Quaternary International 220 (2010) 64–87

Contents lists available at ScienceDirect

Quaternary International

journal homepage: www.elsevier.com/locate/quaint

Pleistocene climate change, natural environments and Palaeolithic occupation of East Kazakhstan

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ARTICLE INFO

Article history:
Available online 17 September 2009

ABSTRACT

The territory of East Kazakhstan (the Southern Altai Mountains, the Bukhtarma and Zaisan/Black Irtysh Basins), still insufficiently investigated because of its proximity to the Kazakh–Russian–Chinese border zone, shows a complex Quaternary history and the associated environmental transformations reflected by intensive geomorphic processes related to the past global climate evolution in conjunction with the regional neotectonic activity. The marked climatic changes are indicated by the preserved palaeolandscape forms in both the mountain and steppe regions, as well as by the glacial and sedimentary geology, palaeoecology and geoarchaeology proxy records indicating long-term variations in temperature as well as humidity. Following the generally warmer Early Pleistocene climates, witnessed by the distribution of deeply weathered red palaeosols, the increased continentality and relief gradient during the Middle and particularly the Late Pleistocene led to establishment of the present-type forest-steppe/semi-desert during warm stages, and the periglacial arid steppe during cold stages correlated with the glaciations in the southern Altai Mountains, and loess deposition in the foothills. The mapped glacigenic and high-resolution loess-palaeosol sections, and contextual environmental archaeology data from the Pleistocene occupation sites provide new evidence of a rather pronounced natural dynamics. Spectacular glaciofluvial terraces in the principal mountain valleys indicate the presence of deep ice-dammed last glacial lakes documented from other parts of the Altai that were subjected to cataclysmic drainages during deglaciations. The recently discovered localities in the Bukhtarma River valley in diverse settings bear witness of a much earlier (Middle–Upper Palaeolithic) inhabitation of this geographically marginal area and adaptation to local mountain and steppe environments predating the Holocene prehistoric cultures. This paper summarizes some results of the initial multidisciplinary Quaternary field studies in the southern Altai region of East Kazakhstan and the adjacent part of Gorno Altai (2003-2007).

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1. Introduction

Palaeolithic archaeology in the Altai is well established. Comparing to the principal areas of systematic investigations in the Rudno Altai, the NW Altai foothills and in the middle Katun River basin of the Central Altai (e.g., Derevianko and Markin, 1990, 1992, 1999; Kungurov, 1993, 2002a, b, 2006; Kungurov and Sitnikov, 1996; Derevianko et al., 1999), the southern mountain and steppe regions of the Altai still remain outside of the main research focus (Chlachula, 2001). Recent (2005–2007) pilot environmental archaeology field reconnaissance in East Kazakhstan in the peripheral area bordered by the Southern Altai Range resulted in discovery of several occupation sites that provide first indices of a chronologically diverse early human inhabitation of this marginal geographic territory, having a major relevance for mapping chronological trajectories and adaptive patterns of the initial prehistoric peopling of inner Asia. The mapped sites are partly exposed on the present surface due to the rather thin and sometime even absent Quaternary sedimentary cover; several sites were located *in situ (sensu lato)* in the stratified geological contexts. These recent discoveries from the upper and lower reaches of the Bukhtarma River valley and the Zaisan/Black Irtysh Basin, representing the main drainage system of the territory, document some of the earliest traces of the pre-Holocene occupation of East Kazakhstan. Apart from the formal (technological–typological) attributes allowing only a general temporal classification of the cultural records, the focus of the performed Quaternary investigations was on palaeoecology and site formation processes linked to past environmental transformations. The geological and chronostratigraphic contexts of the geoarchaeological records may be also used as proxy tools for mapping the regional palaeogeographic evolution (Arkhipov, 1999), including extent of the Late Pleistocene glaciations and the glaciolacustrine basin formation in the broader

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doi:10.1016/j.quaint.2009.09.011

Altai Mountains. The significance of geoarchaeology studies lies in the particular geographical location of the Altai at the margin of SW Siberia, believed to be one of the main passages for the initial human dispersal into north Asia from the southern regions of the continent. Reconstruction of the Pleistocene climate dynamics that shaped the topographic relief of East Kazakhstan and ultimately governed mosaic configuration of the past ecosystems is essential for understanding the process and timing of the early peopling of this territory.

2. Geography and present environments of the study area

The Altai (Russian Gorno Altai) is the major mountain system of southern Siberia with elevations over 4000 m asl., adjoining in the south-east the Mongolian Altai through the Tabon-Bogdo-Ula massive (Nairamdal Mt. 4356 m). The southern (Kazakh) Altai, divided into several main mountain ranges, is its southernmost extension connecting through the Tarbagatay Range (2992 m) and the Dzhundarskiy Alatau (4464 m) to the Tian-Shan Mountains of Central Asia. Geomorphologically, it is structured by the E–W oriented Southern Altai, Sarymsakty, Narym and Kurchum Ranges characterized by steep erosional northern slopes, representing uplifted relics of old plateaus (>3000 m asl.) with 200–400 m above-protruding peaks, and with a decreasing topographic gradient (3900–2300 m asl.) westwards from the central Altai mountain massive.

The key investigated area lies in the southern Altai foothill region including the adjoining steppes in the Russian–Kazakh–Chinese border territory of East Kazakhstan (Fig. 1A). From the east, it is bordered by the Plateau Ukok (2200–2600 m asl) in the upper reaches of the Bukhtarma River fed by glacial waters of the Tabun Bodgo Ola Range (4356 m) and the Southern Altai Range (3483 m) (Rudoy et al., 2000). In the north, it is delimited by the Chokpartas Range (3142 m), the Katun Range (4506 m) and the Listviyga Range (2578 m) of the West (Rudno) Altai. The Narym (2533 m) and Sarymsakty Ranges (3373 m), lining up the Bukhtarma River valley from the south, represent the western margins of the uplifted central Asian mountain systems raised to the present elevations by the late Tertiary/early Quaternary orogenic movement. The southern geographical limit of the investigated area is the Zaisan basin – a tectonic depression filled by the Chernyy (Black) Irtysh River and forming a major natural freshwater reservoir of ca 100 km in width and up to 150 km in length surrounded from the south by the Tarbagatay (2992 m) and the Saur (2930 m) Mountains (Fig. 1B).

The formation of the southern Altai mountain system relates to the Caledonian and Hercynian orogenesis followed by Mesozoic planation succeeded by the re-activated Neogene/early Quaternary tectonics, being most intensive in the central mountain areas. The broader regional geology is structured mainly by Proterozoic green and grey metamorphic slates and granites mantled by Palaeozoic, Devonian, Carboniferous and Palaeogene rocks of volcanogenic as well as sedimentary origin filling the deep syncline depressions (Fig. 2A). The exposed mountain ranges are principally formed by the Palaeozoic sedimentary rocks (sandstone, limestones) with intrusions of metamorphic slates and granites. Karstic cavities are locally developed in the Palaeozoic limestone deposits (Nekhoroshev, 1958; Mikhailov, 1961).

The topographic relief of the Altai was shaped by the Quaternary glaciations accompanied by intensive fluvial erosion and gravity slope processes particularly active in the mountain valleys with best-preserved landforms dating to the last glacial stage. Massive accumulation processes of unconsolidated sediments are well evident in the intermountain depressions (the Chuyskaya, Kurayskaya, Kanskaya in Gorno Altai) at elevations 1500–2000 m asl.

Fig. 1. (A) Geographical location of East Kazakhstan. (B) Location of the principal study area (East Kazakhstan steppes, Bukhtarma Basin, Zaisan Basin, Southern and Central Altai, Altai Plain) with the investigated palaeolithic sites and Quaternary sections discussed in the text. 1–3, Zaisan Basin (I–III); 4, Bolshoy Narym – Bukhtarma Lake; 5, Camp lake site; 6, Izzkuty loess section; 7, Dzambul; 8, Berel'; 9, Krasnaya Gorka (Gorno Altai); 10, Biysk (Altai Plain, West Siberia).

The regional vegetation cover (Fig. 2) includes arid steppe – semi-desert biotopes with a dry rocky surface cover on the southern relief exposures contrasting with the southern Siberian dark taiga forest and rich alpine vegetation on more humid northern slopes dissected by deep mountain ravines (Fig. 2F–H).

The present climate is typically continental, with warm semi-humid summers and cold winters with increasing precipitations on the NW Altai slopes exposed to the Atlantic atmospheric streams (max. 1500–2000 mm/year at 1500–2000 m elevations) sharply contrasting with arid southern mountain regions of the Plateau Ukok (250 mm), the semi-desertic Chuya steppe (100 mm) and the Zaisan Lake basin (200 mm) of East Kazakhstan (Fig. 2C, D). The regional MAT differences are rather pronounced reflecting particular geographic locations and topographic configurations. The mean January temperature decreases from −15 °C in the western foothills to −30 °C in the central Altai valleys with the lowest temperature values on the high-mountain plateaus (down to −60 °C). The mean July temperature +20 °C in the steppe Altai decreases to +15 °C in the southern mountain regions. The highest mean July temperature (+23 °C) is in the Bukhtarma valley, being the warmest area of the Altai bordering the eastern Kazakhstan steppes (Fig. 2E, F). The present snowline lies at 2300 m in the

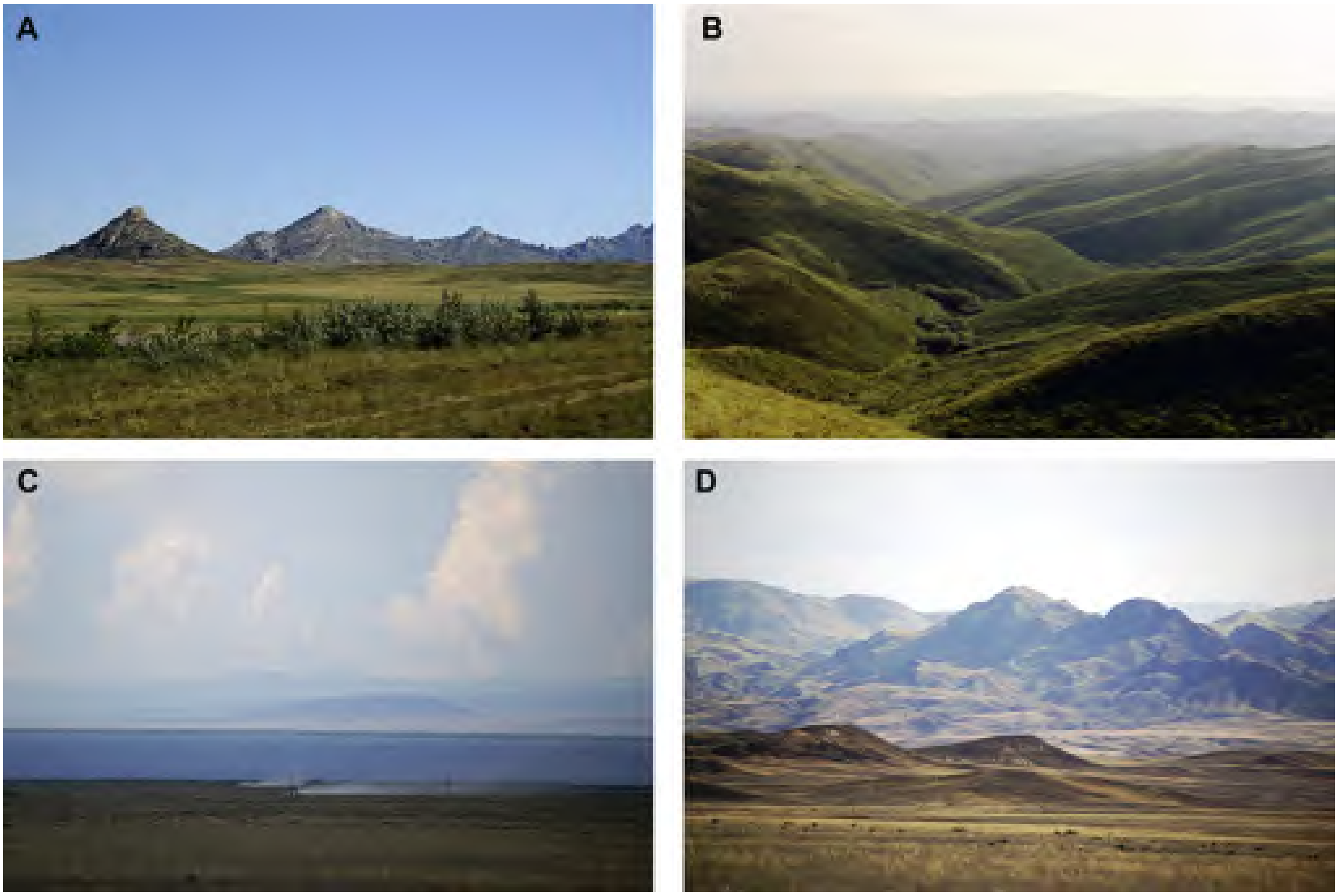

Fig. 2. East Kazakhstan. Diversity of the present ecosystems and topographic settings. (A) semi-arid rocky steppes of NE Kazakhstan with perennial streams and brackish lakes underlain by strongly weathered Pre-Cambrian granites covered by Tertiary and thin Quaternary deposits. (B) Undulating hills of the loess-covered Kalbinskiy Range (1608 m). (C) Semi-deserts of the Zaisan Basin (400–480 m asl.) flanked by the Kurchum Range (2545 m). (D) rocky steppes of the southern Zaisan Basin bordered by the Tarbagatay Range (2992 m). (E) Sandy steppes with migrating sand dunes of the lower Bukhtarma Basin. (F) Grasslands of the central Bukhtarma valley with the Narym Range (2533 m). Pleistocene landscape forms (cirques and boulder lags on the valley floor) attest to intensive past glacial/glaciofluvial processes. (G) the upper Bukhtarma valley, draining ice- and show-covered mountain ranges of the Plateau Ukok and the Southern Altai. (H) The Southern Altai Range (3483 m) with former glacial valleys covered by the alpine tundra and Siberian taiga forest vegetation (all photographs by the author).

humid western (Rudno) Altai and at 2600–3500 m in the southern Altai with forest limits at 2100–2400 m asl. The increased winter aridity contributes through deep ground freezing to formation of insular mountain permafrost. At present, isolated corie glaciers in elevations over 2500 m asl persist on the northern exposures of the Narym Range and the Southern Altai Mountains (Fig. 2F, H), and at higher elevations on the Tabon-Bogdo-Ula Range due to high aridity (precipitation 150–200 mm per year) despite very low MAT ($-10\,^{\circ}$C) (Rudoy et al., 2000). Warm and dry air mountain fen streams add to microclimate conditions reflected by the present biota and soil cover distribution with dark and well-developed steppe chernozems reaching up to the 1500 m elevation in the Bukhtarma valley.

