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Pleistocene environments and palaeolithic occupation of the Northern Minusinsk Basin, southern Krasnoyarsk region

NIKOLAI I. DROZDOV[1] - JIŘÍ CHLACHULA[2] - VITALYI P. CHEKHA[1]

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Abstract: Abundant Early Palaeolithic stone tool assemblages made of local clastic raw materials provide explicit evidence of human occupation of the Minusinsk Basin prior to the last interglacial. The variability of the lithic industries, the differential degree of patination and aeolian abrasion of individual artefacts indicate repeated occupation of this area during several Pleistocene stages. The earliest cultural records represented by pebble tools associated with the Middle Pleistocene fossil fauna from the Northern Minusinsk Basin as well as other southern Siberian river valleys suggest that early people were adapted to local periglacial environments. The last interglacial is characterised by the appearance of a more advanced Mousterian industry of the Levallois tradition, which persisted until the early last glacial stage and appears in the Upper Palaeolithic assemblages dominated by a developed blade technology. Intervals of significant climatic deterioration and onset of full glacial conditions are characterised by the absence of any archaeological finds. Ultimately, the Palaeolithic records from southern Siberia may be used as palaeoenvironmental proxy data complementing the fossil biotic and palaeopedological evidence. The main focus of the current geoarchaeological investigations is to refine the established geochronological framework and detail contextual settings of the earliest human inhabitation within the larger study area.

[1]*Institute of Archaeology and Ethnography, Siberian Branch of the Russian Academy of Sciences (SB RAS), Krasnoyarsk, Russia*
[2]*Laboratory for Palaeoecology, Technical University Brno, FT VUT Zlín, 762 72 Zlín, Czech Republic*

INTRODUCTION

Until about five to ten years ago (depending on the particular geographical area), the earliest archaeological finds from Siberia, or north Asia in general, were represented by Upper Palaeolithic cultures; spatial and temporal correlations of palaeoenvironmental and archaeological proxy data were rather limited. Perhaps due to the linguistic barrier impeding free information exchange, or traditional cultural-historical models of the peopling of the Northern Hemisphere, this view may still persist in some scientific circles, particularly in North America. During recent years, multidisciplinary Quaternary field investigations in the large Russian territory have revealed several hundred early sites, some of them of great antiquity, following large-scale surface cover disturbances due to construction of dams on the largest Siberian rivers and other extensive industrial field operations, such as coal mines and road construction (e.g. LARICHEV et al. 1987, NIKOLAEV - MARKIN 1990, RANOV 1990, DEVIATKIN et al. 1992, CHLACHULA et al. 1994).

Systematic geological and archaeological studies conducted since the late 1980s in the Northern Minusinsk Basin, southern Krasnoyarsk Region, have produced unexpected evidence of early human occupation of this part of Siberia dating to at least the late Middle Pleistocene. Research was initiated in the upper part of the Yenisey River valley after progressive erosion of unconsolidated aeolian and slope deposits by water-table fluctuation of the Krasnoyarsk reservoir exposed 10–40 m high sections. The erosion revealed a nearly complete Late Quaternary geological record containing a series of Early, Middle and Late Palaeolithic stone tool collections and a rich Middle and Upper Pleistocene fauna (DROZDOV et al. 1990, DEREVIANKO et al. 1992). As in other regions of Siberia, the oldest previously known archaeological remains in the region were dated to about 30 000 yr. BP (TSEITLIN 1979, PRASLOV 1984).

Until the ponding of the Yenisey River, the Quaternary geology of the northern Minusinsk area was poorly known (FINAROV 1963, ARKHIPOV 1971, LAUKHIN 1979). The previous field studies were largely limited to neotectonics and geomorphological mapping of the old river terraces, most of which are today inundated by the Krasnoyarsk reservoir. The ongoing lake erosion has exposed a more complex geological structure than was previously assumed. Systematic geological studies have been carried out, largely in connection with archaeological discoveries of early cultural remains in the eroding sections at the lake shore. The main focus of the ongoing investigations has been the reconstruction of the Pleistocene history of the area and establishment of a detailed geochronological framework in order to determine the age of the cultural material and contextual palaeoenvironmental conditions. In addition to the archaeological results, the large-scale sections with thick loess-palaeosol sequences provide an excellent opportunity for independent Quaternary palaeoclimatic studies.

NATURAL SETTING OF THE NORTHERN MINUSINSK BASIN

The Northern Minusinsk Basin lies in the southern part of the Krasnoyarsk Region along the upper reaches of the Yenisey River (52–56° N and 89–94° E). The local geomorphological setting is rather diverse. The basin is one of a series of tectonic depressions in the eastern part of the Altai-Sayan Mountain System. It is bordered on the west by the Kuznetskiy Alatau (maximum elevation is 2178 m a.s.l.), and the western foothills of the Eastern Sayan Mountains on the east (maximum elevation in the study area is 1778 m). The northern part of the basin is delimited by the Solgonskiy and Batenevskiy Kriazh Ranges with altitudes below 900 m. The central part is structurally controlled by a zone of tectonic breaks running in a north-south direction across the Batenevskiy Kriazh Range. In the northwest, the Basin is connected by the Nazarovskaya Depression with the broad Western Siberian Lowland.

Pre-Quaternary geology in the area was controlled by a series of tectonic events. Both relief and geological structure of the southern part of the Krasnoyarsk Region encouraged intensive geomorphological processes in the past. The Cambrian and Proterozoic volcanism disturbed and dislocated the original pre-Cambrian crust composed of igneous and metamorphic rocks. During the Lower and Middle Palaeozoic, orogenesis created a system of mountain ranges separated by deep depressions. Later Hercynian tectonics and the Oligocene orogenic activity modified the area to form the configuration of the depressions in the Minusinsk Basin, which were subsequently filled by Devonian, Carboniferous, Jurassic and Paleogene volcanic, lacustrine and alluvial deposits. Extensive proluvia near the mountain fronts, and lacustrine/alluvial formations in the main sedimentary basins were deposited throughout the Miocene and Pliocene. During the Late Pliocene and Early Pleistocene, an early fluvial system was established, accompanied by ongoing progressive tectonic uplift. Alluvial fans and relics of terraces about 200 m above the present valley bottom date to this period. A neotectonic movement during the early Middle Pleistocene further divided the Minusinsk Basin into the northern and the southern parts. The former was subsequently filled by a complex, polygenetic 10–100 m thick series of alluvial, lacustrine, proluvial and aeolian sediments.

In the upper Yenisey River valley, a series of discontinuous alluvial terraces are relatively distinctively preserved. The lower (Upper Pleistocene) terraces of the Yenisey River (8–12 m, 18–20 m, 30–40 m) are now flooded by the Krasnoyarsk Lake. The earlier, high terraces (70–90 m, 110–130 m, 150–170 m) are preserved mostly as relics. Loess deposits, usually 10 to 20 m thick, and derived from local alluvial plains during glacial periods, are distributed over most of the landscape, but mainly on the western slopes where they are up to 35 m thick. The Yenisey River, in places deeply cut into the bedrock, was artificially dammed in the early 1970s to form the 400 km long Krasnoyarsk Lake, one of the world's ten largest freshwater reservoirs. Due to the river regulation, the water level was raised to 40–100 m above its original stand depending on the proximity of the dam, triggering intensive erosion of the adjacent slopes.

The present climate is generally dry and strongly continental with cold and dry winters with little snow cover (average January temperature is –18.1 °C), and warm to hot summers (average July temperature is +17.6 °C). In the forest-steppe zone in the marginal areas, particularly in the northwestern part of the Minusinsk Basin, continentality and temperature contrast decreases, with about 50 % increase of precipitation to 350–1000 mm per annum, compared to about 200 mm in the central part of the basin. The vegetation cover is characterised by grasslands in the interior basin in the southwest; forest-steppe is established in the northeastern part of the basin and along the foothills, and mixed southern taiga prevails in the mountains. The transitional zone between the (forest-)steppe and taiga is rather narrow, sometimes only a few kilometres broad.

KURTAK ARCHAEOLOGICAL REGION

The principal study area, referred to as the Kurtak Archaeological Region and formally established in 1988 (Drozdov et al. 1990a, 1990b, 1990c), is located in the upper Yenisey River valley in the Northern Minusinsk Basin at 91° W longitude and 55° N latitude (Fig. 1). The area lies in the steppe zone at the Kuznetskiy Alatau Mountains on the western side of the Krasnoyarsk Lake reservoir (the dammed Yenisey River) between the Trifonovka Bay in the south and the Ust'-Izhul' Bay in the north. On the east side of the lake, foothills of the Eastern Sayan Mountains rise directly from the shore. Open steppe stretches over most of the adjacent landscape, with isolated parkland communities of deciduous trees. The Yenisey River is here about 7 km wide (the valley with the upper terraces extends 10–12 km), inundating the Kurtak Syncline. North and south of the Kurtak area, the Yenisey valley narrows to 2–3 km as it cuts through the Novoselovo and Daurskoe Palaeozoic Anticlines.

