

**The Late Glacial history of Gornitsa foreland and
Kovaltsy Palaeolithic site, W Belarus**

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Abstract Palaeoenvironmental studies of Gornitsa foreland have been carried out in relation to archaeological excavations in Kovaltsy Late Palaeolithic site, Grodno district, W Belarus. Geological, geomorphological, lithological, pollen, and osteological research, infrared optically stimulated luminescence (IR–OSL) and ¹⁴C accelerator mass spectrometry (AMS) dating alongside with archaeological evidence provide information about the human and environmental history during the Late Glacial time–period. Situated outside the margin of the Late Weichselian Glaciation investigated territory developed as typical periglacial zone before the degradation of the ice sheet started. Driven by the Late Glacial climatic fluctuations a system of terraces e.g. two periglacial and two uppermost terraces of Neman River valley, were formed. Discovered Kovaltsy Late Palaeolithic site with two principal cultural layers suggests Late Glacial population of the area. Based on combination of typological data and ¹⁴C AMS measurement the lower layer dates primarily to the onset of Late Glacial Interstadial or ~14 500 cal. yr. BP when people of the Late Palaeolithic settled the area. During the initial stages of the population, tundra–steppe landscape dominated the area, and development of the fauna followed this pattern, with a dominance of mammals e.g. mammoth (*Mammuthus primigenius* Blumenbach), wild horse (*Equus caballus* L.), and reindeer (*Rangifer tarandus* L.) which were exploited by people.

Typological information suggests the upper cultural layer was formed at the Late Glacial – Holocene transition e.g. at about 11 500–11 000 cal. yr. BP.

Keywords Palaeoenvironment, Late Palaeolithic, Kovaltsy, Late Glacial, W Belarus.

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INTRODUCTION

Investigations of the nature history and the earliest stages of the post-glacial human colonization have been a key focus for scientists working in the European regions directly influenced by the Late Weichselian ice sheet. When and how people settled newly deglaciated

territories of northern and north–western Europe is a crucial question for the Palaeolithic archaeologists (Blackwell, Buck 2003; Pavlov *et al.* 2004) including those working in the south-eastern and eastern sectors of the Late Weichselian ice sheet e.g. Baltic countries, Belarus, and Kaliningrad region (Russia) (Voznyachuk, Valczyk 1978; Rimantienė 1971, 1996; Zaliznyak 1999;

Kopitin 1999; Kcensov 1988, 1999; Šatavičius 2002, 2004, 2005; Girininkas 2005). Unfortunately, scarcity of absolute dates, that is needed to situate the various Palaeolithic societies in a stratigraphical context, makes chronology of the mostly archaeological sites and stray finds rather tentative. Biostratigraphical dating of the discovered cultural layers is often impossible due to the predominance of terrigenous material in the layer, poor preservation of the palaeobotanical material, re-deposition of the sediments, etc. On a basis of available data the initial habitation of the region may have been related with the Bølling warming (Kabailienė *et al.* 1997; Ostrauskas 2005) or GI-1e interval that started at about 14 700 cal. yr. BP in northern Europe (Björck *et al.* 1998). Therefore existing models of the human dispersal covering the territory are still rather coarse and need to be developed on a basis of new detailed multi-proxy approach.

Archaeological context discovered during the extensive excavations carried out in the territory suggests that people representing different Palaeolithic cultures e.g. Bromme-Lyngby, Swiderian, Baltic Magdalenian, Vilnius group, Eastern Ahrensburg, Krasnoselye and Gravettian inhabited the territory during the particular intervals of the Late Glacial (Rimantienė 1971, 1996; Sulgostowska 1989; Zaliznyak 1999). The territory of Belarus has attracted inhabitants since the Middle Palaeolithic (Kalechic 1984) and tribes of Baltic Magdalenian, Krasnoselye, Grensk, Bromme-Lyngby, Wolkushanska, Vilnius group, Swiderian and etc. population settled in the territory during the Late Glacial (Rimantienė 1971, 1996; Kopitin 1999, 2000; Obuchowski 2004). The occasional penetration of the bearers of Hamburgian Culture recorded in the south-eastern part of the Lithuania territory, were changed by the representatives of Lyngby Culture and Swiderian Culture groups during the final stages of the Late Glacial (Rimantienė 1971, 1996). The oldest Palaeolithic sites of Swiderian culture dated back to the Younger Dryas (Zagorska 1999) have been discovered in Latvia.