3. Palaeogeography of East Kazakhstan

The present geography of East Kazakhstan provides witness of a complex landscape development triggered by past climate change and the regional tectonic activity. Three biogeographic provinces reach the present territory – the central Kazakhstan (Aral Sea – West Siberian) province, the southern Siberian (Yenisei) province and the Central Asian (Tian-Shan – Mongolian Altai) mountain province, with the latter having experienced the most intensive Quaternary topographic evolution accompanied by intensive erosion processes.

The pre-Cenozoic landscape history of the continental areas of Central Asia is characterized by a low topographic gradient of old planation surfaces and former sedimentary sea basins subsequently broken by the late Miocene earth crust movement. Neotectonic activity in conjunction with past global climate changes shaped the former landscape particularly during at the Pliocene/Pleistocene and early Middle Pleistocene.

The Cenozoic orogenesis that accelerated during the Late Pliocene and continued until the early Middle Pleistocene constructed a system of mountain ranges separated by deep depressions subsequently filled by large lakes (Dodin, 1961). Intensive erosion of the uplifted geological formations led to several periods of denudation of the former relief. The latest (Middle Pleistocene) Southern Siberian neotectonic stage caused a further deepening of the Altai Mountain river valleys by up to 100 m in the marginal areas (e.g., Anui, Charysh River basins) and >200 m in the central Katun River valley in Gorno Altai. The former Pleistocene palaeovalleys in East Kazakhstan as well as in the adjacent Gorno Altai are preserved only in relics elevated ca. >100 m above the present floodplains. Formation of the lower (30–40 m) terraces reaching up to 60 m in the Katun River valley is linked with the last interglacial erosion (Baryshnikov and Maloletko, 1999). Intensive Pleistocene fluvial processes markedly shaped topography of the steppe regions suggesting a considerably higher water flow than at the present time (Fig. 3).

Fig. 2. (*continued*).

A most prominent impact on landscape and biodiversity transformations in East Kazakhstan had the Quaternary mountain glaciations, presumably reaching maximum during the Early and Middle Pleistocene in congruence with the records in Gorno Altai (Chlachula, 2001). About five major glaciations are assumed to have taken place in the broader Altai area that contributed to a large-scale landscape restructuring with substantial glacial erosion in the alpine zone and accumulation of thick (pro)glacial, glaciofluvial, proluvial, lacustrine as well as aeolian deposits (Deviatkin, 1981; Arkhipov et al., 1982; Endrikhinskiy, 1982). Because of the erosional nature of the more recent glaciations, the evidence of the earlier (and possibly more extensive) glacial events was largely obliterated by subsequent glacial processes and thus may be preserved only locally in deep mountain depressions and in the foothills. As the trigger mechanism, a significant humidity increase with a moderate cooling in the Kazakh mountains during the Early Pleistocene glaciations in opposite to the Middle and Late Pleistocene glaciations primarily linked to temperature decrease is assumed (Aubekerov and Gorbunov, 1999). In both cases the tectonic uplift of the mountain ranges surely played a significant role. The progressive cooling and regional geo-crynological conditions during the Middle and Late Pleistocene led to permafrost expansion on the northern and central Kazakh plains possible merging with the insular mountain permafrost (Aubekerov and Gorbunov, 1999). The glaciations in the mountain areas affected the adjacent ice-free foothills with prevailing continental cold and arid climate and intensified denudations processes (Kozhamkulova and Kostenko, 1984). The Quaternary climate fluctuations eventually contributed to the aeolian (sand and loess) cover formation with interbedded buried fossil soils mantling the smoothly undulating topography of the Altai foothills (Fig. 13).

Fig. 3. Former Pleistocene palaeovalleys with prominent terrace platforms preserved in the dry steppe regions of East Kazakhstan indicate rather dynamic Pleistocene fluvial processes with a high water flow regime contrasting to the present perennial streams.

4. Pleistocene environments

The territory of East Kazakhstan shows a complex Quaternary history governed by the global climatic evolution in association with the regional geomorphic processes principally related to the Cenozoic neotectonic activity and the Pleistocene glaciations (e.g., Dodonov and Sotnikova, 1994; Dodonov, 2002; Baibatsha and Aubekerov, 2003). Increased aridity during the Middle Pleistocene caused by the progressive uplift of the Central Asian mountain systems blocking humid monsoon streams from the Indian Ocean contributed to establishment of the present atmospheric system and formation of the vast arid steppe/semi-desert zone covering most of Kazakhstan (Aubekerov, 1993; Aubekerov et al., 2003). Diversity of the relief and the changing Pleistocene environments in the mountain and lowland areas of East Kazakhstan played a major role in the history of the local palaeolithic peopling. The past climates and palaeoecology proxy indices from the Southern Altai mountain area and the intermountain xenotheric steppes of the Bukhtarma basin are principally from the glacial/glacigenic records and the preserved geomorphic forms in the upper reaches of the river valley, and from the sub-aerial sediment (loess) sections in the foothills. Throughout the Quaternary, the regional landscape zonation experienced major shifts in diverse topographic settings of East Kazakhstan and the adjacent regions of the Steppe and Gorno Altai, with the present-type taiga forest and steppe-parkland reduction during glacial stages replaced by tundra forest and a cold hyper-arid periglacial steppe. Detailed Quaternary studies from the investigated area carried out at other regions with high-resolution biostratigraphic records (e.g., Sotnikova et al., 1997; Tarasov et al., 1997) are, however, presently absent.

4.1. Early Pleistocene

The regional tectonic activity in conjunction with global climate changes shaped geography of East Kazakhstan repeatedly during the Pliocene/Pleistocene and the Early/Middle Pleistocene transition (Dodonov and Sotnikova, 1994). Until the late Pliocene, major lacustrine basins filled large continental depressions of the east-central Kazakhstan reflecting humid climates with high annual precipitation. In the study area, the Zaisan palaeolake, drained by the ancient Irtysh River, became repeatedly established, reflecting long-term climate fluctuations as well as the activated regional orogenesis leading to a progressive incision of rivers into old sedimentary deposits and ultimately formation of the present hydrological system. The raising Altai Mountains predetermined the present climate regime and the distribution of the corresponding vegetation zones, with humid, precipitation-rich NW slopes of the western (Rudno) Altai and progressively arid southern (SE and SW) areas of the Bukhtarma and Irtysh River basins and the foothills of the Tarbagatay Mountains (Mikhailova, 2002). The transitional zone between the eastern mountains and western steppes of East Kazakhstan (Fig. 2B) did not apparently experience dramatic landscape transformations apart of periodic fluvial and aeolian sedimentary and erosional geomorphic processes.

Warm and humid Pliocene–Early Pleistocene climatic conditions are inferred from palaeosol records, particularly the deeply weathered red soils (Fig. 4) and a mineral (Fe) staining of gravel deposits partly exposed on the present surface (Fig. 5). Intensive "subtropical" interglacial weathering and pedogenic processes in the broader Altai area are indicated by a series of buried Early and Middle Pleistocene red soils in the Rudnoy and the NW Altai Foothills environmentally corroborated by the associated pollen data (Kriger, 1963; Derevianko et al., 1992b; Chlachula, 2001). The Early Pleistocene interglacials characterized by an increased heat balance and humidity rate correlate in vegetation zonation with the distribution of meadow-forests and mixed parklands.

The biotic palaeoenvironmental proxy records from the southern Altai region are still rather sparse, although some unique palaeontological finds of large fauna (Machairodus) dating to Miocene originate from the Zaisan Basin (Sotnikova, 1992). The

Fig. 4. Deeply weathered Pliocene/Early Pleistocene lateritic red soils developed on kaolin and ferruginous clays and locally exposed by the present fluvial erosion in the East Kazakhstan steppe region.

Early Pleistocene fossils from the broader East Kazakhstan include parkland and steppe adapted species, such as woodland elephant (*Palaeoloxodon antiquus* and *Archidiskodon trogontherii*), horse (*Equus mosbachensis*), wild ass (*Equus/Asinus hydruntinus*), kulan (*Equus hemionus*), rhinoceros (*Dicerorhinus kirchbergensis*), giant camel (*Paracamelus gigas*), elk (*Alces latifrons*), deer (*Cervus elaphus*), bison (*Bison schoetensacki*) and other species (*Capreolus* sp., *Elasmotherium sibiricum, Praeovibos* sp., *Ovis ammon*) accompanied by Canidae and Mustelidae (Kozhamkulova, 1981; Kozhamkulova and Kostenko, 1984). A high-mountain forest-steppe stretched over the Altai plateaus as indicated by pollen records with Ephedra as well as large fossil faunas represented by *Hipparion* sp., *Coelodonta* sp. and remains of Elephantidae, Bovidae from the Chuya Steppe on the southern margin of Gorno Altai (Deviatkin, 1965).

4.2. Middle Pleistocene

Geographic and environmental transformations during the Middle Pleistocene triggered by re-renewed neotectonics in the eastern regions of Kazakhstan caused transfiguration of the former hydrological network and a progressive fluvial erosion of earlier deposits (Akhmetyev et al., 2005). The present relief structured by alluvial terrace deposits attests to existence of a more dynamic fluvial system with prominent fluvial terrace platforms contrasting

Fig. 5. A deflated surface of the continental semi-desert in the northern Zaisan Basin with uncovered wind-polished rock debris and gravel deposits with strong iron and manganese staining indicates a long-term increased heat balance and aeolian activity.

with small and seasonal perennial stream draining the area today (Figs. 3,4). Wind activity during dry periods triggered transportations of masses of aeolian sediments blown out from the central deflation basins into marginal areas along the eastern foothills (Fig. 5). The prominent sand dunes in the Black Irtysh River basin along the Kazakh–Chinese border limits (Aygyrkum Sands) resulted from a fine-sand blow-out, leaving behind a coarse alluvial gravel lag matrix forming the present surface cover of most of the Zaisan Basin – the process that continues until today (Figs. 6,7). The increased aridity further contributed to salinisation of freshwater and brackish lakes and their transformation into solonchaks (Kozhamkulova and Kostenko, 1984) typical of the dry central and eastern regions of Kazakhstan. The pronounced climatic continentality during the Middle Pleistocene led to establishment of the present-type forest-steppe/semi-desert vegetation during warm stages and periglacial steppe during cold stages correlated with the mountain glaciations and loess deposition in the foothills.

The Middle Pleistocene mammal communities from the steppe regions are characterized by the Irtysh fossil faunal complex represented by early mammoth (*Mammuthus chosaricus*), horse (*Equus latipes*), kulan (*Equus hemionus*), camel (*Camelus khoblochi*), giant deer (*Megaloceros giganteus* Blum.), red deer (*Cervus elaphus*), bison (*Bison priscus*), saiga (*Saiga tatarica*), cave lion (*Panthera spelaea*) indicating open parkland-steppe habitats and corroborated by small fauna species –Pleistocene hare (*Lepus tanaiticus*), steppe pika (*Ochotona pusilla*), ground squirrel (*Citellus superciliosus*), southern birch mouse (*Sicista subtilis*), great jerboa (*Allactaga jaculus*), grey hamster (*Cricetus* aff. *migratorius*) and other rodent taxa characteristic of the arid xenotheric steppe/semi-desert environments (Kozhamkulova, 1981).

The climate evolution in the SW and SE Altai Mountains points to some major glaciations indicated by massive proglacial and alluvial fan deposits distributed along the central mountain ranges and reaching up to 100 m in thickness, as well as glacial facies underlying more recent Late Pleistocene ice-marginal deposits (Deviatkin, 1965). During the glacial maxima, the intermontane basins were filled by lacustrine sediments and a series of terraces formed along the valley margins as a result of a recessive glacial lake discharge. The highest alluvial terraces in the Katun River basin (Gorno Altai) are correlated with the IVth terrace of the Biya River in NE Altai foothills (Derevianko and Markin, 1987) and may correspond to the uppermost terraces in the Bukhtarma Basin. The Middle Pleistocene age of the alluvial Biya formations on the northern Altai Plains based on the incorporated fossil fauna of the Khasarian Complex (*Mammuthus trogontherii, Bison priscus longicornis, Coelodonta* sp., *Coelodonta antiquitatis, Equus* sp.) (Shmidt, 1984) suggests a large-scale glaciofluvial activity presumably affecting most of the Altai territory prior to the Late Pleistocene.