The Kurtak Archaeologial Region, named according to a nearby farming village translocated from the Yenisey valley before flooding, is about 20 km long and

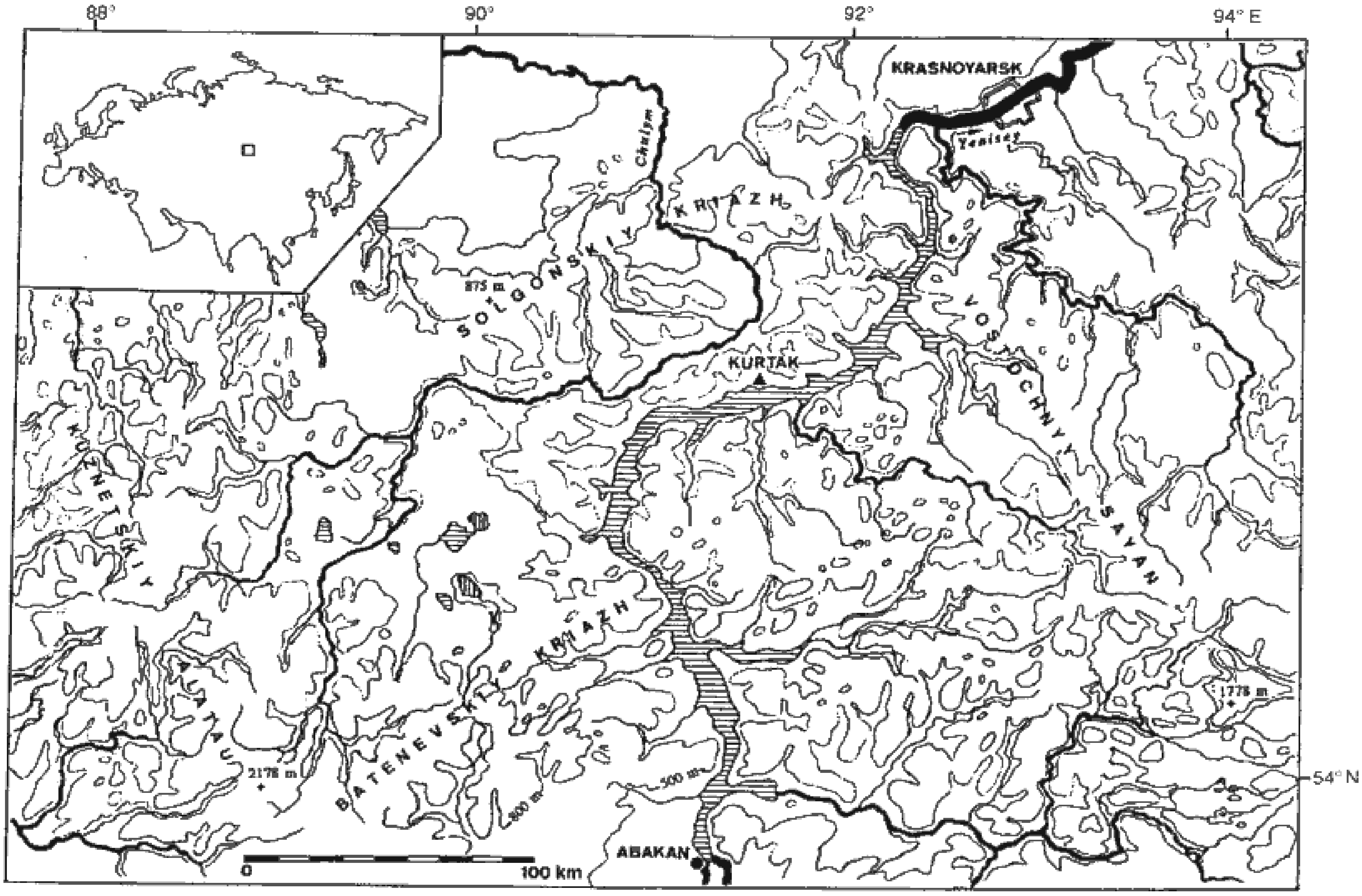

Fig. 1. Geographical location of the principal study area.

is characterised by a series of exposed and continuously eroding sections that have been recently formed by wave erosion. The area has been formally divided into five sectors in respect to local geomorphology:

1. The Trifonovka Sector, located over a distance of ca. 6 km between the Bezguza Bay and the Kamennyy Log (gully) Site at the foot of a 70–80 m terrace relic, is covered by 12–15 m of Quaternary sediments in the eroding part.
2. The Kurtak Sector, extending over 2 km between the Kamennyy Log and the Sukhoy Log Sites, has locally exposed Carboniferous sandstone 5–7 m above the lake level, and 7–8 m of loess and colluvial deposits in the eroded slope walls.
3. The Sukhoy Log Sector, extends about 1.5 km between the Sukhoy Log and the Berezhekovo Sites, and has up to 10 m of exposed bedrock covered on top by thin alluvial deposits and overlain by loess.
4. The Berezhekovo Sector, extending 2.2 km south of Chany Bay, includes relics of two terraces (70–80 m and 90–100 m) covered by a 20–35 m thick loess.
5. The Usť-Izhuľ Sector, which extends for about 5 km north of Chany Bay. It has a more complex geological structure with alluvial fan deposits (2–20 m thick) locally cut into the exposed Carboniferous bedrock, and capped with colluvium and loess (1–10 m). A distorted 60 m terrace is adjacent to the lake shore.

Quaternary geology

Most of the Quaternary studies have been done in the central part of the Kurtak area containing the most complete Quaternary sections (Chlachula; this volume). The top surface is formed by a plateau of the highest flanks of the Yenisey valley, gradually rising westwards towards the Kuznetskiy Alatau foothills. In the shore zone, relics of former river terraces and alluvial fans are locally exposed within the steeply eroded sections at a relative elevation of 70–80 m and 90–100 m. Higher terraces (110–130 m and 150–160 m) are well developed in the landscape relief, and sealed above by 10–15 m of aeolian and colluvial cover deposits. The fluctuation of the Krasnoyarsk Lake prior to the present water level stabilisation (234 m a.s.l.) caused intensive undercutting of the slopes revealing a series of buried soils in the loess deposits. Rich fossil faunas and archaeological records have been eroded from the basal alluvial gravels beneath up to 35 m of loessic deposits. In the southern part of the site, the Carboniferous sandstone bedrock is horizontally exposed at an elevation of 72–75 m above the former Yenisey River, and in places is covered by 1–1.5 m of gravelly alluvium. Because of the unconsolidated nature of the slope sediments, ongoing erosional processes rapidly modify the section relief.

Following the initial geoarchaeological investigations of the Pleistocene sections at Kurtak in 1988 to 1989, four basic stratigraphic units, assigned to the Upper Pleistocene, have been recognised (DROZDOV et al. 1990b, c, LAUKHIN et al. 1990). The four well distinguished and broadly laterally traceable stratigraphic units include (from the base upwards): the pedocomplex of the Kamenolozhskaya-Sukholozhskaya Soils assigned to the last interglacial (Kazantsevo/OIS 5) (*sensu lato*); the Tchaninskaya Unit comprising 0.5–17 m of loess deposits of the early last glacial (Zyriansk/Early Würm/OIS 4); the Kurtak Pedocomplex of the Karginsk/Mid-Würm stage (OIS 3); the Bezguzinskaya Unit comprising 1–10 m of loess deposits of the late last glacial (Sartan/Late Würm/OIS 2). Stratotypes of the above units have been described at the Berezhekovo Site. The underlying stratigraphic record is rather fragmentary and still poorly studied. Although largely Middle Pleistocene in age, some basal colluviated gravelly strata overlying the 70–80 m terrace in the Berezhekovo sector are believed to be Early Pleistocene lying on a Pliocene terrace relic because of their reversed magnetic polarity.

A complete, composite chronostratigraphic profile in the Kurtak area includes:

- the Kochkov Horizon (Early Pleistocene; > 780 ka BP), formed by up to 10 m of alluvial and colluvial deposits on the 60 m terrace relict or the Carboniferous bedrock, and incorporating a fossil fauna (rodents) of the Tamansk Complex of Western Siberia;
- the Lebedskiy Glacial Horizon (the early Middle Pleistocene; 600–380 ka BP), formed by up to 50 m (?) of colluvial deposits at the 110–130 m terrace platform (the Berezhekovo Site), and associated with a large fauna of the Tiraspol Complex of Western Siberia;
- the Berezhekovo Series (the Tobol Interglacial; 380–260 ka BP), formed by up to 15 m of sandy gravelly alluvial deposits (the Razlog Site);
- the Bakhtinskiy Glacial Horizon (late Middle Pleistocene; 260–130 ka BP), formed by periglacial alluvia and colluvia, largely secondary deposits on the 60 m terrace, and palaeontologically associated with *Mammuthus chosaricus* and an early *Equus* sp.;
- the Kurtak Series (the Kazantsevo Interglacial; 130/127–100 ka BP), including the Kamenolozhskaya Soil (2 m) developed on a diverse substratum (the Carboniferous bedrock, alluvium, loess);
- the Muruktinsk Glacial Horizon (the Zyriansk Glacial; 100/74–50 ka BP), including the Sukholozhskiy Pedocomplex of several soil horizons having a total thickness of 2–3.5 m; the Tchaninskaya and the Berezhekovo loess units (up to 10–17 m thick).
- the Kurtak Pedocomplex (the Karginsk Non-Glacial Interval; 50–22 ka BP), including two soil horizons (with ^{14}C dates of > 30 000–29 400 yr. BP, and 25 000 to 22 000 yr. BP) separated by cryoturbated units of the Konoshelskoe Stadial;
- the Bezguzinskaya Unit (the Sartan Glacial; 22 to 10 ka BP), formed by 1–10 m of loess deposits with a well-marked frost wedge horizon dated to 20 000 to 18 000 yr. BP;
- recent (Holocene; <10 ka BP) aeolian (0.5 m) and colluvial (1–7 m) sandy deposits.

The above chronostratigraphic units (CHEKHA - LAUKHIN 1992, DROZDOV 1992) have been tentatively correlated with fluvial terraces in the lower (now submerged) part of the Yenisey valley – Terrace I (8–12 m; late Sartan), Terrace II (15–20 m; early Sartan/Karginsk), Terrace III (30–40 m; Zyriansk/Kazantsevo). The upper terraces – Terrace IV (60 m; late Middle Pleistocene), Terrace V (70–90 m; early Middle Pleistocene), Terrace VI (110–130 m; Early Pleistocene), Terrace VII (150–170 m; Pliocene/Miocene?) are preserved as relics above the lake level.

The earliest Quaternary deposits above the Carboniferous bedrock are exposed only locally in the southern part of the Berezhekovo Site. They include poorly sorted and weathered alluvia, presumably relics of a Pliocene terrace overlain by thin Early Pleistocene gravels (Excavation 1, Strata 8–10) (DROZDOV et al. 1990a). The Pleistocene stratigraphy is best documented in the high sections in the middle part of the site, with up to 25–35 m of loess deposits incorporating a series of variably developed palaeosol horizons, which are better preserved than in the archaeological sections in the southern part of the site, where the cover deposits are thinner, and the buried soils are largely disturbed by solifluction with some hiatuses evident. Although comprising only a small part of the Quaternary period (about the second half of the Middle and most of the Upper Pleistocene), the central part of the Berezhekovo Site, about 1.2 km south of Chany Bay, includes an almost complete and unique high-resolution climatostratigraphic loess-palaeosol record (CHLACHULA; this volume).

