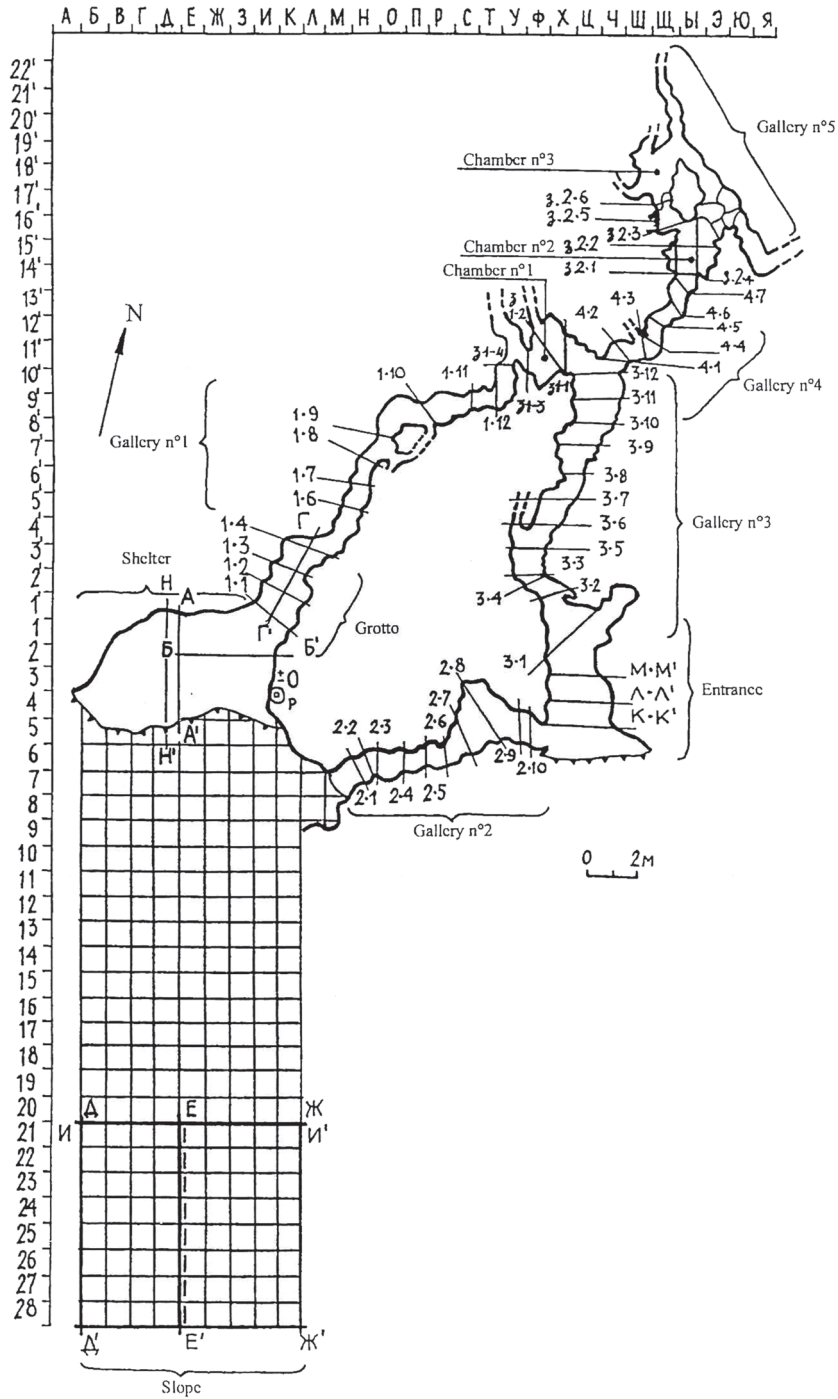


Figure 209: Okladnikov Cave, excavation map (Derevianko, Markin, et al., 2001)

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. Derevianko 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 represent 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 cham-

bers (Derevianko and Markin, 1992, 2011) (Figure 209).