Fig. 7. Active and rather prominent (up to 300 m) sand dunes along the Kazakh–Chinese border limits (Aygyrkum Sands) resulted from a massive and long-term aeolian sediment transport leaving behind the coarse gravel lag forming most of the present surface of the Zaisan Basin.

Regional palaeoenvironmental transformations varied from cold periglacial tundra and mountain forest-steppe established in the extra-glacial zone during glacial stages to arid warm continental steppe – semi-desert in the lowlands and the expanding taiga forests to alpine zones during warm periods with most mosaic biotic habitats in the foothills (Chlachula, 2001).

4.3. Late Pleistocene

Pronounced climatic variations during the Late Pleistocene triggered large-scale geographic restructurings of the Kazakh territories of Central Asia and SW Siberia (Kremenetski et al., 1997). The re-activated orogenesis at the beginning of the Late Pleistocene in conjunction with increased humidity and surface flow are assumed to be the principal agents behind formation of large freshwater lakes in the intermountain depressions and intensified

Fig. 6. Interbedded faces of fluvial/alluvial sandy gravels and fine-grained lacustrine deposits in a 25 m section near the northern Kurchum foothills far away of the present Zaisan Lake shoreline bear witness of changing Pleistocene environments and a periodically significantly increased water body in the Zaisan/Black Irtysh Basin comparing to the present time (Fig. 3C).

Fig. 8. A barchan sand dune field in the lower Bukhtarma basin. The underlying Middle(?) Pleistocene fluvial/alluvial deposits as well as palaeolithic artefacts exposed on the deflated surface buried by up to 50 m of sediments attest to palaeolandscape transformations and dune migration with a dominant western wind-blowing direction.

erosional-accumulation processes in the foothills of Eastern Kazakhstan (Svarichevskaya, 1965). Progressing aridity and aeolian activity following the last interglacial warming contributed to the progressive sedimentary cover formation of loess and sand deposits in the foothill areas adjoining the Steppe Altai (Fig. 8).

The region of East Kazakhstan represents the eastern geographic distribution limits of the late Middle Pleistocene/Last Interglacial *Palaeoloxodon antiquus* large-fauna assemblage (Pushkina, 2007). The Late Pleistocene fossil record from the Bukhtarma and the upper Irtysh Basin includes the typical last glacial parkland-steppe fauna with woolly mammoth (*Mammuthus primigenius* Blum.), woolly rhinoceros (*Coelodonta antiquitatis* Blum.), camel (*Camelus khoblochi* Nehr.), horse *(Equus caballus),* kulan (*Equus hemionus* Pall.), boar (*Sus scrofa* Linn.), red deer (*Cervus elaphus*), saiga (*Saiga tatarica*), roe deer (*Capreolus* sp.), dzheiran (*Gazella subgutturqsa*), elk (*Alces alces* Linn.), reindeer (*Rangifer tarandus* Linn.), aurochs (*Bos primigenius* Boj.), bison (*Bison priscus mediator* Hilz.) accompanied by carnivorous animals – wolf (*Canis lupus*), fox (*Vulpes vulpes*), cave bear (*Ursus spelaeaus*), brown bear (*Ursus arctos*), cave hyena (*Crocuta spelaea*) and small rodent taxa, such as dwarf squirrel (*Citellus pygmaeus* Pall.), long-tail asian squirrel (*Citellus undulatus* Pall.), steppe marmot (*Marmota bobac* Mill.), great jerboa (*Allactaga jaculus* Pall.), earth hare *(Alactagulus)* (Bazhanov and Kostenko, 1962; Kozhamkulova, 1981; Kozhamkulova and Kostenko, 1984). The marked climatic warming mapped by pollen records in the south-central mountain region linked to the mid-last glacial interstadial stage (MIS 3) contributed to expansion of alpine taiga forest dominated by Siberian pine, dwarf birch and spruce extending into the lowland areas (Deviatkin, 1965).

The major regional environmental changes in East Kazakhstan were triggered by the Late Pleistocene glaciations of the Altai Mountains. The regional alpine relief configuration of the central-southern mountain ranges promoted expansion of ice fields of coalescent montane valley glaciers contributing to formation of large proglacial lakes during initial stages of deglaciation documented also in other parts of the Altai (Rudoy, 1990, 1998). Glacial and glacigenic deposits dating to the Late Pleistocene are the most widely distributed and presumably encompass two glacial stages (MIS 4 and MIS 2). In the southern Altai area, these are best-indicated by a series of terminal moraines and spectacular up to 200 m high glaciofluvial terraces near the Uryl village, attesting to rather dramatic natural processes related to the ice-recessional stages (Figs. 9 and 10). These forms may correlate with two terminal moraine limits and glaciolacustrine sediments of glacial lake basins that formed repeatedly in the Chuya–Kuray-Kansk Depressions in the neighbouring area of Gorno Altai (Fig. 1B). The local glaciofluvial/lacustrine terraces with highest erosional surfaces at relative elevations of 80–100 m, 50 m and 30–40 m are interpreted as topographic relics of periodic cataclysmic outburst events of accumulated glacial waters blocked by surging mountain glaciers with the highest levels dated to the early last glacial (MIS 4) (Butvilovskiy, 1985; Baker et al., 1993). In the Chuya-Kuray Basins, the formation of a large interconnected glacial lake during the early Last Glacial (MIS 2) is fixed by radiocarbon dates between ca. 23.3 ka BP and 22.3 ka BP suggesting about a 1000-year duration (Baryshnikov, 1990). Retreat of wasting mountain glaciers during the final deglaciation stages caused latest outbursts of the ice-dammed lakes in the lower Chuya, the middle Katun and the upper Biya River valleys, being the major Altai drainage basins, with the most recent around 15–13 ka BP (Rudoy, 1984; Rudoy and Baker, 1993; Reuther et al., 2006; Reuther, 2008). The final recessional events of the local glacial lake drainage may correlate with

Fig. 9. Location of a close study area of the upper Bukhtarma Basin (southern Altai) The lines indicate direction of the principal Last Glacial glaciofluvial water drainages.

formation of the lowest terraces of the Katun and Chuya Rivers (4–6 m) (Rudoy and Kirianova, 1994). Similar geomorphic processes during the last deglaciation linked to the climate warming at the end of the Pleistocene are visualized in the Bukhtarma Basin.

The latest Pleistocene mountain glaciation in the southern Altai area is believed to be less extensive than the previous glacial episodes corroborating the glacial records from the northern and central Altai areas (Chlachula, 2001). Terminal moraines above the 2000 m elevation indicate that the mountain glaciers did not reach the Altai basins during the last glacial maximum. The last glaciation (MIS 2) in the study area (ca. 23,000–13,000 yr BP) is witnessed except for the glaciolacustrine terraces by cirques, terminal valley moraines, and alluvial fans along the southern foothills of the Southern Chuya Mountains, and in the Koksu River valley adjoining the upper Bukhtarma Basin through the Belaya Berel valley (Fig. 9). Analogous large intermontane glacial basins linked to the Last Glacial mountain glaciations indicated by the characteristic terrace landforms have been mapped in the upper Argut and Dzhazator River valleys (the Samakha Lake) located just north of the upper Bukhtarma Basin as associated with retread of the wasting Altai Mountain glaciers (Chlachula, unpublished data). The local valleys' geomorphology indicates existence of a large glacial basin confined by the surrounding Katun and South Chuya Mountains, just north of East Kazakhstan, eventually drained through the Argut River spillways connected to the main Katun River drainage system. Prominent lateral moraine ridges preserved at the 1500–3000 m elevation testify to a major mountain icecap over the adjacent Katun Range with montane glacier surging into the main mountain valleys during the LGM.

The geological structure of these relic glacigenic landforms of unsorted massive gravely deposits and well-rounded granitic boulders exposed on the present top surface at the 1200–1500 m asl elevation (Fig. 11) provides evidence of rather dramatic, but presumably timely short geomorphic processes reflecting marked Late/Final Pleistocene climatic oscillations. The glacial lake drainage process was likely more gradual as indicated by the preserved terrace-like forms structured by glacial alluvia along the upper Bukhtarma valley on the Chindagatuy–Arshaty–Uryl geo-line (Fig. 9) also mapped in the nearby Dzhazator valley of Gorno Altai with an analogous series of terraces and steppe-forming glaciofluvial benches leaning against the lateral valley rocky walls. More recent cold climate changes indicated by a series of fresh moraines preserved in the Southern Altai Range above the 2500 m elevation point to the mountain ice re-advances presumably during the Pleistocene/Holocene transition (Younger Dryas/Preboreal) and the Little Ice Age (Fig. 12). Fossil periglacial features on the adjacent Plateau Ukok, including large stony polygons up to 10 m in diameter, attest to severe climatic conditions in the extra-glacial/deglaciated mountain areas of southern Altai. The high-mountain plateaus are still locally underlain by perennial, although presently degrading permafrost.

Fig. 11. Massive and poorly stratified structure of the prominent glacial landforms (glaciofluvial terraces/laterally truncated glacial moraines) provide evidence of rather intensive glacial processes in the southern Altai area during the LGM.

The recorded last glacial fauna from the southern Altai basins was largely analogous to that of the preceding glacial stage (Derevianko and Markin, 1987). A certain biotic potential around the Altai glacial lakes is indicated by isolated finds of a typical Late Pleistocene periglacial fauna in the Chuya Basin (2000 m asl.), including *Mammuthus primigenius*, *Cervus elaphus*., *Alces* sp., *Equus caballus*, *Bos* sp., as well as small openparkland rodent species (*Citellus* sp., *Cricetus*, sp.). The biotic records, including fossil pollen suggests a mosaic periglacial tundra-steppe habitat with *Pinus sibirica*, *Abies* sp., *Betula nana*, *Alnus* sp., *Ephedra*, Chenopodiaceae, Gramineae and *Artemisia* (Deviatkin, 1965).

The Pleistocene climatic variations in the western lowland areas and continental depressions of East Kazakhstan are indicated by

Fig. 10. A series of glaciofluvial terraces near Uryl. Topographic configuration of the Bukhtarma valley confined from the south by the steeply rising slopes of the Southern Altai, Tarbagatay and Sarymsakty Ranges (2000–3500 m asl.) predisposed formation of deep glacial lake basins by a periodic blocking ice-waters by surging mountain glaciers during the Pleistocene glacial stages. Well-rounded granitic boulders mark the particular glaciofluvial erosional surfaces prior to the subsequent river incision to the present level.

Fig. 12. Southern Altai Range. A relic corrie glacier valley (MIS 2?) showing later glacial re-advances (I–II) tentatively correlated with Younger Dryas and the Little Ice Age, respectively.

accumulation of aeolian (silty and sandy) deposits in glacial stages and surface stabilization with formation of variously developed palaeosols during warm stages. The loess mantle is modelling the present, smoothly undulating topography of the lower Bukhtarma/Black Irtysh Basin, overlying the granitic bedrock or earlier alluvial formations close to the present river floodplains. Thickness of the loess cover reaches 5–20 m maximum what is significantly less then in the Rudnoy Altai area with up to 30–50 m sediment cover or on the northern Altai Plains with up to 50 m of aeolian deposits mostly Late Pleistocene loess deposits mostly Late Pleistocene (Chlachula, 2001; Evans et al., 2003). The East Kazakhstan loess is also more discontinuous and variably preserved. The common absence of earlier unconsolidated Quaternary wind-born deposits suggests major erosional aeolian deflation events and chronostratigraphic hiatuses. An intensified wind activity with several stages of aeolian reactivation of fine silt derived from large (up to 100 m deep) deflation surfaces is also documented in the neighbouring lowland areas of SW Siberia (Volkov and Zykina, 1983).

The recently mapped and most continuous East Kazakhstan reference loess-palaeosol section Izkutty (49°25′04″N, 82°54′34″E; 420 m asl) on the northern slopes of the Kalbinskiy Range (1380 m) ca. 60 km south of Ust-Kamenogorsk (Fig. 1B) shows a cyclic and well-sorted sediment deposition with several horizons of buried palaeosols of chernozemic and brunisolic order, corresponding to open parkland-steppe and mixed taiga forest, respectively. The fossil soils bear some signs of cryogenic distortions, but less prominent than those observed in the northern Altai regions suggesting a milder and less continental climate. The two major pedocomplexes are correlated with MIS 5 and MIS 3 based on pedostratigraphic criteria, with the most prominent basal chernozemic soil of the last interglacial climatic optimum (MIS 5e) (Fig. 13). The upper part of the studied section, displaying a progressive sediment accumulation with some accretional soil horizons, suggests a pronounced aridization and an increased areal aeolian activity along the south-western margin of the Altai presumably during the second part of the last glacial (MIS 2). The latest climatic fluctuations relate to the thin loess cover deposition interspersed by incipient soil horizons prior to the early Holocene surface stabilization. Chronologically, the documented East Kazakhstan loess-palaeosol section broadly corresponds the last glacial-interglacial cycle based on the climate-diagnostic magnetic susceptibility variation trend correlated with the key southern Siberian loess records (Chlachula et al., 1997; Chlachula, 2003). Analogously as the principal loess sections from the upper reaches of the Ob River drainage, south-western Siberia (Chlachula et al., 2004a; Evans et al., 2003), the Izkutty loess sequence shows a continuous alternating deposition of loess and soil formation events encompassing MIS 1–5. The recorded magnetic susceptibility pattern (Fig. 14), however, displays an opposite magnetic susceptibility pattern with the MS maxima (up to 7×10^{-3} SI) in fossil soils and minima (as low as 3×10^{-3} SI) in loess, similarly as the loess records from the East European Plains (Little et al., 2002).