PALAEOLITHIC ARCHAEOLOGY

Palaeolithic research was initiated in the upper part of the Yenisey River valley after progressive erosion of unconsolidated aeolian and slope deposits from water-table fluctuations of the Krasnoyarsk reservoir after dam construction in 1971 had flooded the valley to 65 m above the original river level at 247 m a.s.l. The twenty-five year lake-shore erosion had caused a gradual 0.5 to 4 km lateral slope retreat accompanied by large-scale landslides of the unconsolidated deposits (consisting mostly of loess) and other mass-wasting processes triggered by distortion of the lateral slope support. The 10–40 m high, steep, and continuously eroding sections exposed a nearly complete Late Quaternary geological record containing a series of palaeolithic stone industries and a rich Middle and Upper Pleistocene fauna

(DROZDOV et al. 1990a, DEREVIANKO et al. 1992). Apart from the subaerial formations, the early cultural record is principally associated with relics of the old (Middle and Early Pleistocene) Yenisey River terraces (70–80 m and 150 m) locally preserved in the form of a thin alluvium and alluvial fan deposits built by erosion of the Early Pleistocene and Pliocene terraces filling the Carboniferous bedrock depressions (e.g. the Razlog Site). The main focus of the current geoarchaeological investigations is to reconstruct Quaternary environments during the palaeolithic peopling of the area, and to refine the established geochronological framework.

Early Palaeolithic

Several sites have been recognised in the Kurtak area with Early Palaeolithic pebble tool stone industries, largely redeposited by past as well as present hydrologic processes. After the first findings of rudimentary flaked stone tools at the Berezhekovo Site in 1987/1988, four other major locations with early lithic artefact occurrences have been recognised (i.e. the Kamennyy Log, Sukhoy Log, Verkhnyy Kamen and Razlog Sites). At all places, artefactually flaked cobbles have been found on the surface of the eroded 60–65 m high terrace remnant exposed by waves undercutting the western slopes of the old Yenisey River valley. Most artefacts have been washed from their original geological context onto the present beach, occasionally together with fossil fauna and later (Middle and Upper) Palaeolithic stone tools derived from loess deposits above the terrace. Ongoing wave action has caused sorting of the flaked lithics as well as other clastic materials. This phenomenon is particularly apparent at the Kamennyy Log Site, extending 2–4 km south of Berezhekovo, with large flaked cobbles dispersed in the southern part of the site, where there is the most intense wave energy. Most of the small-sized artefacts and lithic fragments are concentrated in the northern part, where less turbulent waters seasonally inundate the adjacent beach. At the Sukhoy Log and Verkhnyy Kamen Sites, most of the coarse pebbly alluvium has been washed away, and the macrolithic industry with large fossil bones (mainly of early forms of mammoth and horse) is found directly on the Carboniferous sandstone bedrock that forms prominent ramparts elevated 1–7 m above the lake. At the latter site, the presence of *Mammuthus chosaricus* DUBR. implies a glacial (Samarovo/Riss) age for the Early Palaeolithic cultural assemblage, assuming that both records are contemporaneous (DROZDOV et al. 1990a).

A more complex situation is found at the Razlog Site situated 3 km north of Berezhekovo. Up to 25 m thick alluvial fan deposits fill a depression between two bedrock ramparts 90–120 m high. Abundant and formally variable lithic artefacts are found with large mammal bones among cobble gravels on the shore at the foot of an eroding 20 m high alluvial fan capped by about 10 m of Late Pleistocene aeolian and colluvial loess sediments. Except for artefacts from the eroded 60 m terrace, most of the culturally modified lithics have been introduced from the slope colluvium, including weathered gravels secondarily derived from the highest (130–150 m) terraces above the site. The Tobol/Riss 1/2 (OIS 7) Interglacial has been the estimated minimum age for the stone artefact assemblages (> 250 ka BP).

Principal archaeological excavations have been carried out at the Berezhekovo Site, covering about 60 m^2 at Excavation 1 and 80 m^2 at Excavation 2 (DROZDOV et al. 1990a, DEREVIANKO et al. 1992). At the first location, Upper Pleistocene (Middle Palaeolithic – "Mousterian-like") stone artefacts are found in the colluviated chernozemic soil (Stratum 7) of the last interglacial. Earlier flaked lithics are secondarily distributed in a 70–80 m Middle Pleistocene alluvium (Stratum 8a), also incorporating fossil remains of *Mammuthus primigenius* BLUM. and *Equus mosbachensis*, assigned to the end of the Tobol (Holstein, Mindel/Riss) interglacial. The 0.7 to 1.0 m colluvium is presumably formed by redeposited and poorly sorted sandy gravels of a 90–100 m terrace above the section. At the second location, a small collection of rudimentarily modified and secondarily rolled artefacts was found in the 0.5–0.7 m thick Early Pleistocene/early (?) Middle Pleistocene alluvium/colluvium (Stratum 6). The suggested age of the lithic industry is chronostratigraphically inferred with respect to the established geo-archaeological framework of the Berezhekovo Site. Early and Middle Palaeolithic artefacts are also dispersed in large numbers on the present lake shore.

At all sites in the Kurtak area, cobble-sized clastic raw materials (mostly quartzite, and some vein quartz and basalt) collected from the alluvial gravels, were used for stone tool production. At least two Early Palaeolithic industries can be recognised on the basis of degree of corrosion and differential patination (CHLACHULA et al. 1994). The first (older) series, comprising part of the collections from the alluvial fan at the Razlog Site and possibly some artefacts from the neighbouring Verkhniy Kamen Site, is characterised by weathered, stained and heavily-rolled quartzite tools with a uniform dark brown or cinnamon patina covering both the unmodified as well as flaked faces of particular specimens (Fig. 2). The second (younger) series, including most of the stone artefacts from other sites, is distinguished by a lesser degree of abrasion and white unpatinated flake scars on cobbles with yellowish cortex (Fig. 3). Only occasionally, a reddish patina occurs on the flaked cobble faces. Because of the same (secondary) geological provenance of both industries, an original distribution of the older series at Razlog on the high 100–120 m terrace is assumed. These early artefacts are believed to have been subsequently redeposited in the process of erosion of the Early Pleistocene/Pliocene terrace and colluviated with

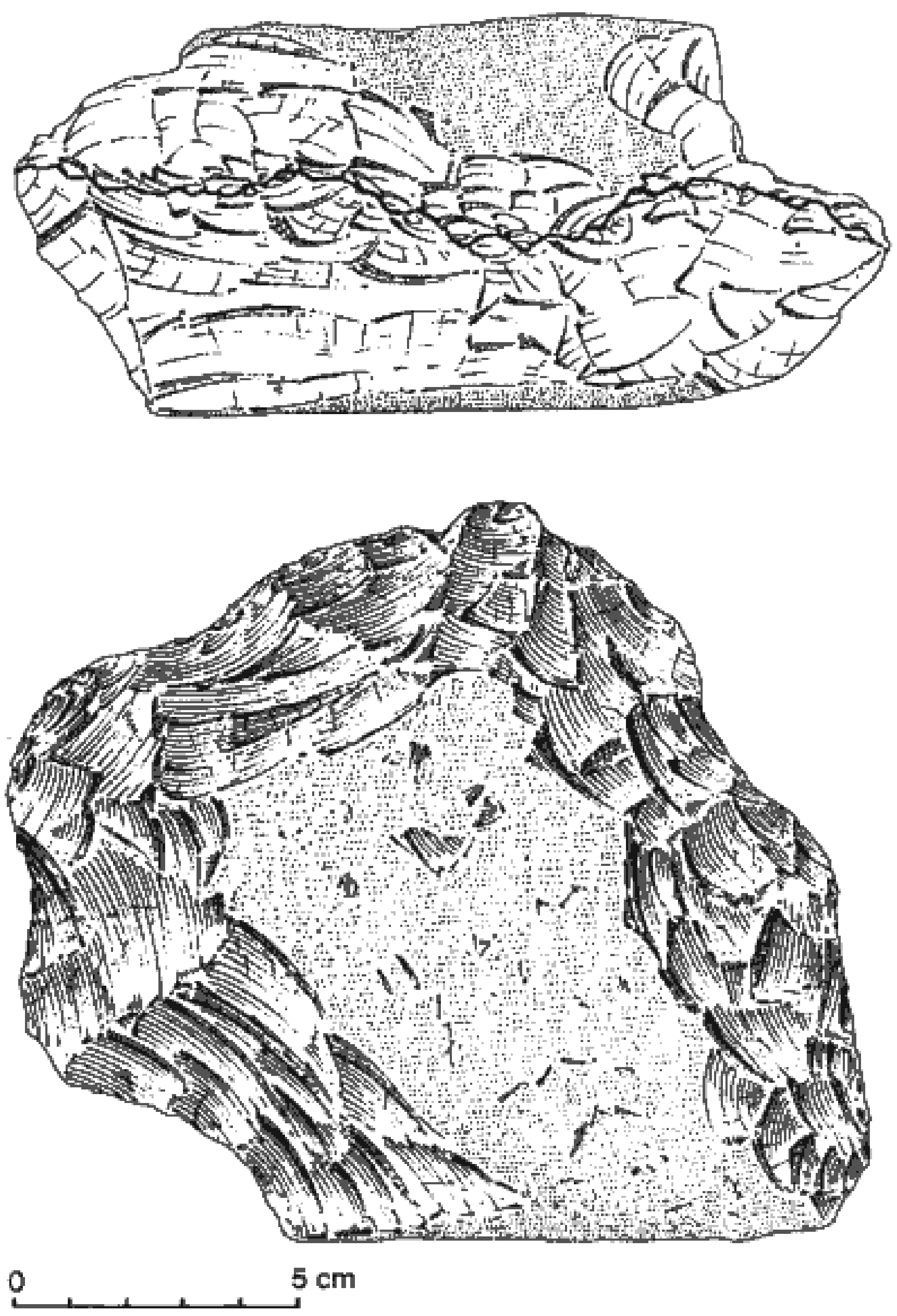

Fig. 2. Razlog site. Strongly abraded and brown-patinated bifacial chopper/core on a quartzite cobble (Series 1) from Middle Pleistocene alluvial fan deposits (all drawings by J. Chlachula).

other weathered and patinated clastics within the formed alluvial fan at the foot of the terrace. Formation of the fan was a gradual process, with a periodic appearance of a dry sandy-gravelly surface under a shifting channel environment, presumably occupied by early people leaving behind the more recent, unpatinated and less abraded stone tools.