Discussing the adaptation strategies of the Palaeolithic society the scarcity of the available data representing the eastern and south-eastern sectors of the Last Glaciation should be stressed. Scientists acknowledges that climatic variations played an important role in human adaptation but exactly what and precisely how, is much less clear (Gamble *et al.* 2004). To fill above mentioned gaps reconstructions of the Late Glacial environmental and population history were carried out in Lithuania, Latvia and Belarus during the recent decades. First of all, migration pattern and chronological framework as well as remains of subsistence economy of the Palaeolithic population have been investigated (Chernjavski, Shtyhav 2000; Šatavičius 2002, 2004, 2005; Obuchowski 2004; Girininkas 2005; Ostrauskas 2005; Zagorska 1999; Bobrowski, Sobkiwiak-Tabaka 2006; Połtowicz 2006) suggesting establishment of the earliest human groups during the Bølling-Allerød Interstadial. Alongside with archaeological data some investigated sites have been provided with the environ-

mental setting (Kabailienė *et al.* 1997; Stančikaitė *et al.* 2002) indicating environmental pattern, chronological framework and development of the particular sites. Environmental history, including detailed survey of the Late Glacial vegetation (Zernitskaya 1997; Simakova 1998; Veinbergs, Jakubovska 1999; Goslar *et al.* 1999; Šeirienė *et al.* 2006; Stančikaitė *et al.* 2004, 2008, 2009; Kupryjanowicz 2007; Heikkilä *et al.* 2009; Amon *et al.* 2010) and migration of the fauna (Lõugas *et al.* 2002; Daugnora 2004; Daugnora, Girininkas 2005; Ukkonen *et al.* 2006) have been discussed providing information for the further reconstruction of the human dispersal routes, adaptation strategy, subsistence of the human groups and etc.

This paper presents the results of interdisciplinary studies carried out in the W Belarus where apparent record of Palaeolithic hominid presence have been discovered on the terrace of Neman River. Abundant geological, palaeogeographical and archaeological material shows that the terraces of the Neman River formed during and immediately after the degradation of the Late Weichselian ice sheet were the first in the region to be inhabited by the Stone Age population (Voznyachuk, Valchuk 1978; Kalechic 1984; Baltrūnas 2001). Some years ago Kovaltsy archaeological site dated back to the Late Palaeolithic has been discovered on the Gornitsa foreland, confluence of Neman and Gornitsa rivers. During the last decade the detailed archaeological studies of this site were carried out by the international team under the leadership of Dr. V. S. Obukhowsky. However, until the last years not so much was done reconstructing the Late Glacial environment here. Consequently, this study was driven by two factors e.g. firstly – to understand the Late Glacial history of the particular area; and secondly – unravel population history of the area during the Late Glacial. The multi-proxy data of archaeological, geological-geomorphological investigations alongside with the results of the grain size, pollen and osteological analyses, ¹⁴C AMS measurement and results of optically stimulated luminescence dating (OSL) have been used to reconstruct the history of Palaeolithic population and palaeoenvironment.

SITE DESCRIPTION

Situated in the territory of Grodno Upland (Fig. 1), W Belarus, Gornitsa foreland (53°37'N, 23°59'E, 112–118 m above sea level (a.s.l.) is a part of the territory formed by the glacial advances of the Middle Pleistocene Saalian Glaciation (Makhnach *et al.* 2004). This conclusion was based on the results of the multi-proxy investigations of the interglacial deposits discovered in the Gornitsa River valley (Halicki 1951). Results of these investigations argued for the Late Muravian (Eemian) age and lacustrine genesis of the bed (Voznyachuk, Valczyk 1978; Sanko *et al.* 2002). As no till layer has been discovered on the top of