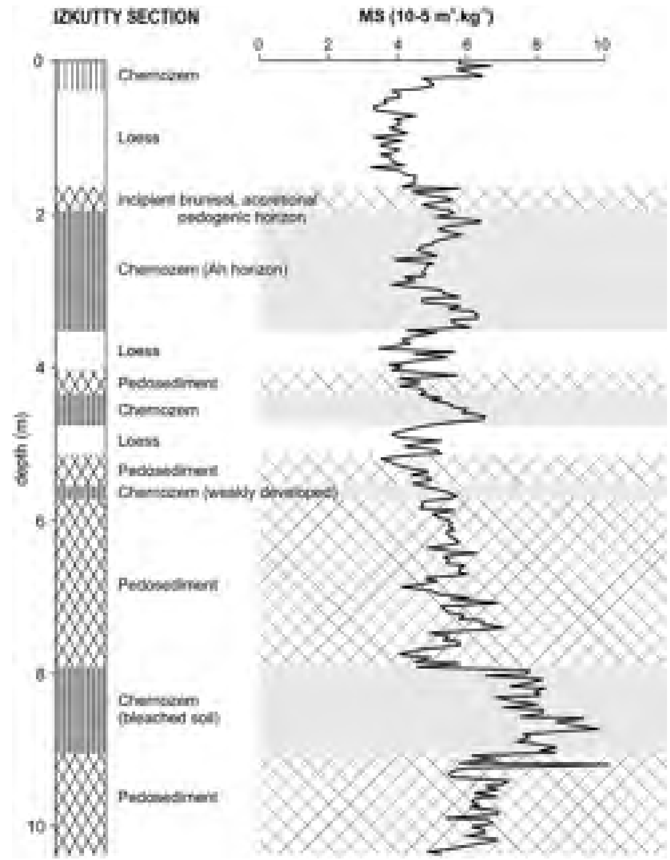

Fig. 14. Magnetic susceptibility (LF) record of the Izkutty loess-palaeosol section (10 m) correlated with pedostratigraphy with compact as well as accretional soil horizons, encompassing an interval of the last interglacial-glacial cycle.

Fig. 13. Loess section at Izkutty on the western slopes of the Kalbinskiy Range (Altai with a regionally most continuous Late Pleistocene stratigraphic sequence (scale 2 m).

Fig. 15. Zaisan Basin. Relics of eroding Early/Middle (?) Pleistocene sections of fluvial and alluvial fan deposits topped by a terra rossa soil incorporating in the upper part of the sequence rudimentary flaked stone artefacts assigned in respect to their contextual stratigraphic position as Early Palaeolithic.

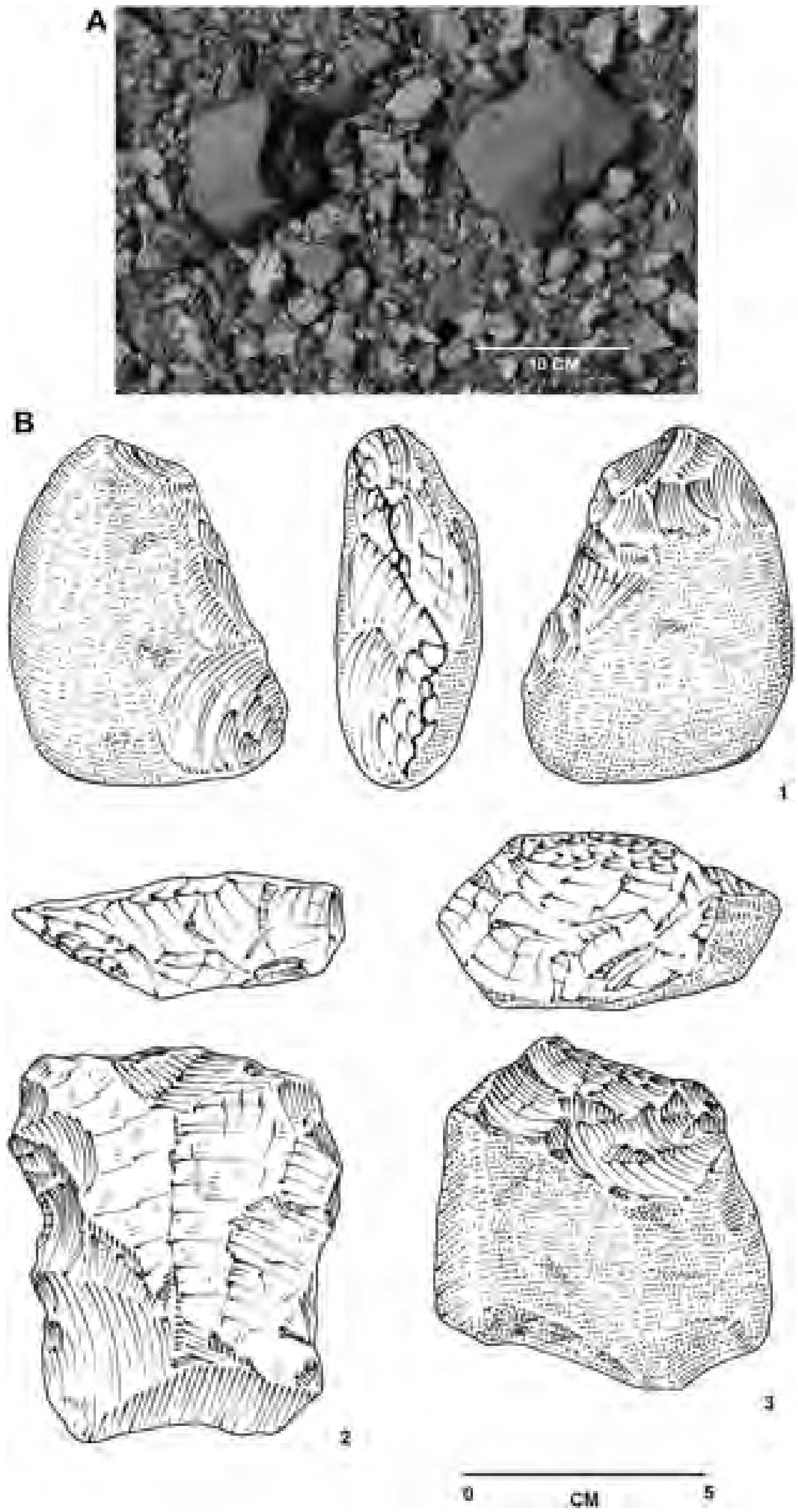

Fig. 16. Zaisan Basin. A. Crudely worked stone tools made on diverse raw materials scattered in concentration on the present deflated surface, unsealed of the former sediment cover. Variability of formal lithic attributes (aeolian abrasion and patina, desert varnish, mode of technology) indicates several stages of the local Pleistocene occupation. Scale 10 cm. B. The Early Palaeolithic industry: 1 bifacial chopper (quartz), 2 retouched flake with sings of reworking (quartzite), 3 unifacial chopper (quartzite). All lithic industry drawings by the author.

Fig. 17. Shoreline of the Bukhtarma Lake with the palaeolithic Narym Site (at the bottom part).

Accretional pedogenic horizons display the transitional MS values. A specific mineralogy composition of the parent material of the aeolian deposit is assumed to be the main controlling factor (Babek et al., in preparation).

The loess-palaeosol formations from the broader (Russian–Kazakh) Altai area provide the most detailed multiproxy chronostratigraphic correlation of past climatic cycles as well as a most accurate evidence of evolutionary landscape transformations (e.g., Arkhipov et al., 1982, 1986, 2000; Arkhipov, 1989; Volkova, 1991; Zykina, 1999; Chlachula and Kemp, 2000; Chlachula, 2001; Chlachula et al., 2004b; Chlachula, this volume).

5. Palaeolithic evidence

The recorded archaeological sites from the southern Altai region originate from diverse geological contexts as well as geographic settings (Fig. 1B), providing new evidence of a multiple, though still only broadly dated inhabitation of the East Kazakhstan territory. The Palaeolithic sites were previously mapped from the adjacent geographic areas from the Aleya valley, Rudnoy Altai, located NW of the Bukhtarma/Irtysh River basin and the Anui valley, NW Altai (Kungurov, 2002a; Derevianko and Shunkov, 1992). In both cases, the sites are interpreted as Middle Palaeolithic (Mousterian) completing the present evidence of the pre-Upper Palaeolithic peopling of central Eurasia.

The cultural records found in secondary context in old alluvial deposits indicate distortion of occupation sites established in the former Aleya valley by subsequent Late Pleistocene fluvial and colluvial processes – an analogous process observed at presently eroded banks of the Gilyovsk dam, exposing stone industries and coarse gravels washed from underneath the loessic sedimentary cover (Kungurov and Sitnikov, 1996). The sites in the Leninogorsk Basin assigned to the Middle, early Upper and Final Palaeolithic (Derevianko et al., 1999) indicate a repeated occupation of the western Altai foothills in congruence with the well-documented Stone Age prehistory from the northern and central parts of the Altai (Shunkov, 1990; Chlachula, 2001). Presently, over 100 sites have been mapped in the western Altai region dating from the Middle Palaeolithic to the Neolithic Periods (ca. 70–7 ka BP) (Kungurov, 2002b, 2006).

From the broader Altai area, several Middle Palaeolithic artefacts were located in a deeply stratified geological context in fluvial sandy–gravelly lenses of the Biya River terrace buried by ca. 20 m of loess deposits at the periphery of the city of Biysk, the Northern Altai Plains, southern Siberia (Fig. 1B) (Chlachula, unpublished data). The overlying high-resolution loess-palaeosol record enclosing most of the Late Pleistocene climate history (Evans et al., 2003) well fixes the pre-last glacial age of this site. No earlier and chronologically well-established sites in the northern Altai are known till now. Reports on the early Middle Pleistocene occupation were previously made from the southern margin of West Siberia (e.g., Deviatkin et al., 1992) as well as in southern Kazakhstan (Aubekerov and Artiukhova, 1990; Derevianko et al., 1998; Vishnyatsky, 1999).

5.1. Black Irtysh/Zaisan basin

The initial geoarcheology field survey (2006–2007) in the Zaisan Basin (400–480 m asl.) resulted in locating several open sites with diagnostic palaeolithic stone industries. The basin outlines a major tectonic depression filled by alluvial and lacustrine sediments and hosting the Zaisan Lake fed (and drained) by the Black Irtysh River (Fig. 1B). The climatically extremely continental intermountain depression, opening to NW into the Bukhtarma Basin, is bordered from the north by the western foothills of the Kurchum Range (2645 m), from the south by the topographically prominent Tarbagatai Range (2992 m) and by the Aygyrkum Sand hills closing it from the east.

At several locations, the recorded palaeolithic tools were found eroded from old, presumably Early Pleistocene gravelly formations

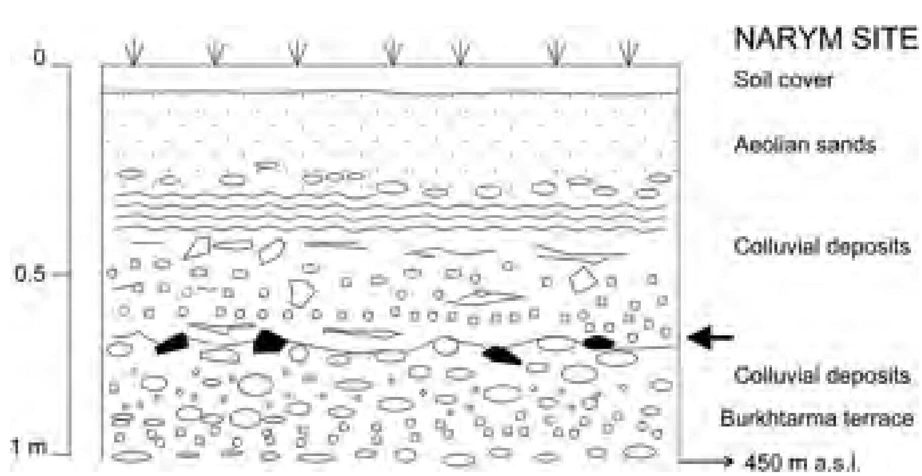

Fig. 18. Schematic stratigraphic profile of the Narym Site with the position of the Palaeolithic artefacts (in black; indicated by the arrow).