There are no apparent technological or typological differences between the two industries. All artefacts, forming a very rudimentarily modified "pebble industry", are produced by hard hammer, direct percussion techniques. Unifacial choppers and simple cobble cores, both characterised by only a few flake removals, are the most frequent forms. A specific tool type with a protruding laterally flaked distal edge is often encountered in the archaic (older-series) assemblage at Razlog. More elaborate flaking, present on some bifacial choppers, is rare. Most flakes exhibit limited unifacial or alternate retouch, although a few better-produced side scrapers occur. Changing Pleistocene climates in the study area during and after episodes of the early human occupation are evidenced by a varying degree of patina and/or aeolian abrasion. A dark red-brown patina found on the archaic series of artefacts (Series 1) indicates a warm and relatively humid climate, despite the fact that no other palaeopedological evidence in the form of red soil was recorded in the sections. Intensified aeolian activity during early cold climatic intervals exposed and abraded abandoned archaeological remains prior to their (re)burial under loess cover.

Chronology of most of the Early Palaeolithic record in the Kurtak Archaeological Region is based on the relative chronostratigraphy of the industry-incorporating deposits within a larger geomorphological setting. A (late) Middle Pleistocene age for the less-weathered Early Palaeolithic stone tool collections (Series 2) is supported by their stratigraphic position beneath a complex of palaeosols, including one or two well-developed interglacial chernozemic soils. As stated above, greater antiquity is assumed for the more corroded lithic industry (Series 1) from the Razlog Site. Nevertheless, so far possibly the oldest cultural evidence comes from the excavated Section 1 at the Berezhekovo Site in the upper part of a 0.3–0.5 m thick bed (Stratum 8) (Drozdov et al. 1990a). The associated remains of large fauna (early forms of *Equus* sp.) and rodent taxa suggest an early Middle Pleistocene age (> 0.5 Ma BP). A very early age (> 1 Ma BP?) may be implied for occasional artefacts

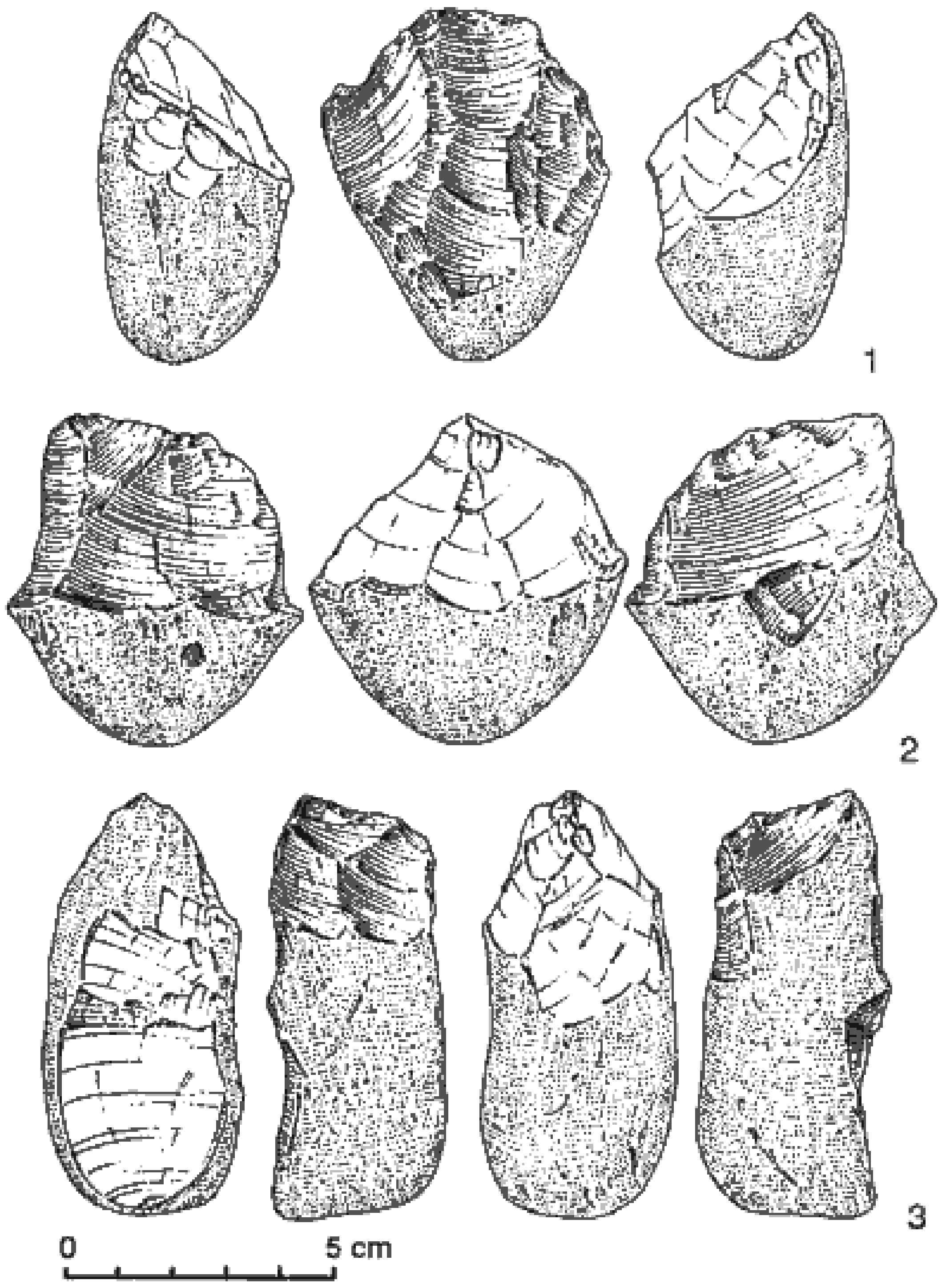

Fig. 3. Kamennyy Log Site. Early Palaeolithic quartzite pebble-tool industry collected on the present-day beach (Series 2).

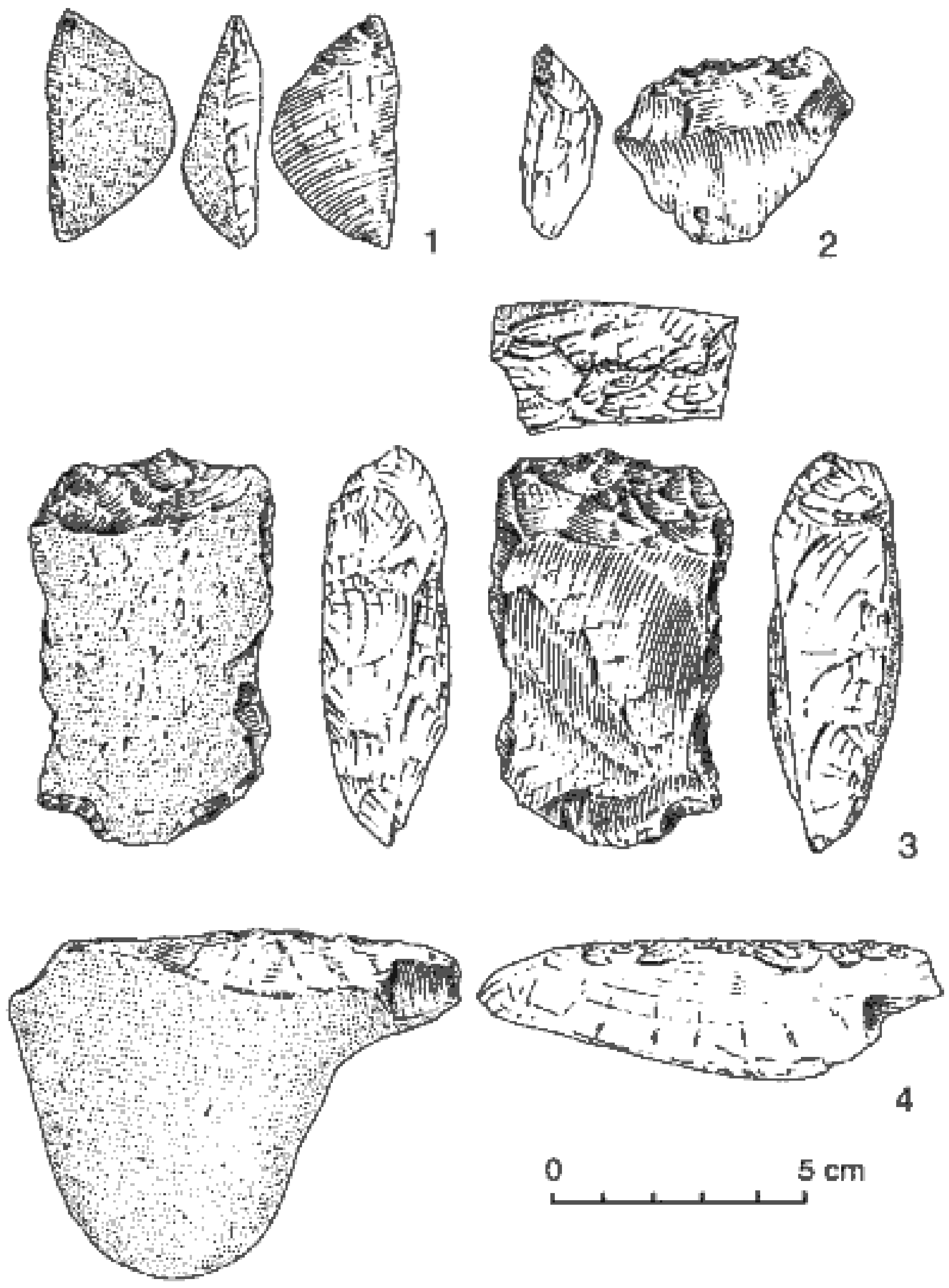

Fig. 4. Berezhekovo Site. Early Palaeolithic industry on quartzite eroded from a 65 m alluvial Yenisey River terrace covered by 30 m of loess deposits with a recorded M/B palaeomagnetic reversal.

eroded from the 65 m terrace (Fig. 4). This is covered by 30 m thick loess deposits, in the basal part of which two palaeomagnetic reversals have been recorded, with the latter (characterised by a normal polarity) correlated tentatively with the Jaramillo Event (0.98–0.9 Ma BP). Confirmatory chronometric data and location of artefacts *in situ*, however, are necessary.