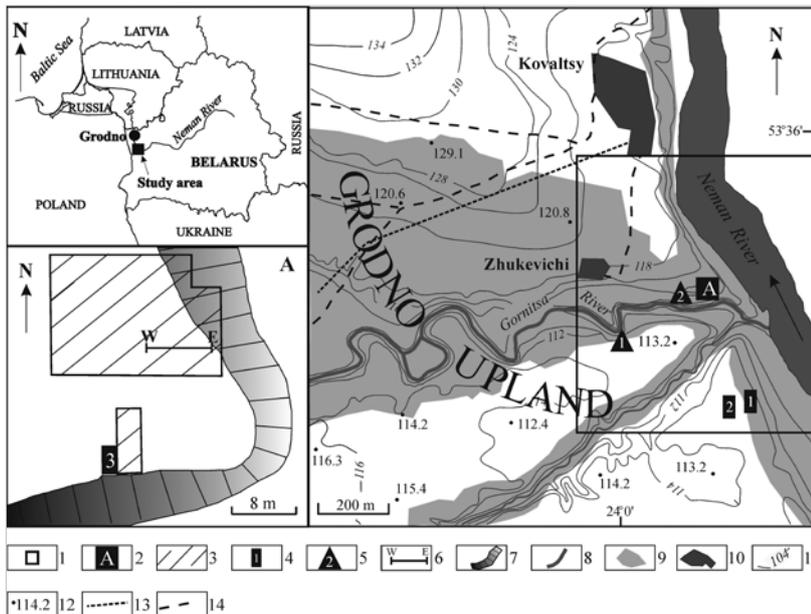


Fig. 1. Location map of investigated area with Kovaltsy archaeological site (A): 1 – study area; 2 – Kovaltsy archaeological site; 3 – excavated area; 4 – test-pit; 5 – outcrop; 6 – cross-section line (Fig. 2.); 7 – slope; 8 – river; 9 – forest; 10 – village; 11 – isoline; 12 – altitude; 13 – electric line; 14 – road. Compiled by B. Karmaza, 2010.

Eemian strata, the conclusion confirming an absence of the Late Weichselian ice formations in area followed (Sanko *et al.* 2002).

The surface of the Grodno Upland consisting of the moraine hills, ridges and plains stretches in the surroundings of the NW-SE orientated foreland formed on the left bank of the Neman River, on the confluence with Gornitsa River (Fig. 1). Kovaltsy archaeological site laying at about 115–116 m a.s.l. and covering an area of about 300 m² has been discovered on the fourth terrace of Neman River valley, on the top of Gornitsa foreland consisting of sandy deposits and partly covered by pine forest.

ARCHAEOLOGICAL BACKGROUND

The archaeological record shows that the territory of Belarus has attracted inhabitants since the Middle Palaeolithic (Kalechic 1984). The Upper Palaeolithic sites including Yurovichi (26 000 ¹⁴C yr. BP) and Berdyzh (23 000–24 000 ¹⁴C yr. BP) were situated in the upper and middle part of the Dnieper River basin (Chernjavski, Shtyhav 2000). Judging from the frequency of radiocarbon dates obtained on numerous archaeological sites including those situated in the territory of the present Belarus, the population density in Eastern Europe significantly increased during the time-span 16–14 cal. kyr. BP (Dolukhanov *et al.* 2001). Formation of a new landscape with increasing biogenic productivity has been determined by changing climatic regime. Hereby mentioned human expansion may have been caused by the changing environmental situation. During the Late Glacial from Allerød to

Younger Dryas, one saw the appearance of Late Palaeolithic sites belonging to Bromme-Lingby, Gravettian and Krasnoselye traditions in the territory of present Belarus (Rimantienė 1971, 1996; Sulgostowska 1989; Zaliznyak 1999; Kopitin 1999; Kcensov 1988, 1999). Swiderian sites were in existence between the second half of Younger Dryas and the 1st quarter of the Preboreal (Obukhowsky 2004).

The Neman River valley has attracted inhabitants since the Late Palaeolithic (Rimantienė 1971, 1996). Archaeological artifacts of this age have been discovered both in Lithuania and Belarus (Rimantienė 1971; Kopitin 1999, 2000; Satavičius 2002, 2004, 2005; Girininkas 2005). In 1999 Kovaltsy archaeological site (Fig. 1, A) consisting of two cultural layers (Fig. 2) has been discovered on a top of fourth terrace of Neman River and investigated during 1999, 2000, and 2004–2009 (Fig. 1, A). All together 327 m² have been excavated. The upper strata

consisting of buried soil and sand reaches up to 40 cm in depth though this bed is much thinner or even disappears in the peripheral parts of the site. Lithological composition as well as geological structure of this layer implies it has been re-deposited.