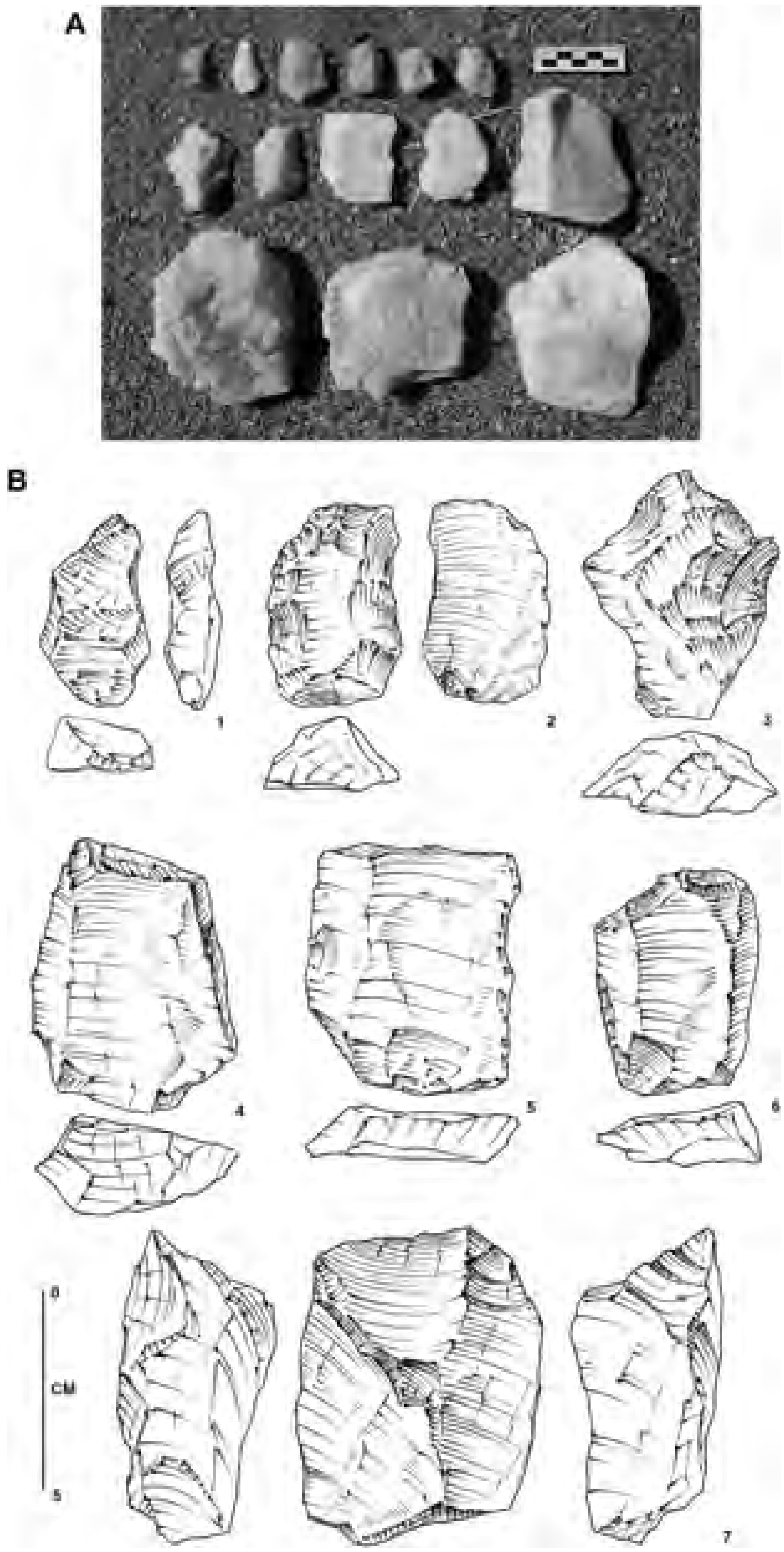

Fig. 19. Narym Site. A. The Lower/Middle Palaeolithic industry made of white quartz eroding on the present lake shore with coarse gravels from the relict Middle Pleistocene alluvium (a river terrace/an alluvial fan). Scale 5 cm. B. 1, 3-6 pointed / retouched flakes, 2 scraper, 7 core.

preserved as relic palaeo-relief forms (e.g., 48°38′30″N, 83°32′29″E; 443 m asl) indicating a large-scale erosion activity in the Zaisan Basin leading to excavation and removal of part of the former surficial sediment cover (Fig. 15). The surficially mapped cultural loci are indicated by concentrations of diagnostic antropogenically flaked lithics displaying a various degree of mineral (Fe, Mn) staining, aeolian abrasion and desert varnish (Fig. 16), suggesting, in the absence of enclosing datable geological contexts, a certain chronological differences between the particular occupation sites as well as favourable occupation environments.

The formal characteristics of the recorded lithics are more or less uniform with similar technological and typological traits of stone tool production. In general, the simply flaked types formally classified as simple unifacial and bifacial choppers, cores and marginally retouched flakes are the most dominant, reflecting physical properties of the clastic raw materials (2–5 cm large pebbles mostly of quartz, quartzite and jasper) originating from early fluvial deposits (washed alluvial fans and fragments of river terraces). Since the surface of the present semi-desert with a rather minor grassy and lichen vegetation (Fig. 5) was clearly subjected to an intensive and long-term deflation activity periodically removing the Quaternary sedimentary cover, a more exact age of the localities (generally assigned as Pleistocene) remains open.

The changing Pleistocene climates during and after the particular occupation episodes are indicated by the differences in colour of patination as well as wind polish. A dark reddish-brown patina found on the most archaic artefact series indicates warm and relatively humid interglacial Early/Middle(?) Pleistocene climatic conditions. Aeolian activity that presumably intensified during the cold intervals of the Late Pleistocene exposed and subsequently abraded the flaked cobbles and culturally modified rock debris fragments prior to their partial and temporary (re-)burial under thin aeolian sediments. Some sites may have been repeatedly exposed and subsequently sealed by migrating sand dunes that locally form active and marked relief forms in the arid regions of East Kazakhstan (Fig. 8). The high numbers of the mapped sites attest to an intensive early human occupation of the Zaisan Basin during the Pleistocene.

5.2. Narym site (Bukhtarma Basin)

The earliest recorded Pleistocene (Lower/Middle Palaeolithic) archaeological site from buried contexts from the investigated area of East Kazakhstan (Bolshoy Narym District) is located in the easternmost part of the Kalbinskyy Range foothills (1380 m) on the left bank of the Bukhtarma/Zaisan Lake at 380 m asl, (49°16′15″N, 84°05′39″E) ca. 30 km from the Bolshoy Narym town and ca. 150 km from the city of Ust-Kamenogorsk (Fig. 1B). The steeply rising Narym Range (1300–2500 m) forms a natural topographic boundary on the opposite southern side of the lake. The stone artifacts were found in the present erosional zone of the Bukhtarma River locally exposing an old alluvial formation presumably relics of a Middle Pleistocene (60 m) terrace or a distal part of a Pleistocene alluvial fan formed on the adjacent hill slope (Fig. 17). Calcium carbonate crust precipitation on the culturally flaked lithics points to a former burial by loess deposits. The present sedimentary cover is rather thin comparing to the western loess-blanked slopes of the Kalbinskyy Range (the Izkutty section), although ca. 10 km farther west in the Bukhtarma valley some massive accumulations of still active aeolian sands form active barchan dune fields up to 20 m high above the deflation basin (Fig. 8).

The recorded cultural lithics with clear and diagnostic antropogenic stone-flaking attributes are incorporated *in situ (sensu lato)* in the 0.5–1 m thick gravelly alluvium covered by 0.1–0.5 m aeolian sandy–silty and coarse colluvial talus deposits (Fig. 18). The tools are made on white high-quality quartz fragments probably originating from weathered and locally exposed mineral quartz veins enclosed by metamorphic schists and granites forming the regional bedrock and in part subsequently water-rolled to alluvial clastics during the alluvial terrace formation. The study assemblage represents rudimentarily modified "core and flake industry" produced by a hard-hammer, direct-percussion technique (Fig. 19). Most artefacts are characterized by only a few flake removals and can be formally classified as polyhedral cores, choppers and variously modified flakes with pointed or partly retouched lateral edges. A more elaborate distinct flaking is evident on some bifacially flaked tool forms.

The temporal assignment as Middle Pleistocene corresponds the formal lithic industry technological and typological characteristics in corroboration with the contextual geological and geomorphic position. A strong wind polish on some artifacts indicates a certain surficial exposure and provides additional indices for the archaeological site antiquity. Several analogous cultural occurrences were also found in the same geological contexts along the opposite Bukhtarma lake shore area, indicating a certain degree of redeposition by past as well as present erosional processes. Regardless of the general Middle Pleistocene chronological classification, the Narym Site currently documents one of the earliest prehistoric occupations mapped in East Kazakhstan.

5.3. Camp Lake site (East Kazakhstan steppe region)

The Camp Lake site (that is referred to just as one example of several recorded sites in the East Kazakh steppes) is positioned near the lake shore at the surficial brown schist bedrock exposure (49°29′00″N, 61°49′21″E). The open site is exposed on the present surface without a stratigraphied context due to the very thin surficial sediment cover (Fig. 20). The recorded lithic industry (predominantly retouched, denticulate, notched or pointed flakes and blades made of the local grey schist fragments and fluvial pebbles) are found in a discrete concentration scatted in the vicinity of the bedrock exposure, attesting to a certain multifunctional use associated with exploitation of local natural resources (Fig. 21). Apart of the Palaeolithic and Mesolithic occupation recorded in the Altai foothills, in the eastern river basins and the continental depressions, the former occupation sites found in the presently arid steppes of East Kazakshtan nearby small lakes or dried-out saline lacustrine depressions provide additional evidence of a spatially

Fig. 20. Camp Lake Site, East Kazakhstan steppes. Location of early prehistoric sites near former as well as persisting basins with exploitation of local, including mediocre-quality stone raw materials is a typical feature of the East Kazakhstan Palaeolithic traditions.

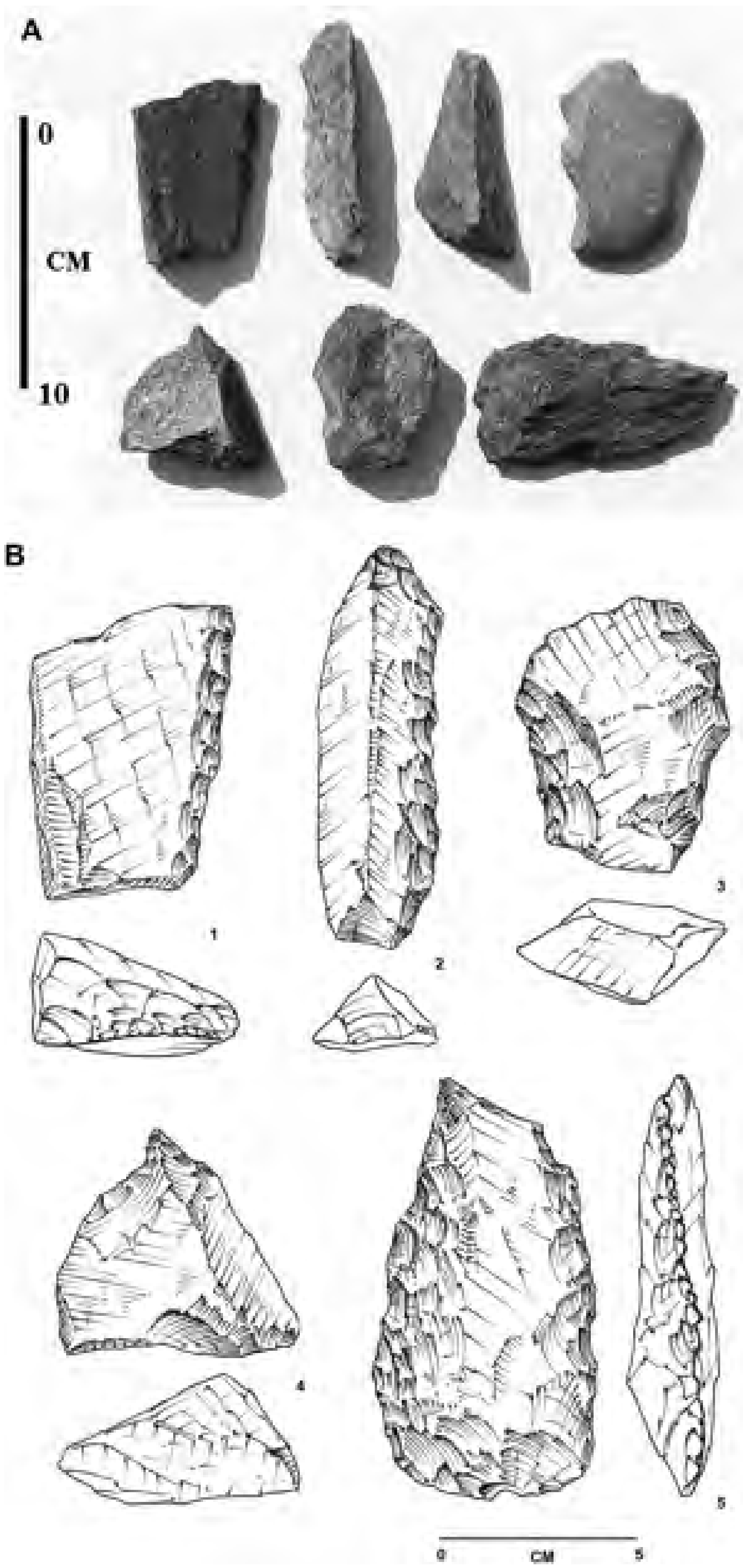

Fig. 21. Camp lake Site. A-B. Lithic industry (partly retouched, denticulate, notched and pointed flakes and blades) made of schist fragments and fluvial pebbles found in concentrations near the local bedrock exposure attest to a functional diversity linked to exploitation of local (aquatic?) resources.