#### STRATIGRAPHY 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 <sup>14</sup>C BP, and stratum 2 between 38.5 and 37 ka <sup>14</sup>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 <sup>14</sup>C BP and one date indicating an age between 33 and 32 ka <sup>14</sup>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 <sup>14</sup>C BP. The sample was

## LAMINAR TECHNOLOGY AND THE ONSET OF THE UPPER PALEOLITHIC IN THE ALTAI, SIBERIA

Layer	Context	Material	Material details	Lab code	Age	Method
1	Shelter	Fauna-bone		RIDDL-718	33,500 ± 700	<sup>14</sup> C
2	Shelter	Fauna-bone		RIDDL-719	37,750 ± 750	<sup>14</sup> C
2	Shelter	Human-bone	Adult humerus	KIA-27010	24,260 ± 180	<sup>14</sup> C
2	Shelter	Human tooth	left lower M3	/	/	/
3	Shelter	Human bone	Sub-adult humerus (OK1)	KIA-27011	29,990 ± 500	<sup>14</sup> C
				Beta-186881	34,860 ± 360	<sup>14</sup> C
				OxA-15481	37,800 ± 450	<sup>14</sup> C
3	Shelter	Fauna-bone		SOAN-2458	>16,210	<sup>14</sup> C
3	Gallery 1	Fauna-bone		SOAN-2459	28,470 ± 1250	<sup>14</sup> C
3	Shelter	Fauna-bone		RIDDL-720	43,700 +1100/-1300	<sup>14</sup> C
3	Shelter	Fauna-bone		RIDDL-722	43,300 +1300/-1500	<sup>14</sup> C
3	Shelter	Fauna-bone		RIDDL-721	32,400 ± 500	<sup>14</sup> 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  $38.8 \pm 1.5$  ka BP for chamber 1, stratum 3 and  $44.6 \pm 3.3$  ka BP and  $44.8 \pm 4$  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 side-scrapers (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 bi-directional 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 occurrence 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 <sup>14</sup>C BP. U-series dates indicate older ages that would fall beyond 40 ka <sup>14</sup>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 m<sup>2</sup> 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  $19,150 \pm 80$  <sup>14</sup>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 were 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	<sup>14</sup> C
5	Bone-fauna	AA-30754	32,250 ± 705	<sup>14</sup> C
5	Bone-fauna	AA-30755	34,780 ± 725	<sup>14</sup> C
5.1	Charcoal	AA-37184	35,200 ± 1300	<sup>14</sup> C
6	Bone-fauna	AA-38232	>41,000	<sup>14</sup> C
6	Bone-fauna	AA-38321	>41,000	<sup>14</sup> C
4-6m depth	Bone-fauna	SOAN-786	>40,000-45,000	<sup>14</sup> C
4-6m depth	Bone-fauna	SOAN-787	>40,000-45,000	<sup>14</sup> 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 abundant 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. Chagyrskaya 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 as 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,  $23,480 \pm 300$   $^{14}\text{C}$  BP (BIN-4980) and  $37,000 \pm 1000$   $^{14}\text{C}$  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		
<b>Open-air</b>	* 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? * <i>UK1-2, strata 11-8</i>
<b>Cave</b>	* Denisova, central chamber layer 21-12 * Okladnikov strata 7-1 * Chagyrskaya unit 3	* Denisova entrance zone, layers 10-9 * <i>Ust-Kanskaya</i> * <i>Strashnaya</i>	* <i>Denisova main chamber, layer 11</i> * Denisova entrance zone, layer 8 * <i>Denisova east gallery, layer 11</i> * <i>Maloyalomenskaya, layers 3-4</i>	* <i>Denisova central chamber, layer 9</i> * Denisova entrance zone, layers 7-6 * <i>Denisova east gallery, layer 9</i>