Amount of terrigenous particles including pebble and gravel increased in the lower cultural layer

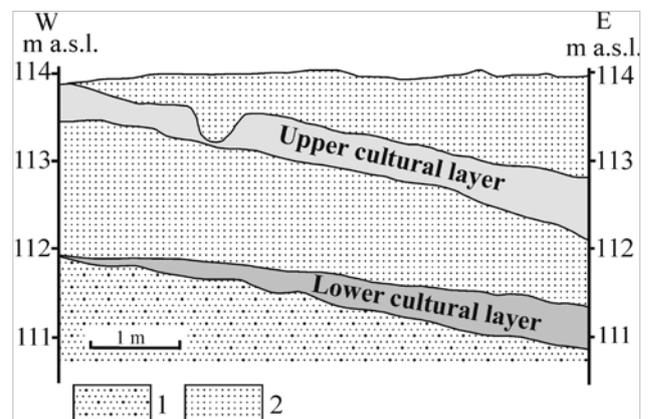


Fig. 2. Schematic cross-section of the archaeological trench from Kovaltsy Late Palaeolithic site, showing natural and cultural deposits: 1 – fine grained sand; 2 – very fine grained sand. Compiled by T. Ostrauskas, 2010.

the depth of which varies from 1–2 cm to 60–70 cm approaching the margin of the Neman River terrace. This strata was especially rich in different finds e.g. 6500 specimens of flint debitage and tools including truncated blades and flakes, tangled points, backed blades, burins, perforators and end scrapers (Figs 3 and 4), crumbs of reddish ochre, bones and decorations made of fossils have been discovered.

METHODS

Geological–geomorphological survey and sampling

Geological and geomorphological investigations i.e. digging of the test-pits and investigation of the outcrops, field observation and interpretation of aerial photographs (scale 1:17 000; year 1952), was the basis for the geological-geomorphological reconstruction and collecting of the samples for the different analyses applied. All together three test-pits were dug. The test-pit No. 3 (250 cm depth) was situated next to the archaeological site (Fig. 1, A). Test-pits No. 1

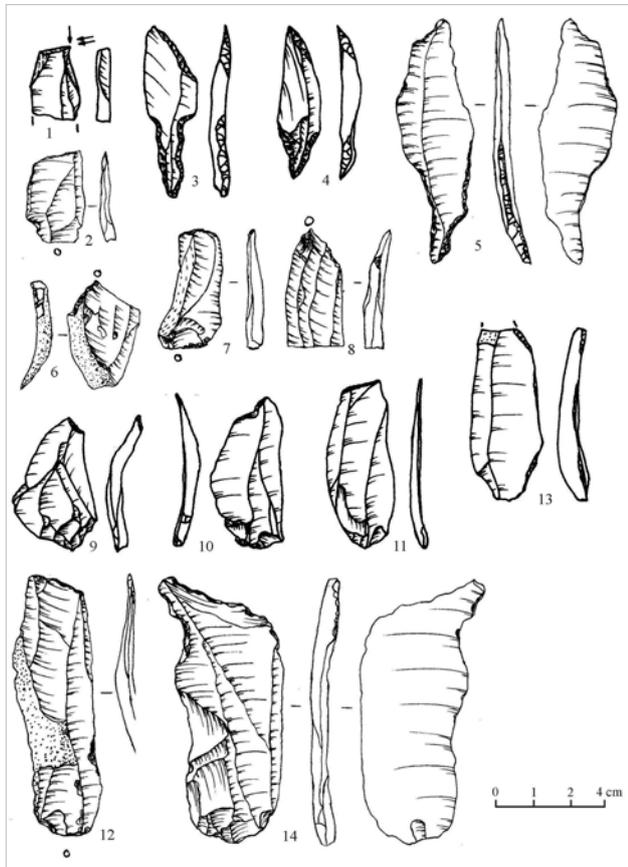


Fig. 3. The lower cultural layer: burin – 1; truncated blades and flakes – 2, 6–11, 13; tanged points – 3–5; backed blade – 12; perforator – 14. Compiled by T. Ostrauskas, 2010.

and No. 2 (100 cm depth) were dug in offsite area (Fig. 1). Two outcrops of the Gornitsa River valley discovered close to the Kovaltsy archaeological site were examined as well. The exposed sediment layers were characterized in terms of thickness, colour and lithological composition.