Fig. 22. Dzhambul Site, the upper Bukhtarma River valley. An open occupation site positioned on a granitic bedrock platform overlooking the former glaciofluvial basin provides evidence of the Pleistocene peopling of intermountain areas of southern Altai.

more extensive Pleistocene peopling of this territory at various stages of the Pleistocene.

5.4. *Dzhambul site (Bukhtarma basin)*

The Dzhambul occupation site is located in the upper reaches of the Bukhtarma River (49°14′51″N, 86°18′23″E; 1090–1070 m asl) at the eastern foothills of the Listviyaga Range below the Kokkezen Mt. (2367 m) near the Dzhambul village (Fig. 1B). The local topographic setting is a typical Altai mountain valley with an incised Holocene floodplain below the former (post-last glacial) river terraces broadened to form an intermontane basin bordered from the south by the steeply rising Tarbagatay range (2738 m). The local relief is intensively modelled by the last glacial processes related to the southern Altai glaciations and the associated glacigenic processes. The open occupation site (Fig. 22) is positioned on an inclined granitic bedrock platform at altitude of 1070–1100 m along northern (south-exposed) margin of a former (Last Glacial) glaciofluvial basin above the present Bukhtarma River.

The spatial artefact distribution on the slope foot over a concentrated area of ca. 30 × 50 m indicates some erosion from the original geological position as documented by the cultural lithics found *in situ* below the present surface on top of the granitic bedrock platform shallowly buried by mixed colluvial and strongly calcareous aeolian sediments (Fig. 23). The lithic industry is represented by expedient stone tools and utilized rock fragments made on small (4–10 cm) granitic cobbles and small-to medium size (2–20 cm) green schist fragments exclusively of local origin. Several stone tools are made on quartzite cobbles from the Bukhtarma River alluvial deposits. Some artefacts bear evident sings of wind erosion, whereas most of the excavated specimens are relatively less corroded. The formal composition of the expedient and time-transgressive Final Palaeolithic/Mesolithic complex includes unifacial and bifacial choppers made on granitic cobbles (Fig. 24A), massive retouched side-scrapers (Fig. 24B) as well as rather typologically diverse and partly retouched implements on natural green schist fragments showing unequivocal and diagnostic sings of distal and lateral flaking and antropogenic use despite the unusual character of the raw material applied. Microscopic optical and SEM use-wear analyses on selected specimens disclosed anthropogenic cut marks and polish traces resulting from human working (analysis by Ignacio Clementes, Institute of Archaeology, Barcelona). Apart of the lithic industry, some additional indices of human occupation were found at the upper slope elevations with artificially cut granitic boulders to form shallow 5–10 cm basins (Fig. 24C). Functions (hide-processing?) as well as a more exact age of these very interesting findings, however, remain unclear.

In respect to the geomorphic position of the archaeological site on the eroded granitic foothill slope intensively abraded by the glacigenic erosion linked to the latest Bukhtarma valley glaciation and the subsequent glacial lake drainage, the recorded site occupation evidently postdates these events and can be interpreted as Final Pleistocene (late Last Glacial), tentatively ca. 15–10 ka BP old. This time determination corroborates the chronology of the last glacial lake drainage in the Chuya Basin, Gorno Altai, based on the cosmogenic rock exposure dates of ca. 16 ka BP (Reuther et al., 2006). The local inhabitation of the Southern Altai area is clearly linked to the major warming at the end of the Pleistocene.

5.5. *Berel' site (Bukhtarma basin)*

The Berel' site (49°22′14″N, 86°26′10″E‘; 1107 m asl.) is located at the eastern foothills of the Listviyaga Range enclosing the upper Buktarma River valley from the north on the partly exposed granitic bedrock promontory 15–20 m above the Bukhtarma River near its confluence with the Belaya Berel' tributary (Fig. 1B). The lower, west-oriented part of the slopes of the adjacent hill (1568 m) are covered by a relatively thick (3–7 m) local loess cover. From the south, the valley is bordered by the Tarbagatay (2738 m) and the Southern Altai (3483 m) ranges (Fig. 25). Genetically, the local loess formation show a heterogeneous geological structure resulting from interaction of both aeolian and solifluction processes.

The archaeological material is represented by a formally diverse lithic industry made predominantly of local green schist (the expedient archaic-looking macro-lithic stone tool component analogous to the Dzhambul site), but also of high-quality grey–green siliceous rock pebbles worked into small and partly retouched blades typical of the Upper/Final Palaeolithic traditions (Fig. 26A). Most instruments (Fig. 26B) show only a minor attrition indicating a former burial under the present surface (analogous to the Dzhambul Site) as documented by the associated geological contexts with *in situ* occurrences of both lithic components forming a single archaeological complex. The enclosing layers are structured by

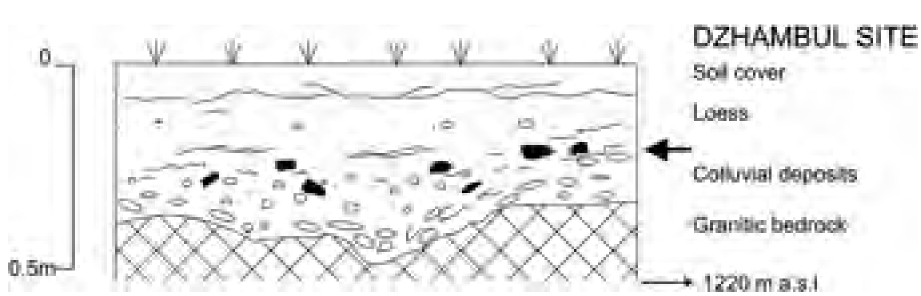

Fig. 23. Schematic stratigraphic profile of the Dzhambul Site with the position of stone artefacts (in black; indicated by the arrow).

Fig. 24. Dzhambul Site. (A) A bifacial stone tool made on a hard granite cobble is a part of the recorded and typically expedient lithic industry. (B) Massive side-scraper with laterally retouched working edge (size 17 cm). (C) Dzhambul Site. Antropogenically cut granitic boulder to form a shallow fluid-retaining depression with incision marks along the outer margins.

mixed matrix-supported calcareous loessic deposits with colluviated inclusions of small alluvial pebbles and local bedrock fragments, indicating some distortion of the original site setting due to climate fluctuations. Relatively “fresh” glacial striations on the metamorphic schist bedrock, forming the site promontory over the present floodplain, confine the temporal occupation assignment, post-dating the last Late Pleistocene (presumably MIS 2) Bukhtarma valley glaciation.

Both the Berel’ and Dzhambul archaeological sites geomorphologically located at the strategic palaeo-topographic positions overlooking the former Bukhtarma River valley provides evidence of earlier migrations into the deglaciated mountain areas of Southern Altai in some climatically moderate phases during the late Last Glacial (MIS 2) following the LGM and adaptation to the local periglacial mountain environments. Both sites probably represent one specific Final Palaeolithic tradition.

Fig. 25. Bere’l Site. View from the Upper/Final Palaeolithic site positioned on the schist bedrock rampant eastwards into the Bukhtarma valley.

5.6. *Krasnaya Gorka site (Chuya basin, Gorno Altai))*

Evidence on the Palaeolithic inhabitation of the high-mountain areas also comes from the Chuya basin in the adjacent southern part of Gorno Altai, Siberia, broadening the geomorphic range of the documented Pleistocene occupation settings. The Krasnaya Gorka (“Red Hill”) site (50°08′06″N, 88°21′43″E) discovered in 2002 near the Chagan–Uzun village on the right side of the Chuya River (1730 m asl.) near its confluence with the Chagan–Uzun River (Fig. 1B) is positioned at terminal limits on top of an alluvial fan (1780 m asl). The matrix-supported clastic (sandy-gravelly) alluvia are mantling truncated faces of the tectonically uplifted and close to vertically oriented bedrock strata (anticlines), forming an elevated relief extension of the western foothills (2130 m) of the Kurayskiy Range (3446 m) bordering the Chuya River valley from the north (Fig. 27). The river valley is flanked from SW by the steep foothills (2926 m) of the Northern Chuya Range (4177 m), creating a rather narrow geomorphic corridor connecting the south-eastern Altai intermontane (Chuya and Kuray) basins with the main Katun River valley opening further in the northwest.

The cultural finds (stone artefacts) are eroded from the 0.2–0.5 m thick alluvia overlying evidently rather ancient (Early Pleistocene/Pliocene?) and deeply weathered reddish ferruginous clays giving the particular local designation to the locality (Fig. 28). The lithic industry with archaic technological and typological attributes

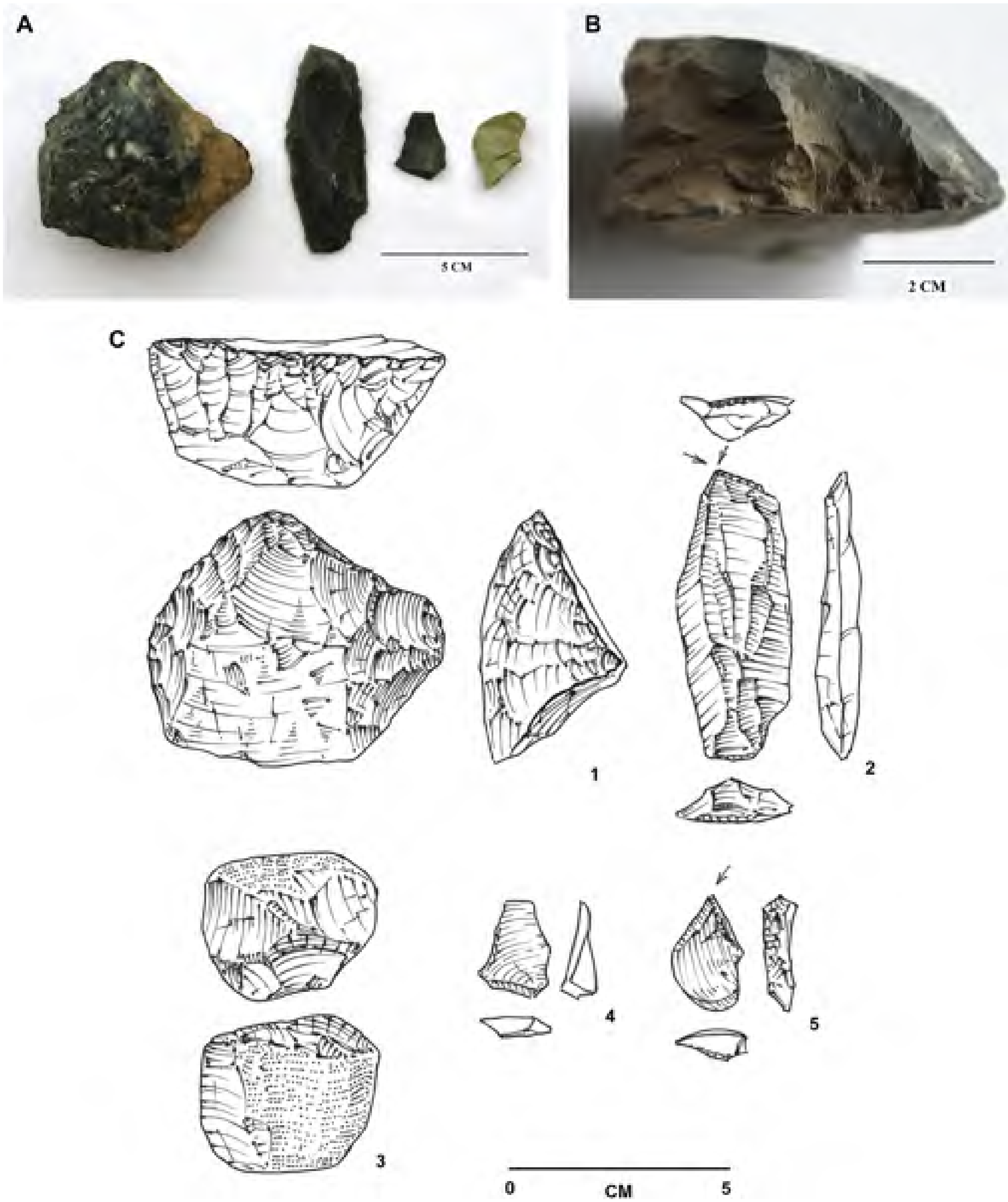

Fig. 26. Bere'l Site. A. Lithic industry made on a high-quality gray and green chert (blades), and natural and secondarily retouched schist fragments (flakes) indicate a particular cultural adaptation to local Final Pleistocene/early Holocene Altai Mountains environments. B. A close-up view of a working edge of the pointed bilateral side-scraper (*Fig. 26A and 26C left*). C. 1 side-scraper, 2 retouched and utilized blade / burin, 3 pebble-core, 4 *débitage* flake, 5 dihedral burin (Fig. 26A).