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

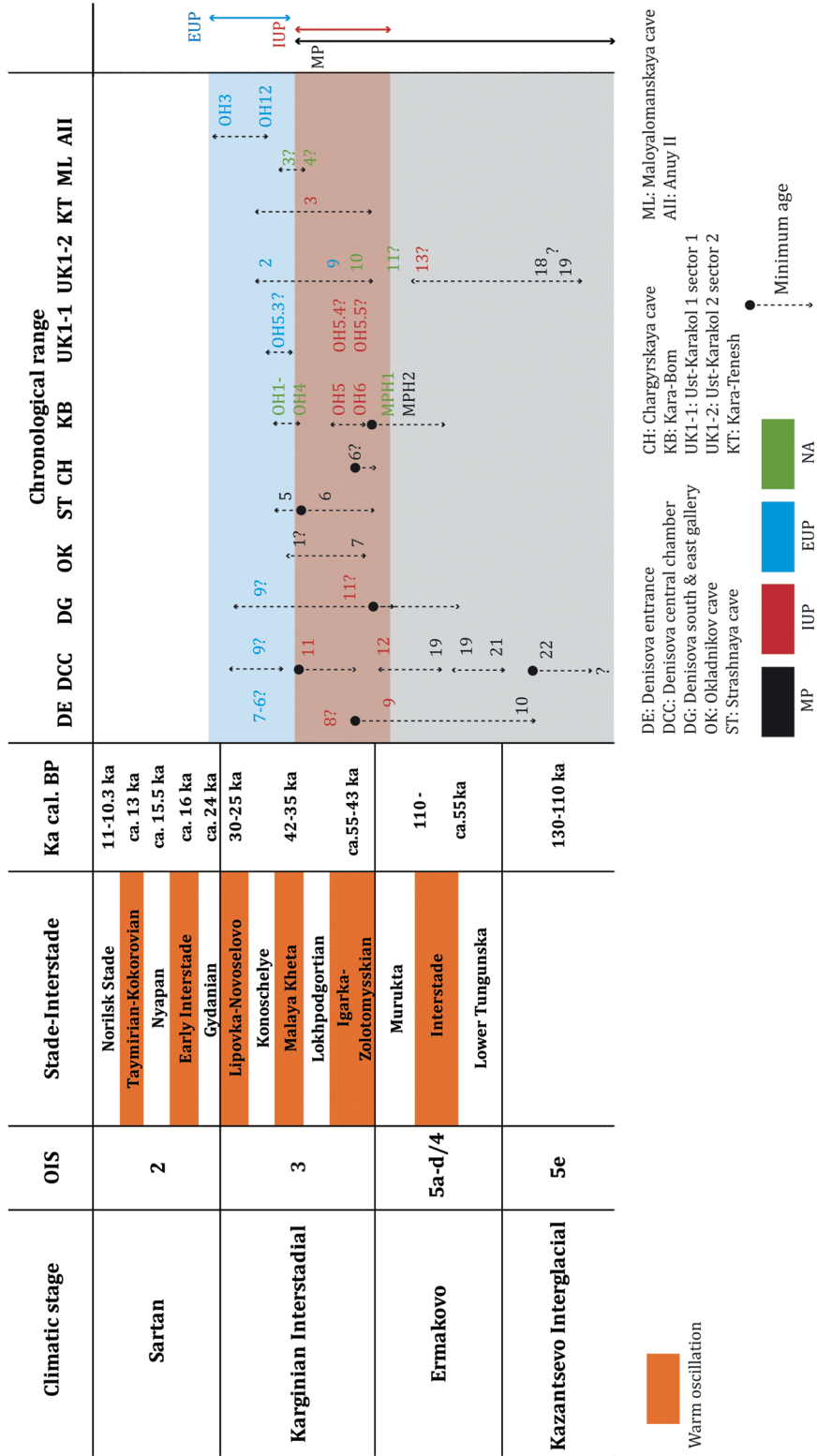


Figure 210: Summary of the regional chronological data

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 Haesaerts 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 central 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 re-deposited 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-

illustrate 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 antiquitatis* 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 antiquitatis* 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 palynological 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 parsimo-

nous to consider that IUP occupations took place during a temperate/warm phase. Based on the  $^{14}\text{C}$ , 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 Konoschelic cooling. The latter is marked by the presence of ice wedges between 31 and 30 ka  $^{14}\text{C}$  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.