Sediment samples for pollen survey and IR–OSL dating were taken from the side of the test-pit No. 3 (Fig. 5). Sediments were sampled at 2 cm intervals for pollen survey (18 samples analyzed), bulk samples of 10–20 cm thickness were taken for IR–OSL dating (eight dates) and parallel sequence was sub-sampled

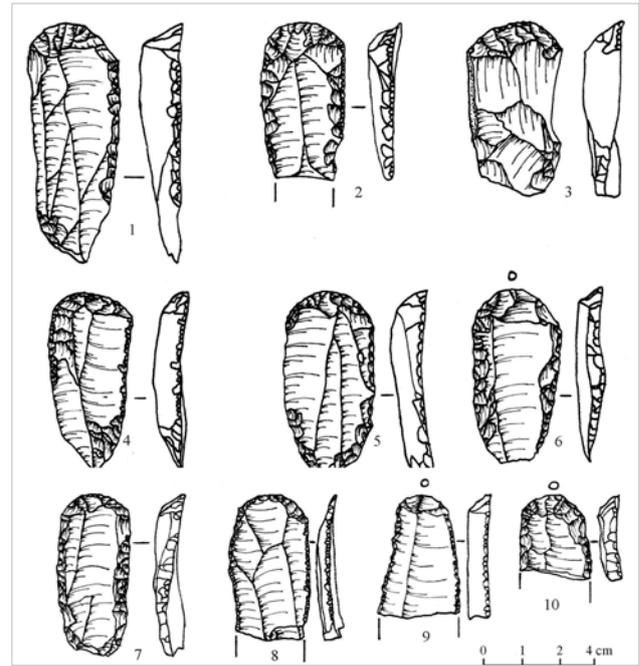


Fig. 4. The lower cultural layer: endscrapers – 1–10. Compiled by T. Ostrauskas, 2010.

for grain size investigations (8 samples analyzed). Several samples (10–20 cm thickness) representing different lithological units of the test-pit No. 1 (one sample, 60–80 cm depth), test-pit No. 2 (one sample, 75–95 cm depth) and outcrop 2 (three samples at the depth of 80–100 cm, one sample – 110–130 cm depth, one sample – 130–150 cm depth) were taken for the grain size analysis as well.

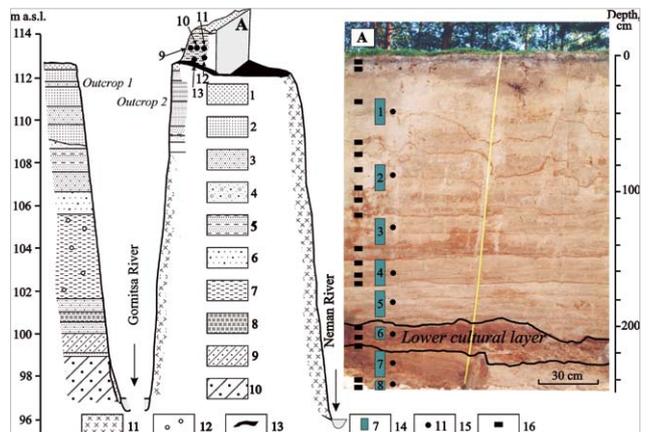


Fig. 5. Geological cross-sections of Gornitsa River outcrops and test-pit No. 3 with sampling points: 1 – soil; 2 – fine grained sand; 3 – various grained sand with gravel; 4 – gravel; 5 – fine grained silty sand; 6 – various grained sand; 7 – silt; 8 – sapropelithe; 9 – brown till; 10 – grey till; 11 – deluvium; 12 – mollusk shells; 13 – cultural layer; 14 – samples for IR–OSL dating and grain size analysis; 15 – samples for grain size analysis; 16 – pollen samples. Compiled by V. Baltrūnas, B. Karmaza, 2010.