Overall, the cultural evidence from the Minusinsk Basin indicates that parts of southern Siberia, including the Kuznetsk and upper Angara River basins (Derevianko et al. 1990, Medvedev et al. 1990), were clearly occupied at several stages during the Middle Pleistocene.

Middle Palaeolithic

The Middle Palaeolithic cultural horizons in the Kurtak area have been recorded within the Late Pleistocene loessic deposits. A Middle Palaeolithic lithic industry, characterised by a "Mousterian-like" tradition and distinguished by the Levallois (i.e. prepared core) technology, has been found at the Kamennyy Log II (Sections 9–11, Excavations 2–4) and Berezhekovo Sites (Excavations 1–2) in the last interglacial Kamenolozhskaya Soil and the Sukholozhskiy Pedocomplex of the early last glacial interstadials. Typical Levallois specimens are also scattered in the shore zone at other sites in the Kurtak area, but without clear geological contexts (Fig. 5).

The only Middle Palaeolithic locality in the study area with an unweathered lithic industry found *in situ (sensu stricto)* is the Usť-Izhuľ Site discovered in August 1993 and investigated in the summer of 1994 (Drozdov et al. 1995, Laukhin et al. 1997). There, a unique palaeontological and archaeological assemblage was found after exposure of the river bank by wave erosion in the shore zone at the Usť-Izhuľ Bay 10 km north of Kurtak on a 65 m Early Pleistocene terrace of the Yenisey River (Fig. 6). The fossil fauna remains were incorporated in the Bmk horizon of a secondarily gleyed reddish soil, the upper part of which was colluviated and interstratified by yellow-grey-greenish silty deposits, above a compact chernozemic Ah horizon. Taxonomically, the fauna included an early form of *Mammuthus primigenius* Blum., *Coelodonta antiquitatis* Blum., *Bison priscus* Boj., *Equus* sp., *Cervus elaphus* L. and *Marmota* cf. *baibacina* Kastschenko and *Meles meles* (taxonomic determination by N. D. Ovodov and I. Foronova). The most abundant species-mammoth-is represented by the mostly juvenile remains of at least 12 individuals, parts of which were recorded in anatomical or-

Fig. 5. Verkhnyy Kamen Site. Middle Palaeolithic stone industry-flake (1) and core with a prepared platform (2).

Table 1. Radiocarbon dates from the Kurtak area

Date (BP)	Site/Section (Horizon)	Material	Context
14 300 ± 100 (LE-1457)	Kurtak III/R_2[5]	charcoal	loess
14 390 ± 100 (LE-1456)	Kurtak III/R_1[5]	charcoal	
14 600 ± 200 (GIN-2101)	Kurtak III/R_2[5]	charcoal	
16 900 ± 700 (GIN-2102)	Kurtak III/R_1[5]	charcoal	
9 000 ± 1500 (IGAN-1046)	Kamennyy Log I (hor. 13)[1]	charcoal	
20 800 ± 600	Kashtanka (hor. 9)[6]	charcoal	Kurtak PK
21 800 ± 2000 (IGAN-1049)	Kamennyy Log I[1]	charcoal	
23 830 ± 2000 (IGAN-1050)	Kamennyy Log I[1]	charcoal	
23 470 ± 200 (LE-2833a)	Kurtak IV (hor. 11)[5]	charcoal	
23 800 ± 900 (LE-4155)	Kurtak IV (hor. 11)[5]	charcoal	
24 000 ± 2950 (LE-4156)	Kurtak IV (hor. 11)[5]	bone	
24 170 ± 230 (LE-3351)	Kurtak IV (hor. 11)[5]	charcoal	
24 400 ± 1500 (IGAN-1048)	Kamennyy Log I[1]	charcoal	
24 800 ± 400 (GIN-5350)	Kurtak IV (hor. 11)[5]	charcoal	
24 805 ± 425(K PK)	Kashtanka (hor. 9)[6]	charcoal	Kurtak PK
24 890 ± 670 (LE-3357)	Kurtak IV (hor. 11)[5]	bone	
27 470 ± 200 (LE-2833)	Kurtak IV (hor. 12)[5]	charcoal	
29 400 ± 400	Kashtanka (hor. 11)[6]	charcoal	Kurtak PK
29 410 ± 310 (SOAN-2806)	Berezhekovo 21 (hor. 3)[2]	charcoal	Kurtak PK
> 30 000 (SOAN-2807)	Berezhekovo 21 (hor. 3)[2]	charcoal	Kurtak PK
30 400 ± 700 (AECV-1938C)	Berezhekovo - North[7]	wood	Kurtak PK
31 650 ± 520 (LE-3352)	Kurtak IV (hor. 17)[5]	charcoal	
32 380 ± 280 (LE-3638)	Kurtak IV (hor. 17)[5]	bone	
34 800 ± 1200 (GIN-6090)	Kurtak IV/9[3]	charcoal*	Km. Soil[8]
35 600 ± 1200 (GIN-6089)	Kurtak IV/7[3]	charcoal*	Km. Soil
38 300 ± 1000 (GIN 6088)	Berezhekovo 21 (hor. 6)[4]	charcoal*	Km. Soil
> 35 000 (SOAN-2805)	Kurtak IV [2]	charcoal	loess
> 42 100 (AECV-1939C)	Usť-Izhuľ [7]	bone	colluvium.
> 40 050 (AECV-2033C)	Usť-Izhuľ [7]	charcoal	colluvium
> 41 810 (AECV-2032C)	Usť-Izhuľ [7]	charcoal	colluvium
> 42 190 (AECV-2034C)	Usť-Izhuľ [7]	charcoal	colluvium

[1] CHERKINSKIY et al. 1990; [2] DROZDOV et al. 1990a; [3] DROZDOV et al. 1990b; [4] DROZDOV et al. 1990c; [5] SVEZHENTSEV et al. 1992; [6] DEREVIANKO et al. 1992a; [7] CHLACHULA, unpublished data; [8] Kamenolozhskaya Soil. *Contaminated stratum (secondary intrusion of dated organic matter) (according to CHLACHULA 1995).

der. A rich malacofauna and rodent fossil remains were also present.

The perfectly preserved stone tool assemblage was largely exposed during the subsequent excavations in direct association with the abundant fossil fauna record as well as some other cultural features. Lithic artefacts (mostly represented by unmodified flakes), made from various clastic rocks selected from river gravels, were flaked and used directly at the site. Modified (flaked, cut and scraped) bones of rhinoceros and bison, bones and tusks of mammoth, and a flaked reindeer antler were found. The spatial distribution of the skeletal remains suggests that the large animals were hunted by palaeolithic people in the nearby area and transported in pieces (dissected parts) to the site. This interpretation is supported by finds of three mammoth juvenile skulls, two left mammoth shoulderblades, a left femur still attached to the tibia and a bison skull. The fossil remains, recorded largely in anatomical order, were concentrated in a discrete area of ca. 6 x 8 m. Nearly 200 artefacts, mostly flaked from several large quartzite, quartz, basalt and silicate-rock cobbles, and collected by the early people from the Yenisey River terrace, were dispersed among the bones within an interstratified silty-clayey matrix. Some of the artefacts show signs of the (proto) Levallois tradition. The exceptional nature of the discovery is also documented by three fireplaces, one of which (F3) was found between a large mammoth tusk and a broken reindeer antler, and evidenced by dispersed charcoal over an area of about 4 m^2, with a radiocarbon date > 42 190 yr. BP (AECV 2034C). The second fireplace (F2), 1–1.5 m in diameter (> 40 050 yr. BP; AECV 2033C), was situated about 5 m from the first one. The third fireplace (F1) (> 41 810 yr. BP; AECV 2032C) was located about 70 m north of the main occupation site, with a small set of artefacts, including a well-produced unifacial chopper, found nearby. Charcoal analysis suggests that coniferous wood (*Abies* sp.) was used as the fuel in all the fireplaces. Associated malacofauna (e.g. *Pupilla muscorum* L.; *Pupilla loessica* LZK.; *Succinea oblonga elongata* SAND.; *Vallonia tenuilabris* BRAUN) are all typical of loessic mollusc species characteristic of xerotheric continental grassland environment. The last interglacial age of the site is inferred from the stratigraphic geological position confirmed by palaeomagnetic studies, and corroborated by