Fig. 27. Krasnaya Gorka Site (Gorno Altai). View from the cultural site positioned on a promontory (a top surface of an alluvial fan, 1780 m asl) into the Chuya River valley.

includes coarse and marginally retouched flakes and flaked rock/nuclei fragments of high-quality local clastic raw materials (jasper, chert, hornstone, quartz, quartzite) originating from the old alluvial formation (Fig. 29). The spatial and topographic distribution of the artefacts corresponds to the strategic position of the archaeological site above a mountain stream at the northern closure of the Chuya Basin and the adjoining geomorphic neck – a valley narrowing, connecting the former (Last Glacial) glaciofluvial basin with the Kuray Basin (Rudoy, 1998). The age of the local alluvial fan formations (up to 50 m thick) and particularly developed along the eastern margins at the Kuray Range is believed to be Middle Pleistocene and associated with cold climatic fluctuations (Deviatkin, 1965). In respect to the geological context of the cultural record, partly exposed by past as well as present erosional processes, the chronology of the site is only generally assigned as Late Pleistocene, although its age may be potentially higher.

In view of the geomorphic site position at the key loci of the periodic drainage of a major glaciolacustrine basin filing the present Chuya depression (70×50 km large at altitude of ca. 1750–2200 m asl) at the elevation of ca. 50 m above the present Chuya River, the preservation of the cultural evidence partly exposed on the surface suggests a less dynamic glacial lake drainage processes and shallower glacial water levels filling the upper reaches of the Chuya valley. The postulated cataclysmic ice-dammed lake release during

Fig. 28. Krasnaya Gorka Site (Gorno Altai). Stone artefacts scattered on the alluvial fan surface and selectively made on high-quality rocks (jasper and chert originating from the gravelly alluvia) with signs of the Middle Palaeolithic Levallois stone-flaking technique.

the deglaciations (Baker et al., 1993; Rudoy, 1998) was evidently most vigorous further down in the central Katun basin following the steep topographic gradient (from 2000 m to 500 m asl.) from the southern Altai intermontane depressions draining into the lower reaches of the river valley. The environmental viability of the study area is also supported by the biotic proxy records of cold forest-steppe with pine (*Pinus silvestris*, 71%) and birch (*Betula* sp., 23%;*Betula nana*, 6%), grasses and herbs established in the extra-glacial zone between the Chuya Basin glacial lake and the adjacent ice-covered mountain foothills (Deviatkin, 1965).

Other Pleistocene age initial occupation (Middle and Upper Palaeolithic) sites previously mapped in the Chuya Basin (Derevianko and Markin, 1987; Chlachula, 2003) indicate environmentally feasible Late Pleistocene inhabitation conditions on the plateaus and in the upper reaches of the river valleys geographically deep in the Central and Southern Altai. These early (including Mousterian) sites suggest a limited extent of the Late Pleistocene ice-cover probably confined to the main mountain ranges with a reported TL date of 58 ± 6.7 ka BP from non-glacial deposits from the Sailyugem Range, southern Chuya Depression (Rudoy and Kirianova, 1996). An ice-free setting with small tributary bays occupying the local subsidiary river valleys filling into the central intermontane depression are indicated by organic varved clays from the Chagan–Usun section in the Krasnaya Gorka site vicinity radiocarbon dated to ca. 32–25 ka BP (Rudoy and Kirianova, 1994). Accumulation of glacial waters during the early Last Glacial probably started only after ca. 25 ka BP in respect to the radiocarbon dates of $25{,}300 \pm 600$ BP (MGU-IO-65) from basal glaciolacustrine sediments (the Chuya section), and the dates of $23{,}250 \pm 400$ BP (SOAN 2239) and $22{,}275 \pm 370$ BP (SOAN 2240) from the middle and upper part of the glacial lake formation (the Iniya section) (Baryshnikov, 1990). Conclusively, the present palaeoenvironmental proxy records from the Chuya Basin in conjunction with the geoarchaeological data support the possibility of the local early human occupation at several climatically moderate stages during the Late Pleistocene and likely even before that time.

5.7. Biysk (Biya basin, Altai Plains)

Apart of the above East Kazakhstan and the Gorno Altai sites, the new stratified cultural record from Biysk from the Northern Altai Plains adds to the presently documented spatial distribution and geological context variety of the palaeolithic sites in the broader Altai region. The mapped and archaeologically significant Late Quaternary section (Fig. 30) (52°34′21″N, 85°17′01″E) is located at the southern margin of the Biysk-Chumysh Upland (300–400 m asl.) near the confluence of the Katun and Biya Rivers, being the principal tributaries of the Ob River (Fig. 1B). Diagnostic palaeolithic artefacts were found *in situ* in a deeply stratified geological context in fluvial 0.3.–0.5 m thick sandy-gravelly lenses of an old alluvial formation, presumably a relic of the Middle / early Late Pleistocene terrace, buried by ca. 20 m of stratified loess deposits at the NE periphery of the city of Biysk (Altai District), southern Siberia (Fig. 31). The culturally modified and wind-polished lithics are represented by several laterally retouched flakes (side-scrapers) and small hard-percussion-flaked cobbles (choppers) made from high-quality quartzites originating from the local sandy-gravel alluvia (Fig. 32). The strong aeolian abrasion indicates exposure on the former occupation surface prior to the burial under 20 m thick loess deposits. Some Palaeolithic stone arrifacts from the nearby area of confluence of the Biya and Katun River were reported previously (Lapshin, 1982).

The overlying high-resolution loess-palaeosol record chronologically enclosing most of the Late Pleistocene climate history (Evans et al., 2003) fixes the pre-last glacial age (>100 ka BP) age of

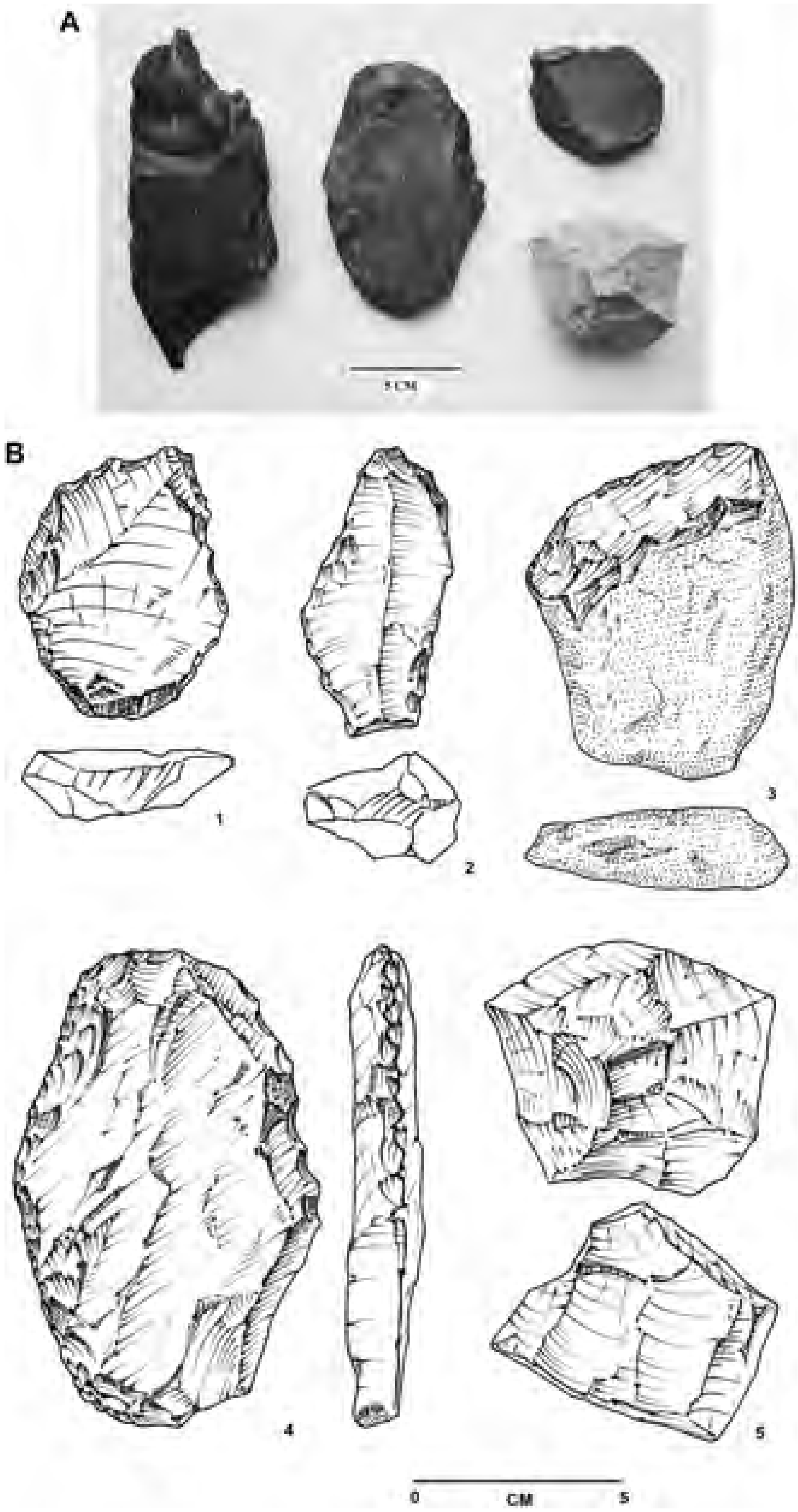

Fig. 29. Krasnaya Gorka Site (Gorno Altai). A. The Middle Palaeolithic stone artefacts. From left: pointed flake /chert/, side-scraper /chert/, retouched flake /quartzite/, prepared polyhedral core /sandy limestone/. B. 1-2 retouched flakes, 3 distally-utilized pebble / chopper, 4 side-scraper, 5 polyhedral core (Fig. 29A).

Fig. 30. Biysk Site (Northern Altai Plain). Up to 50 m loess sections above the Biya River overlying fluvial deposits. The sub-aerial record in the upper part of the sequence provides evidence of marked Late Pleistocene climate fluctuations with the highest sedimentary loess input during the early and late Last Glacial (Evans et al., 2003).

this site in congruence with the overall character of the stone tools defined as Middle Palaeolithic, as well as the last interglacial large fossil fauna originating from the alluvial formation. No earlier and geoarchaeologically well-established and stratified sites are known from this area till now, although some reports of earlier Middle Pleistocene occupations were made from the southern margin of West Siberia (e.g., Deviatkin et al., 1992). The deeply buried and well-documented stratigraphic position of the cultural finds from Biysk corresponds to the Middle and Lower Palaeolithic site occurrences mapped in southern Siberia from similar geological context of thick loess deposits exposed by present fluvial erosion along the main Siberian river drainages – Irtysh, Yenisei, Angara (Drozdov et al., 1999; Chlachula et al., 2004b).

6. Palaeolithic peopling of East Kazakhstan and southern Altai: the present geoarchaeology perspective

Geographic distribution of the recently discovered archaeological localities shows the wide range of former occupation habitats as well as diversity of the present geological contexts and topographic settings with the occurrences of the Palaeolithic records. The Zaisan and Bukhtarma sites from the steppe/semi-desert part of East Kazakhstan provide so far the earliest indices of the Pleistocene peopling of this marginal and so far unexplored territory. The referred sites expand the presently mapped palaeolithic oikumene centred in the southern regions of Kazakhstan with the earliest (Lower and Middle Palaeolithic) localities in the Karatau mountain region (i.e., the Kyzyltau, Koshkorgan, Shoktas localities) and the northern Balkhash Lake area (Aubekerov and Artiukhova, 1990; Derevianko et al., 1998; Vishnyatsky, 1999). In the adjacent parts of central Asia, analogous Early/Middle Palaeolithic records represented by a simple core-and-flake industry occur in travertine deposits in the arid zone of eastern and southern Kazakhstan (Artiukhova, 1990; Derevianko et al., 1997; 1998), deeply buried in loess sections in the major southern Siberian river valleys (e.g., Drozdov et al., 1999) as well as largely exposed on the old deflation surfaces in western and central Mongolia or Gorno Altai (Derevianko et al., 1985, 1992a). The geographical distribution of these site settings in the presently arid and climatically extremely continental areas (including the Zaisan Basin) attests to more favourable and particularly humid environmental conditions in early stages during the Pleistocene.

In the neighbouring western Mongolia, the earliest Palaeolithic sites are found in the opened southern valleys, whereas the later cultural locations concentrate in the hilly central and northern parts of the country as a result of climatic shifts towards a strongly continental climate and a pronounced regional aridization (Derevianko et al., 1992a). The Pleistocene occupation is assumed to have concentrated in the foothills during interglacial periods, and shifted into more open plain settings during glacial periods. Parkland forest-steppe in the foothill areas may have been the most favourable locations for occupation (Deviatkin and Malaeva, 1990; Baryshnikov and Maloletko, 1999). In the Mongolian Altai, the earliest sites are deeply buried in old alluvial fan deposits, but also distributed exposed on high river terraces located in the former transitional forest/steppe zone (Derevianko et al., 1990). A mosaic landscape and diversity of ecosystems with mountain forest-steppe, saline steppe and alpine steppe provided potential for early human inhabitation. Climatic fluctuations and differential amounts of precipitation were clearly the principal factors behind this geographical distribution pattern.