Analytical methods

The grain size analysis was carried out using 19–sieve FRITCH set where dry debris was subdivided into the following fractions: >2.0; 2–1.6; 1.6–1.25; 1.25–1;

1–0.8; 0.8–0.63; 0.63–0.5; 0.5–0.4; 0.4–0.315; 0.315–0.25; 0.25–0.2; 0.2–0.16; 0.16–0.125; 0.125–0.1; 0.1–0.08; 0.08–0.063; 0.063–0.05; 0.05–0.04; 0.04–0.01 and <0.01 mm. Sediments and their grain size fractions are described using classification suggested by Last (2001). Chronological attribution of the lower cultural layer is supported by the results of AMS dating of the bone sample analyzed at the Centre for Isotope Research (CIO), University of Gröningen. The calibration program OxCal v3.10 (Bronk Ramsey 1995, 2001) with the IntCal04 data set (Reimer *et al.* 2004) was used for the calibration of ¹⁴C date.

Eight sediment samples for IR–OSL dating were collected from the profile exposed within the area of archaeological excavations. The dating was performed at the Research Laboratory for Quaternary Geochronology (RLQG), Institute of Geology, Tallinn University of Technology, Estonia. The sediment samples taken from the Kovaltsy site were prepared for IR–OSL dating using standard RLQG procedures (Molodkov, Bitinas 2006).

The material for the osteological investigations was collected in the lower cultural layer. Additional material was collected during the sieving of the sediments from the lower cultural layer with meshes of 1 mm in 2008–2009.

The samples of 1–3 cm³ were prepared for pollen analysis using a standard chemical procedure (Erdtman 1936; Grichuk 1940), including treating the sediments with a heavy liquid (CdI₂+KI). Pollen identification was based on Moore *et al.* (1991).

RESULTS

Geomorphology of the area

Investigated territory with Kovaltsy archaeological site is situated on the left bank of the Neman River valley (Fig. 6). The width of the valley reaches up to

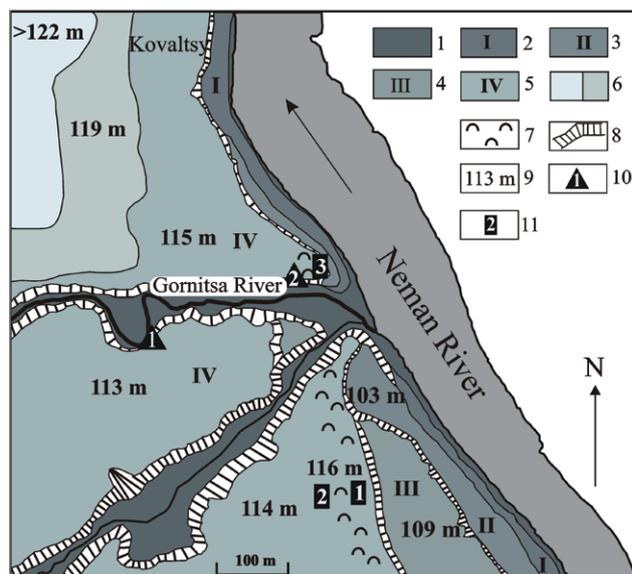


Fig. 6. Geomorphological scheme of the investigated area: 1 – floodplain; 2 – the first terrace; 3 – the second terrace; 4 – the third terrace; 5 – the fourth terrace; 6 – periglacial terraces (two levels); 7 – areas affected by aeolian processes; 8 – slopes; 9 – altitude, m a.s.l.; 10 – studied outcrops; 11 – test-pits. Compiled by D. Karmazienė, 2010.

Table 1. Lithological description of the studied profiles. V. Baltrūnas, B. Karmaza, 2010.