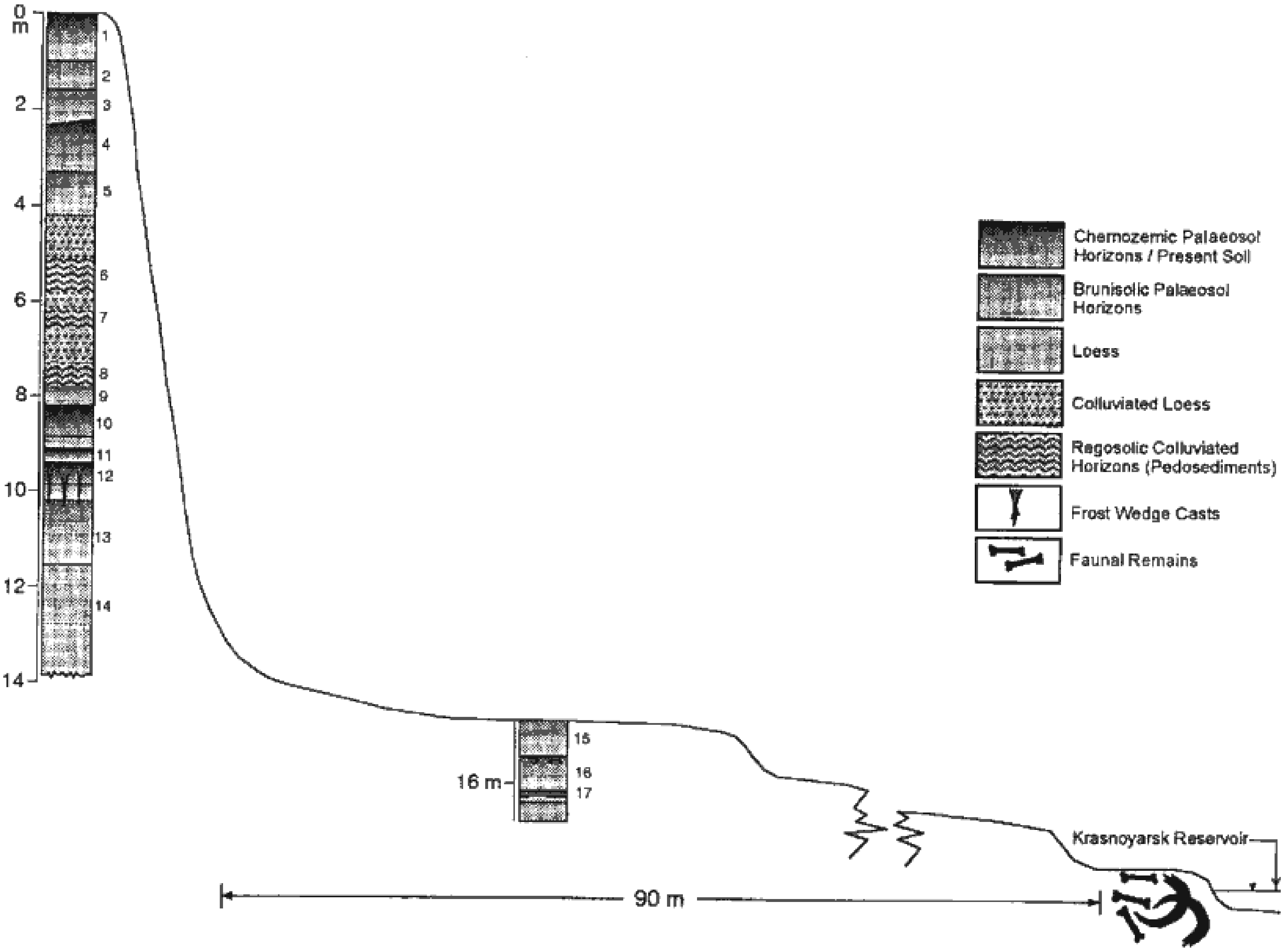

Fig. 6. Usť-Izhuľ Site. Stratigraphic position of the Palaeolithic occupation site.

the taxonomical classification of the mammoth remains which produced a radiocarbon date of > 42 100 yr. BP (AECV 1939c). The Usť-Izhuľ Site I is without parallel in Siberia in its taphonomical, contextual and archaeological completeness.

At present, there is no consensus that the Middle Palaeolithic lithic industry can be really associated with the classical European and Near Eastern Mousterian, although Mousterian influences in the Altai cave sites are evident. Also, the Middle Palaeolithic technology of stone flaking, especially the Levallois technique, survives for some time in the later southern Siberian lithic assemblages.

Late Palaeolithic

The Late Palaeolithic stone industries have been recorded in the Sartan loess and intercalated, weakly developed interstadial soils (Tab. 1). At the Kashtanka Site, two cultural horizons dated to 21 800–24 800 yr. BP are located in the upper part of Stratum 11 near the top of the Kurtak Pedocomplex within a 3–3.5 m loess deposited on a 70–80 m terrace platform (Drozdov et al. 1990b). At the Kamennyy Log Site I, analogous tools have been recovered from two cultural layers (Stratum 11) in humic loamy sediments radiometricaly dated between 23 500 and 24 900 yr. BP. A Late Palaeolithic site has been discovered at Usť-Izhuľ, close to the Middle Palaeolithic "mammoth site". Finally, the most recent palaeolithic find comes from the Listvenka Site with radiocarbon dates of 13 590 ± 350 yr. BP and 12 750 ± 140 yr. BP.

Overall, the palaeolithic record from the Kurtak area provides evidence that the Minusinsk Basin was repeatedly occupied by early people during the Pleistocene, including colder stages with periglacial conditions. Ultimately, the abundant cultural remains can be used as another, although indirect and still not sufficiently dated, important source of proxy data for reconstructing the Quaternary environments and palaeoclimatic history of the region. Although still fragmentary, the biotic (floral and faunal) data combined with the palaeolithic record provide additional evidence of climatic evolution in the upper Yenisey River valley during the Pleistocene.

BIOTIC EVIDENCE

Palaeobotanical record

Most of the palaeobotanical evidence consists of pollen data, as only rarely has fossil wood been found in the Kurtak loess sections. Palynological studies have been carried out chiefly at two principal localities – Berezhekovo and Kamennyy Log, largely in conjunction with buried cultural occupation surfaces. At present, the longest and so far the most complete record comes from the Berezhekovo Section 1. Nevertheless, as with most other pollen evidence, the chronology is only tentatively determined, particularly for the earlier records.

The basal part of the Berezhekovo sequence formed of a thin Middle Pleistocene alluvium (Stratum 8) yielded pollen of Siberian "cedar" (*Pinus sibirica*), spruce, and fir, suggesting the presence of southern taiga in the area. A more informative assemblage came from a chernozemic/luvisolic soil (Stratum 7) variously assigned to the penultimate (Tobol OIS 7) interglacial or the last (Kazantsevo OIS 5e) interglacial. A mosaic steppe-parkland with pine and birch is documented by a pollen record (Complex I) with 35–98 % grasses including herbaceous plants – *Asteraceae* (43–58 %), *Chenopodiaceae* (0.6–1.9 %); 1–13 % arboreal taxa – *Pinus silvestris* (34–58 %), *Pinus sibirica* (7–10 %), *Betula* sp. (27–31 %), *Betula nana* (2–3 %), *Salix* (6.5 %), *Alnaster fruticosus* (3.4 %); and 1–52 % of spores, dominated by *Botrychium* (84 %) (Drozdov et al. 1990a)

The overlying loess with a gleysol horizon at the base (Strata 6–4) includes pollen (Complex II) indicative of a humid boreal mixed forest with birch, fir and spruce, suggesting a colder climate than at present, likely of the early last glacial age. Arboreal taxa (44–58 %) prevail in the record with *Picea* sp. (24–51 %), *Pinus silvestris, Abies sibirica* and *Betula* cf. *albae* (5–17 % each), *Pinus sibirica* (< 8 %), followed by spores (33–40 %) with *Botrychium* and Bryales, and smaller amounts of grasses (3–29 %). A marked fluctuation of arboreal (mostly coniferous) and non-arboreal taxa among the particular strata is apparent. Drier conditions than in the underlying horizons are indicated by pollen data from an incipient brunisolic soil (Stratum 3) typical of a mixed forest and forest steppe with pine and birch (Complex III). Arboreal taxa include *Pinus silvestris* (33–42 %), *Betula* sp. (35 %), *Picea* sp. (11 %), grasses (27 %) with *Cyperaceae, Asteraceae, Chenopodium;* and some spores (9 %). Cold steppe with pine and birch characterises the overlying initial soil (Stratum 2), with pollen (Complex IV) dominated by grasses (59 %) – *Chenopodiaceae, Cichoriaceae, Asteraceae* (85.7 % in total); with fewer trees (34 %) and spores (6 %). The pollen record (Complex V) from the lower part of the Holocene soil (Stratum 1) includes grasses (74 %), trees (16 %) with *Betula albae* (68–98 %) and *Pinus silvestris* (2–32 %), and spores (10 %) with *Bryales* and *Polypodiaceae*, typical of a dry continental climate and characterising the present parkland steppe in the surrounding area.

An analogous pollen record, covering the Late Pleistocene, has been derived from the Kamennyy Log Excavation 1. Seven climatic phases have been specified in terms of the general palaeoclimatic evolution. Phase I, assigned to the last interglacial, is characterised by southern taiga-steppe vegetation, with coniferous forest taxa dominated by spruce, pine and cedar, and open parkland communities with pine and birch. Expansion of boreal forest is assumed for Phase II with a distribution increase of *Pinus silvestris*. A cooling trend during the Phase III caused a shift towards a forest-tundra setting, followed by warming during Phase IV leading to re-establishment of southern taiga. A new climatic deterioration with a more pronounced continentality and return to a cold tundra environment is associated with Phase V. The succeeding mixed boreal forest with pine and birch (Phase VI), and a cool humid steppe (Phase VII) relates to warming and cooling stages, respectively. Phase VII marks the recent climatic conditions within a southern parkland-steppe (Drozdov et al. 1990b).

Pollen of *Larix, Pinus, Picea, Abies* and *Betula* has been also found in the Upper Pleistocene (interstadial?) colluviated loess deposits (Derevianko et al. 1992). Finally, at the Kurtak IV Site, a cool (arboreal) forest-steppe with birch, pine, larch and spruce, and some spores (*Lycopodium alpinum, Selaginella sibirica*) have been dated to the late Karginsk Interstadial (ca. 24–23 ka BP).

In summary, the palynological data document shifts in the vegetation patterns between southern taiga and forest steppe in the Minusinsk area, also inferred by more regional pollen analysis (Koltsova 1990), and corroborating the local loess-palaeosol record. During warmer Late Pleistocene interstadials, conditions similar to the present were established with steppe and forest-steppe replaced by forest-tundra and steppe-tundra during colder glacial intervals.

Palaeontological record

In comparison with the palaeobotanical data, the palaeontological record has been largely derived from secondary and/or poorly documented stratigraphic contexts. Most of the bones and teeth, either well-preserved or in fragments, have been eroded onto the present beach. Nevertheless, provenance of some of the faunal material can be determined from the stratigraphic position of exposed fossil-bearing deposits. Much less data come from controlled excavations of more limited extent.