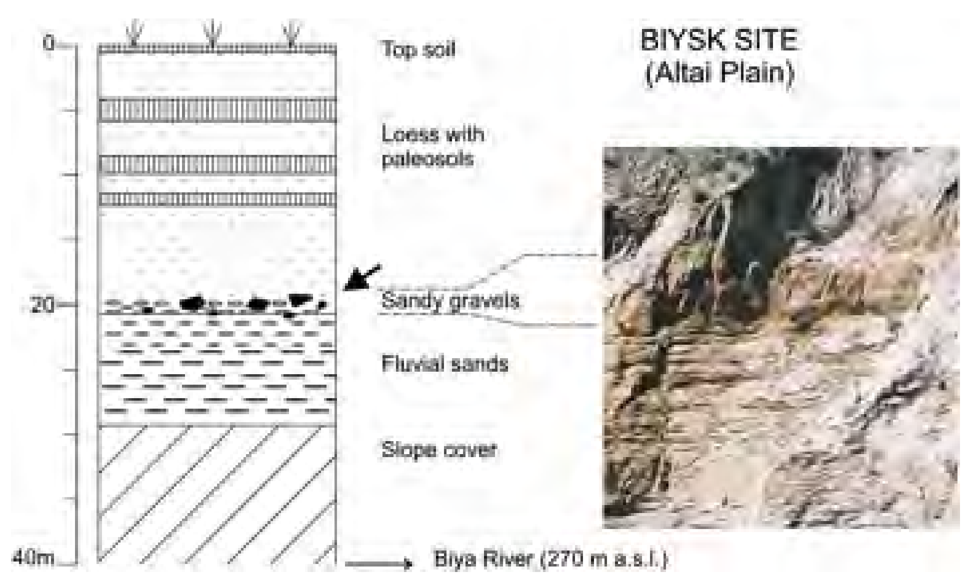

Fig. 31. Biysk Site (Northern Altai Plain). Schematic profile of the investigated section with the position of the Middle Palaeolithic artefacts (in black; indicated by the arrow). The Late Pleistocene loess overlies fossiliferous Last Interglacial fluvial deposits incorporating the cultural lithics from the deeply buried (−20 m) geological context.

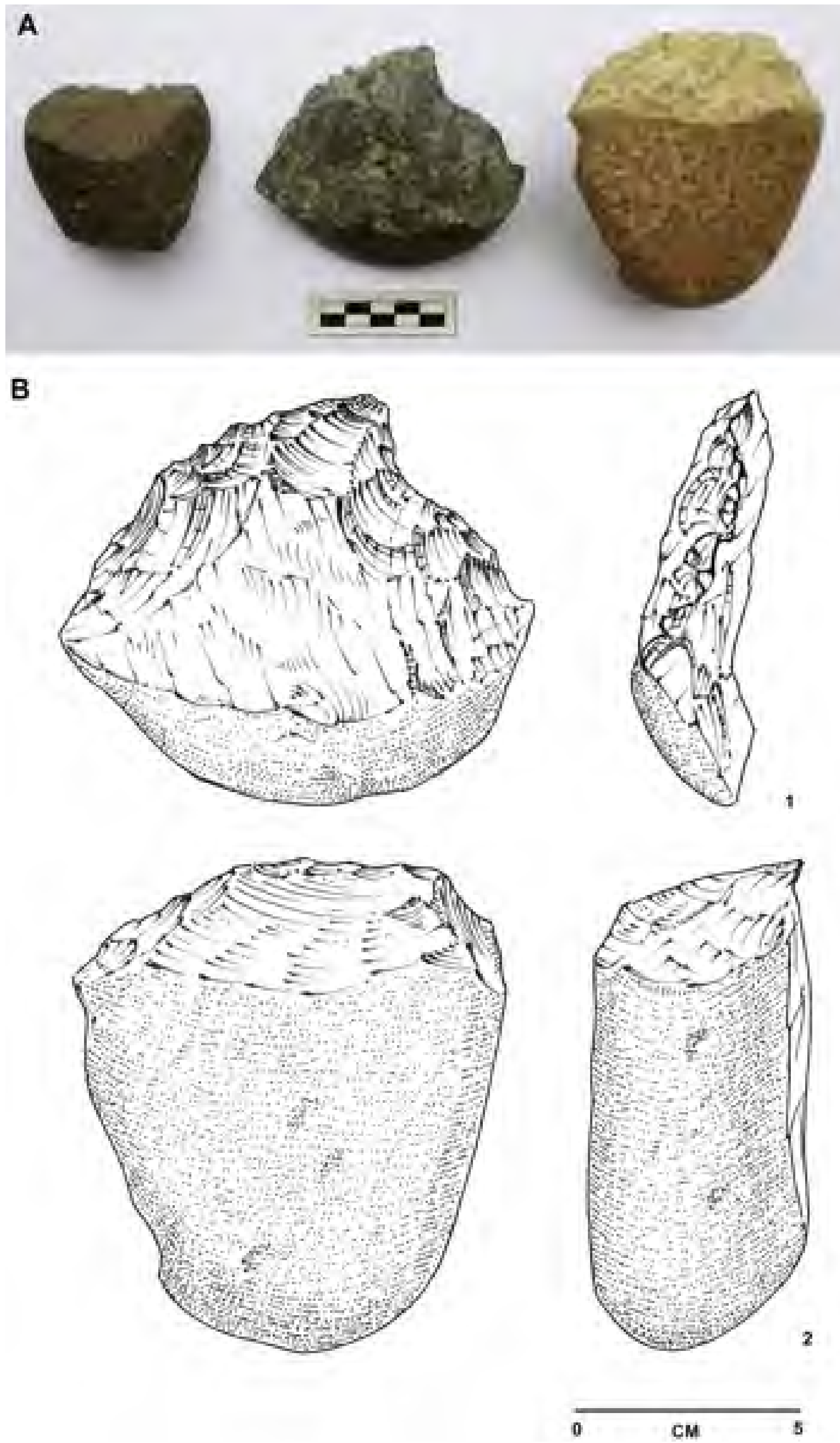

Fig. 32. Biysk Site (Northern Altai Plain). A-B. Rudimentary flaked artefacts (choppers and a laterally retouched flake/centre/) found in the stratified geological position on top of the late Middle Pleistocene/Last Interglacial Biya River terrace beneath colluviated loess. The strong wind polish of the lithics' flaking faces attests to a temporal exposure of the cultural remains prior to the burial by the early Last Glacial loess.

In the high-mountain depressions of the south-eastern Gorno Altai (the Chuya and Kuray Basin), the Palaeolithic sites are similarly represented mainly by surface finds, although some isolated locations with stratified geological context are documented (Chlachula, 2001). The rather thin surface cover reflects the very low-sedimentation rate of aeolian deposits and intensive past erosional processes characteristic of the continental upland areas of central Asia, including most of Mongolia and the Eastern Kazakhstan. The early sites are principally associated with the Late Pleistocene fluvio-lacustrine terraces and alluvial fan formations along the margin of the Chuya-Kuray Basins deposits or are positioned on the 40–50 m elevated platforms particularly in the SW Kuray Range foothills in places of local bedrock exposures (Bigdon, Chechketerek, Chaganburgazy) (Derevianko and Markin, 1987). Analogously to the Krasnaya Gorka site, exclusively local lithic raw materials were used for stone tool production collected from local proluvial deposits or directly extracted from the bedrock outcrops (mostly felsite and occasionally vein quartz). Similarly as in the Kazakh Altai, chronology of the local palaeolithic records can be extrapolated only from their general technological attributes of the preserved lithic industries also indicating some age differences in the differential degree of aeolian abrasion of the individual stone tool specimens. The limited number of the sites does not allow a closer temporal assessment as well as a cultural classification of the cultural assemblages assigned according to the specific stone-flaking criteria to the Middle Palaeolithic, early Late Palaeolithic, Late Palaeolithic and Final Palaeolithic (Derevianko and Markin, 1987).

Contrary to the East Kazakhstan sites located in the presently semi-desertic continental basins, the recorded Zhambul and Berel' sites provide the first evidence of the Late/Final Palaeolithic prehistoric expansion into the deglaciated and environmentally newly opened southern Altai mountain ecosystems during the Final Pleistocene associated with the major climate warming and mountain ice retreat. The existence and the subsequent cataclysmic drainages of ice-dammed lakes during the late Last Glacial documented in the archaeologically significant intermontane Chuya and Kuray depressions of Gorno Altai near the Russian–Mongolian border in the altitude of 1750–2000 m asl may have had only a limited impact on the local mountain plateau inhabitation. The cultural evidence from the locations distributed on the present surface or shallowly buried displays in part rather rudimentary technological traits analogous to the Buhktarma valley sites (Chlachula, 2001), although these must not be chronologically necessarily contemporaneous.

The sub-aerial sediment formations in the foothills and the relic landforms in both the steppe and mountain areas of East Kazakhstan point to major and periodic shifts in the Pleistocene climates over the southern Altai territory for the last several hundred of thousand of years. The geographical distribution and contextual geological position of the mapped cultural records reflects a climatic instability in the broader Altai area closely linked with the Pleistocene glaciations that contributed to major landscape restructurings with intensive erosion of the glaciated alpine zone and accumulation of thick (pro)glacial, alluvial, proluvial, lacustrine and aeolian deposits in extra-glacial areas. In the investigated zone of East Kazakhstan, the thickness of the Quaternary sedimentary cover markedly decreases further west and south in direction of open steppe and semi-deserts where the basal and strongly weathered granitic bedrock is overlain only by thin sheets of old fluvial deposits exposed by deflation processes. Accordingly, the preservation potential of the multiproxy palaeo-biotic and geoarchaeological evidence incorporated *in situ* in the geological contexts and the particular topographic settings reduces in respect to the thickness of the intact sediment cover with the best preserved and chronostratigraphically secured records found in the fine wind-born sediment (loess) accumulation areas along north-western/south-western margin of the Altai Mountains. In the high-mountain regions exposed in the past to destructive glacial and glaciofluvial processes, only the Final Pleistocene/post-glacial cultural records are assumed to become preserved in the original geological position. In the open rocky steppe/desert regions as well as on the unglaciated mountain plateaus and basins, the palaeolithic evidence scattered on the present surface was partly obliterated by the past fluvial processes and the intensive aeolian activity.

Overall, the topographic and contextual distribution of the mapped early sites corresponds well to the analogous (palaeo)landscape pattern from the Russian Gorno and Russian Steppe Altai with most sites related to the topographic 300–1000 m asl relief reflecting a specific cultural environmental adaptation to the Pleistocene local settings (Baryshnikov, 1992; Baryshnikov and Maloletko, 1999). In sum, the lately investigated territory was clearly occupied at various stages during the Pleistocene in diverse settings and under various environmental conditions.

7. Conclusion

The Quaternary climate history and the associated environmental transformations in the southern Altai area are still rather insufficiently documented because of the absence of systematic field studies in the Russian-Chinese border zone of East Kazakhstan (Fig. 1). According to the present evidence, this marginal geographical area experienced major environmental transformations and rather dramatic past geomorphic processes observed in the preserved relic landscape forms in both the mountain and steppe regions, as well as by the (glacial and sedimentary) geology, palaeoecology and geoarchaeology proxy records indicating long-term variations in temperature and humidity. The neotectonic activity particularly intensive in the eastern part of the Kazakh territory along the central Asian mountain rim extending from the Pamir to the Altai in the north influenced the specific regional topographic configuration with intensive erosional and sedimentary processes. The Pleistocene glaciations in the mountain areas periodically affected the adjacent ice-free foothills with formation of a variably preserved sedimentary cover and expansion of xenotheric steppes attesting to rather pronounced climate continentality strengthening during the Late Pleistocene. The spectacular glaciofluvial terraces developed in the Bukhtarma. Argut and Chuya River basins associated with the cataclysmic openings of intermontane glacial lakes and wastage of blocking mountain glaciers due to the global warming during the late Last Glacial attest to rather dramatic geomorphic processes in the central and southern Altai triggered by past climate change. The loess sections in the northern and south-western Altai foothills represent the major and most susceptible source of palaeoclimate and palaeoenvironmental proxy data.

The Pleistocene climate shifts predetermined the regional palaeolandscape development, environmental conditions and ecology for the regional early human inhabitation. The recorded sites from the lower Bukhtarma River and the Zaisan/Black Irtysh Basins with the characteristic Lower/Middle Palaeolithic stone tool inventories point to favourable and less continental conditions in the former fluvial basins during the Middle Pleistocene. The human occupation sites found in the present arid steppes and semi-deserts of East Kazakshtan around lakes or dried-out saline lacustrine basins and manifested by simply worked artefacts scattered on the deflated surfaces provide evidence of a spatially extensive occupation of this vast territory at various stages of the Pleistocene. The documented Late/Final Palaeolithic peopling of the upper Bukhtarma River valley is clearly linked to the last major warming at the end of the Last Glacial. Microclimate conditions recorded in the northern and central Altai valleys may have played a significant role in the initial peopling of this marginal area of Central Asia.

The contextual Quaternary geology and palaeoecology data from the investigated archaeological sites and the stratified glacigenic and loess-palaeosol sections provide evidence of a marked environmental dynamics triggered by past climate change. The discovered palaeolithic sites indicate an earlier inhabitation of this broad territory in diverse topographic settings predating the formerly documented Holocene prehistoric and early historic (Iron Age) cultures. Further Quaternary studies in the mountain as well as steppe regions of East Kazakhstan are of major relevance.

Acknowledgements

Quaternary investigations in the southern Altai area, Gorno Altai and East Kazakhstan were supported by National Geographic (1997–1998) and the Czech Cooperation Development Programme (RP/6/2005).

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