Apart from the unique faunal assemblage found in situ at the Ust'-Izhul' Site, so far the most complete faunal record comes from the Berezhekovo Excavation 2 (Drozdov et al. 1990a). There, remains of *Ursus* sp., *Bison priscus* Boj., *Citellus* sp., *Myospalax* sp., and a variety of rodents (*Microtus gregalis* PALL., *Microtus oeconomus* PALL., *Lemmus obensis* BRANTS, *Arvicola terrestris* L. and *Sorex* sp.) were found in a 0.7–1.0 m thick chernozemic soil disturbed by solifluction (Stratum 5). An early form of *Mimomys* sp. and *Prolagurus* sp. are believed to indicate an Early Pleistocene age (DROZDOV et al. 1990c). However, this assignment does not corroborate the occurrence of a large Middle Pleistocene fauna (< 730 ka BP), including *Coelodonta antiquitatis* BLUM., *Equus hemionus* PALL., and *Bison priscus* BOJ., recorded in the underlying 0.4–0.7 m thick gravelly sand alluvium (Stratum 6). Further research is therefore needed to clarify this issue.

At the Berezhekovo Excavation 1, wooly rhinoceros (*Coelodonta antiquitatis* BLUM.) was found in the lower part of the Tchaninskaya Loess Series (Stratum 3) of the early last glacial stage. A typical cold loessic molluscan fauna, indicative of a dry climate, has been recorded from the aeolian deposits (Stratum 5), represented by *Succinea oblonga* DRAP., *Pupilla muscorum* L., *Pupilla turcmenica* BTTG., *Vertigo pseudostriata* (LZK.), *Columella columella* (MRT.), *Vallonia* aff. *enniensis* (GREDL.) and *Euconulus fulvus* (MOLL.). A rich fauna, including *Ursus* sp., *Equus* sp., *Coelodonta antiquitatis* BLUM., *Capreolus capreolus* L., *Megaloceros giganteus* BLUM., *Rangifer tarandus* L., *Bison priscus* BOJ., *Ovis* sp., *Lepus* sp., *Alactata* sp., *Myospalax* sp., *Lagurus lagurus* PALL., *Arvicola* sp. and some mollusc species (*Pupilla muscorum* L., *Pupilla turcmenica* BTTG., *Vertigo pseudostriata* LZK. and *Columella columella* MRT.) came from the 3 m thick Berezhekovskaya Loess Series (Stratum 6) with advanced gleying and some krotovinas in the lower part (DEREVIANKO et al. 1992). A Middle Pleistocene fauna with *Equus mosbachensis-germanicus, Coelodonta antiquitatis* BLUM., *Megalocerus gigantheus* BLUM., *Bison priscus* BOJ., *Saiga tatarica, Lagurus lagurus* PALL., and rodents *Mimomys oeconomus* PALL., *Myospalax* sp., *Mustela* sp. were found in the lower, partly redeposited 0.8 m thick interglacial soil (Stratum 7). Some Upper Pleistocene rodent taxa such as *Microtus gregalis* and *Arvicola terrestris* L. would not contradict the earlier chronology, as the later species most likely burrowed into and became incorporated within the deeper deposits. *Equus* sp., *Equus* cf. *hemionus, Rangifer tarandus L., Sorex* sp., *Citellus* sp., *Lemmus obensis* BRANTS, *Microtus* sp. from the underlying 0.2–0.5 m of alluvium (Stratum 8) characterise an earlier, probably periglacial, faunal community. Finally, *Mimomys* sp., *Prolagurus* sp., *Allophaiomys* sp. represent the earliest fossil rodent remains from the 0.4–1.1 m relic of presumably Early Pleistocene alluvium in the basal part of the section (Stratum 9) (DEREVIANKO et al. 1992).

At the Kamennyy Log Site I, a mixed late Middle Pleistocene and Upper Pleistocene fauna collected along the present lake shore, but eroded from primary geo-contexts, includes an early form of *Mammuthus primigenius* BLUM., *Equus mosbachensis-germanicus, Equus* cf. *przewalski* POL., *Equus* off. *hydruntinus* REG., *Coelodonta antiquitatis* BLUM., *Alces alces* L., *Rangifer tarandus* L., *Bison priscus* BOJ. (DROZDOV et al. 1990a). Some rodents (*Myospalax myospalax* LAXM., *Citellus undulatus* PALL.) came from a more intact geological position from the Sukholozhskiy Pedocomplex assigned to the early last glacial stage (OIS 5d). An early form of *Mammuthus primigenius* and *Equus mosbachensis-germanicus* was also recorded in the 3–4 m thick periglacial alluvium below the first last interglacial chernozem (i.e. the Kamenolozhskaya Soil).

Fossil remains (*Ursus* sp., *Panthera spelaea* DOLDF. and *Alces alces* L. representing a typical interstadial assemblage of the periglacial type have been radiometrically dated (24 000–23 000 yr. BP) at the Kurtak Site IV from a cultural horizon (DROZDOV et al. 1990a). Fauna (*Equus caballus, Megaloceros giganteus, Bison priscus* and *Coelodonta antiquitatis*) from the chernozemic soil below (> 35 000 yr. BP) is most likely of last interglacial in age. A (late) Middle Pleistocene fauna has been collected from a 12 m platform below a 160 m terrace from the Verkhniy Kamen Site, mainly represented by early forms of mammoth (*Mammuthus chosaricus* DUBR.) and horse (*Equus* sp.), presumably from the Samarovo (Saalian) Glacial.

In summary, in despite of the less cohesive picture of palaeoclimates and the problematic dating of the earlier finds, the fossil record clearly indicates a wide range of large as well as small animals occupying the Northern Minusinsk Basin at various stages during the Middle and Late Pleistocene (Tab. 2). The presence of cold-adapted species suggests a certain ecological potential of periglacial environments for diverse biotic communities that expanded during stadial intervals. The high number of rodent species from warmer interstadial and interglacial soils document their specific natural habitat within dry, cold steppe and forest-steppe settings.

QUATERNARY ENVIRONMENTS: A SUMMARY

The geological and palaeoecological data from the Northern Minusink Basin show patterned climatic changes during the Quaternary period leading to the development of the present environment. Within a broader area, trends toward a strongly continental climate characterised by increased aridity and high seasonal fluctuations can be followed in the geological record since the late Pliocene. The subsequent development during the Quaternary is evidenced by zonal shifts in vegetation distribution, with expansion of a taiga forest northward during interglacial periods and warmer interstadials, succeeded by subarctic periglacial forest-steppe, and tundra-steppe during cold glacial intervals, when the tree cover periodically became much reduced and spatially limited to refugia in the southernmost portions of

Table 2. Quaternary environments in the Kurtak area: a summary of the pedological, biotic and cultural evidence (CHLACHULA 1995)

Period/Stage $\delta^{18}O$	Setting	Soil/PK	Fauna	Flora	Early Sites
Holocene (< 10 ka)– ($\delta^{18}O$ Stage 1) (Kurtak Sk_{2-1})	Parkland Steppe	Chernozem Luvisol	*Ursus* sp. *Lepus* sp. *Marmota* sp.	*Betula albae* *Pinus silvestris* *Pinus obovata* *Alnus* sp., *Salix* sp. Asteraceae, Fabaceae Cyperaceae, Bryales Polypodiaceae	N/A
LATE PLEISTOCENE					
Sartan Glacial (22–10 ka) ($\delta^{18}O$ Stage 2) (KS 29 Sk_3)	Tundra-Steppe Gleysol	Gleyed Regoso	*Mammuthus primigenius* *Pupilla loessica* *P. muscorum* *Succinea oblonga*	*Betula nana* *Salix* sp. *Artemisia*	*Blade Industries* Kamennyy Log Ust'-Izhul'2
Karginsk NonG (55–22 ka) ($\delta^{18}O$ Stage 3) (KS 29 Sk_{13-4})	Forest-Steppe Boreal Forest (Taiga)	Brunisol Gleyed Brunisol Chernozem Cryosol	*Ursus* sp. *Panthera spelaea* *Alces alces*	*Pinus silvestris* *Picea* sp., *Abies* *Betula, Larix* sp. *Lycopodium alpin.* *Selaginella sibirica*	Kamennyy Log (hor. 11) Kashtanka (hor. 11)
Zyriansk Glacial (110/73–55 ka) ($\delta^{18}O$ Stage 4) (KS 29 Sk_{17-14})	Tundra-Steppe Forest-Tundra	Gleyed Regosol Gleyed Brunisol	*Bison priscus* *Alces alces* *Coelodonta ant.* *Equus przewalski* *E. hydruntinus* *Succinea oblonga* *Pupilla muscorum* *P. turcmenica* *Vertigo pseudostriata* *Columella columella* *Vallonia enniensis*	*Artemisia* *Chenopodium* *Pinus silvestris*	
Kazantsevo InterG (130–110/73 ka) ($\delta^{18}O$ Stage 5) (KS 29 Sk_{25-18})	Forest-Tundra Forest-Steppe Steppe	Gleyed Brunisol Brunisol Chernozem	*Equus caballus* *Bison priscus* *Coelodonta ant.* *Megaloceros giganteus* *Ursus* sp. *Myospalas* m. *Citellus* sp. *Microtus greg.* *M. oeconomus* *Lemmus obensis* *Arvicola terrestris* *Sorex* sp.	*Picea* sp. *Pinus sibirica* *Pinus silvestris* *Betula albae* Cyperaceae Asteraceae Polypodiaceae Cichoriaceae	*Mousterian* Berezhekovo (hor. 7) Kamennyy Log Ust'-Izhul'
MIDDLE PLEISTOCENE					
Tazov Glacial (180–130 ka) ($\delta^{18}O$ Stage 6) (KS 29 Sk_{28-26})	Tundra-Steppe Forest-Tundra	Gleyed Regosol Gleysol Colluviated loess *Pupilla muscor.* *P. turcmenica* *P. loessica* *Columella col.* *Vertigo pseudos.* *Succinea oblonga* *Vallonia tenuilabris*	*Mammuthus primigenius* *M. chosaricus* *Coelodonta antiquitatis* *Equus hemionus* *E. mosbachensis-germanicus* *Rangifer tarandus* *Megaloceros giganteus* *Ovis* sp., *Lepus* sp. *Lagurus lagurus* *Cervus elaphus* *Marmota barbacina* *Meles meles*	*Artemisia* *Betula nana* *Pinus silvestris* *Abies sibirica* *Chenopodium*	*Early Levallois* Ust'-Izhul'1 *Pebble Industries* Kamennyy Log Razlog
Tobol InterG (390–270 ka) ($\delta^{18}O$ Stage 7) (KS 29 Sk_{32-29})	Forest-Steppe Parkland-Steppe Steppe	Brunisol Luvisol Chernozem	*E. mosbachensis* *Coelodonta ant.* *Megaroceros g.* *Bos primigenius* *Saiga tatarica* *Lagurus lagurus* *M. oeconomus* *Myospalax* sp. *Mustela* sp.	*Pinus silvestris* *Pinus sibirica* *Betula* sp. *Salix* sp. *Alnus* sp. Asteraceae Botrichium	*Pebble Industries* (60–65 m terrace) Kamenyy Log Sukhoy Log Razlog: II series Verkhnyy Kamen Berezhekovo 1 (hor. 8a)
EARLY PLEISTOCENE					
(< 780 ka) Glacial Interglacial			*Equus* sp. *E.* cf. *hemionus* *Rangifer tarandus* *Sorex* sp., *Citellus* sp. *Lemmus obensis* *Mimomys* sp. *Prolagurus* sp. *Allophajomys* sp.		Berezhekovo 2 (hor. 6) Berezhekovo (65 m terrace) Razlog: I series (alluvial fan)

Siberia. Complex ecological changes are indicated from both pollen and fossil faunal remains recorded from stratified alluvial and loessic deposits.

According to the recent data, the earliest occupation in the upper Yenisey region occurred at the latest during the second half of the Middle Pleistocene. During early glacial stages, glaciers in the Western Sayan Mountains expanded down into the foothills to about 300–400 m altitude preceded by a down-slope migration of dark coniferous forest. In the Northern Minusinsk Basin, protected by mountains from the west and east, and separated by high ranges from the frigid northern tundra, favourable (although periglacial) conditions are believed to have persisted in this area during that time. This is evidenced by the abundant fossils from the earlier periglacial alluvia, as well as the colluvial reworking of the older (late Middle Pleistocene) Kurtak loess, indicative of a relatively humid and moderately cold climate with minor oscillations.

The pre-Late Pleistocene palaeoecology is not as well known because of the discontinuous and largely fragmented stratigraphic record. The most complete picture emerges for the Quaternary environments of the last glacial-interglacial cycle. At the time of the Middle Palaeolithic occupation correlated with the Kazantsevo Interglacial, broad areas of southern Siberia were covered by coniferous or mixed forests, with forest-steppe distributed in lower elevations and near the river valleys, and steppe in the southern interior basins. During the early last glacial stage, periglacial forest-steppe expanded to cover most of the upper Yenisey Basin. Following a period of intensive loess deposition, a renewed pulse of pedogenic processes during the Karginsk Interstadial led to formation of zonal soils as a result of warm climatic oscillations archaeologically illustrated by the appearance of transitional Middle/Upper Palaeolithic industries. The interstadial mosaic landscape with parkland vegetation was transformed into periglacial tundra during the late last glacial stage characterised by developed Upper Palaeolithic cultures persisting until the final stage of the Pleistocene. This palaeoclimatic and cultural evolution pathway can be documented over much of southern Siberia.

PALAEOLITHIC OCCUPATION OF SOUTHERN SIBERIA

Although the earliest occupation of Siberia is speculated to have taken place as early as 800 ka BP or even before that time (e.g. MOCHANOV 1992), the recent and stratigraphically well documented discoveries provide clear evidence that the territory was inhabited at least since the (late) Middle Pleistocene. Usually, the Tobol Interglacial (390–270 ka BP) is believed to have been the most favorable time to colonise vast territories of Siberia, when the MAT was by 3–4 °C higher than at present (ARKHIPOV 1991). Early people are assumed to have migrated from the south as far north as 60° N latitude repeatedly during warmer Pleistocene periods (DEREVIANKO 1990). The main colonisation of southern Siberia is visualised to have occurred during interglacials, whereas only local movements of Palaeolithic groups are envisaged during cold intervals, particularly the earlier glacial stages (YAMSKIKH 1992).

In southern Siberia, four major archaeological regions have been recognised over the last several years. In addition to the Northern Minusinsk Basin with the adjacent Eastern Sayan and the Kuznetskiy Alatau Foothills, these include the Southern Minusinsk Basin and the Western Sayan Foothills, the Krasnoyarsk-Kanskaya forest-steppe, and the upper and middle Angara River valley with tributaries (VASILEVSKIY et al. 1988, DROZDOV - CHEKHA 1992).

In general, the palaeolithic record can be assigned to four chronological stages.

Stage 1 – the earliest definitely known cultural remains come from the Yenisey Basin and are associated with high river terraces tentatively dated to a pre-Samarovo (Mindel/Riss) interglacial (CHEKHA - LAUKHIN 1992). The earliest palaeolithic occupation in the middle Angara River region, with a typical core and flake industries analogous to those from the Kurtak area, is documented at the Igetei Site chronostratigraphically assigned to the following Samarovo/Riss Glaciation/ OIS 6, i.e. prior to 130 ka BP (MEDVEDEV et al. 1990). Other very early (i.e. Middle Pleistocene) sites are located at Filimoshki and Mokhovo near Krasnogorsk in the Kuznetsk Basin (DEREVIANKO 1990). The Mokhovo Site is of particular interest, as this is deeply buried (–30 m) in the Bachatsk Crater in the Kuznetsk coalmine area. The Middle Pleistocene age of the recorded stone tools, referred to the Acheulian tradition, is stratigraphically and palaeontologically supported by an interglacial malakofauna from the artefact-bearing deposits (NIKOLAEV - MARKIN 1990).

Stage 2 – the second stage includes a "Mousterian-like" tradition in the Minusinsk Basin found in the last interglacial chernozemic steppe soil and the early last glacial pedocomplex. Corresponding finds have been recently discovered in the Angara River basin as well (i.e. the Mal'ta Site in the Belaya River valley; MEDVEDEV, personal communication 1997). Expansion of the occupation habitat into the mountain area is likely to have occurred after the last interglacial during warm early last glacial interstadials when examples of the Mousterian industry, with the characteristic Levallois technology, appeared at sites in marginal areas. A temporal hiatus is assumed for the early last glacial maximum when cultural remains are absent. The Middle Palaeolithic settlement correlated with the last interglacial and the first half of the last glacial (ca. 130–40 ka BP) and anthropologically characterised by an early form of *Homo sapiens* and by *Homo sapiens neander-*

thalensis is particularly well documented from the southern Siberian mountains. A concentration of the Mousterian occupation is in the Russian Altai foothills with numerous cave sites dated prior 40–50 ka BP (e.g. the Denisova, Okladnikova, Strashnaya, Usť-Kanskaya and Kaminnaya Caves) (Derevianko - Markin 1992). The identical geographical distribution of later sites and time-transgressive stone tool technologies suggest a possible local cultural continuity into the later Upper Palaeolithic sites (Derevianko - Markin, this volume). The Mousterian sites are also known from Khakassia, the Sayan foothills and the upper Angara River basin (Praslov 1984).

Stage 3 – broader parts of southern Siberia were reoccupied during the warmer mid-last glacial interstadials correlated with transitional Middle/Upper Palaeolithic industries, distinguished by a high percentage of archaic "Lower" and "Middle" Palaeolithic tool types. In the Minusinsk Basin, this occupation has been recorded in the lower part of the Kurtak Pedocomplex characteristic of a mixed forest-steppe (the Kashtanka and Kurtak IV Sites), with ^{14}C dates between 24 900 and 21 800 yr. BP (Chekha - Laukhin 1992). The occupation area was gradually vacated towards the end of the Karginsk Interstadial before total abandonment around the last glacial maximum (20–18 ka BP). Analogous Upper Palaeolithic sites are distributed on 23–25 m river terraces in the Western Sayan Mountains (Vasilev 1990), as in the Angara valley with the well-known Usť-Koba Site (Drozdov 1992). It is mostly assumed that the main settlement in Siberia and the Russian Plain occurred during this time, i.e. in the later part of the mid-last glacial interval (ca. 30 000–24 000 yr. BP).

Stage 4 – the last Pleistocene colonisation stage includes the late Upper Palaeolithic stone industries best known from the upper Yenisey and Angara River regions. The most intensive concentration of occupation sites relates to a warm interstadial between 16–13 ka BP, prior to the final cold oscillation. At that time, the famous Afontova Gora and Kokorevo cultures appeared.

Without doubt, the spatial and temporal distribution of early cultural remains document climatic instability over large parts of Siberia during the Pleistocene. Particular geographical locations of early sites indicate that environmental conditions during the early periods were generally more favourable for palaeolithic occupation than during later periods (Chlachula 1995).

CONCLUSIONS

The evolutionary process of the Palaeolithic colonisation of Siberia is still poorly understood, although every year archaeological investigations supply new, sometimes rather unexpected and surprising, evidence about the early human prehistory of this part of Asia. Early cultural evidence documented by stone and/or bone artefacts provides a significant source of proxy data which can be used to present a chronostratigraphic reconstruction of past environments and climate change. The traditional views, assuming a very late (Late Pleistocene) inhabitation of most of northern Eurasia, have been definitely challenged. Current data show that people were present long before that time. Several recent archaeological discoveries disprove the long-held assumption of a late penetration by Upper Palaeolithic people into the middle and high latitudes of northern Asia. Instead, glacial-interglacial and stadial/ interstadial cycles may have regulated periodic movement of early people northwards in response to climatic fluctuations, predetermining the inhabitability of large geographical areas. Nevertheless, during glacial maxima, most of Siberia seems to have been vacated, especially during the earlier periods, because of the expansion of continental glaciers, and presence of harsh and inhospitable environments in periglacial areas. Gradual adaptation to cold natural habitats accelerated during the Late Pleistocene in connection with the cultural and biological evolutionary adjustment, enabling people to establish permanently in the vast Siberian territory.

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