Depth, (cm)	Sediment unit	Description
Test-pit 3 (Kovaltsy archaeological site)		
0–14	5	Black sandy soil
14–112	4	Yellow very fine grained well-sorted sand with patches of brown sand with limonite (iron hydroxide)
112–200	3	Brown very fine grained well-sorted sand with scattered charcoals (1–3 mm)
200–212	2	Reddish brown clayey sand (cultural layer) with scattered organic, worked flint and remains of bones in lower part (210–212 cm) where amount of pebble and gravel increased
212–270	1	Yellow very fine grained laminated sand
Outcrop 2		
0–20	5	Brown soil
20–170	4	Yellow very fine grained well-sorted sand with interlayer's of brown sand with limonite (iron hydroxide)
170–500	3	Yellow very fine grained well-sorted sand with admixture of fine grained and middle grained sand (350–460 cm)
500–520	2	Gravel and pebble with flint
520–540	1	Dark yellow compact silt with scattered pebble
Test-pit 1		
0–10	2	Brown soil
10–100	1	Yellow very fine grained well-sorted sand with patches of brown sand with limonite (iron hydroxide) and remains of worked flint
Test-pit 2		
0–35	2	Light grey various grained sand with low organic and great number of flint on the surface
35–100	1	Yellow very fine grained well-sorted sand with patches of brown sand with limonite (iron hydroxide)

3.5 km and is about 25 m in depth. The initial stage in the development of the Neman River valley is represented by the periglacial alluvium of the Late Weichselian Glaciation, forming the upper most part of the Quaternary strata in the region (Voznyachuk, Valchyk 1978). Two levels of the periglacial terraces (~119–122 m a.s.l.) are recorded north–westwards from the investigated area. The geomorphological map indicates presence of four well developed terraces along the valley of the Neman River (Fig. 6). Formation of this terrace system has been driven by the Late Glacial and Holocene

climatic changes (Starkel *et al.* 2007). The fourth terrace with Kovaltsy archaeological site consists of various-grained sand (113–116 m a.s.l.) is partly reworked by aeolian activity. The third terrace (~109 m a.s.l.) consisting of various and medium-grained sand and considerably reworked by aeolian processes has been recorded south–eastwards from the Gornitsa River valley. The second terrace of the Neman River (~103 m a.s.l.) lies as a narrow belt along the valley and the first one (99–100 m a.s.l.) was recorded downstream from the mouth of Gornitsa River. Only small fragments of alluvial bed whereas occurred alongside the valley.

Description of the sediment sections

Investigated profiles (Table 1) are composed of minerogenic sediments mainly. Lithology of the 250 cm long test-pit No. 3 (Fig. 5) consists of basal sand (270–212 cm). Above that is 12 cm depth lower cultural layer consisting of clayey sand with organic, flint and bones (from 212 to 200 cm), which then changes to very fine grained sand (from 200 to 112 cm). From 112 to 14 cm is very fine grained sand with patches of brown sand with limonite (iron hydroxide). The upper cultural layer is absent in this section.

Lithology of the 100 cm depth test-pits No. 1 and No. 2 shows the composition very similar to that described in the test-pit No. 3 e.g. predominance of very fine grained sand with patches of brown sand with iron hydroxide (100–10 cm interval, test-pit No. 1 and 100–35 cm interval, test-pit No. 2). A layer of terrigenous material (silt with scattered pebble, 540–520 cm depth) comprises the lower part of the outcrop 2.

Table 2. Results of ¹⁴C AMS dating. Hans van der Plicht, W. Sidorowich, 2010.

Archaeological site	Dated material	Reference laboratory	¹⁴ C yr. BP	Calibrated time, cal. yr. BP	
				95.4%	68.2%
Kovaltsy	<i>Equus caballus</i> L.	GrA-38920	12 420±50	14 830–14 160	14 600–14 235

Table 3. IR–OSL results and radioactivity data for the samples from Kovaltsy site. A. Molodkov, 2010.

No	Laboratory number	Field No	Depth, (m)	U (ppm)	Th (ppm)	K (%)	IR-OSL-age (ka)
1	RLQG 1878-019	K-1	0.40	0.67	3.27	1.76	6.1 ± 0.7
2	RLQG 1877-019	K-2	0.90	0.70	4.16	1.50	6.0 ± 0.6
3	RLQG 1876-019	K-3	1.30	0.71	2.33	1.58	6.2 ± 0.7
4	RLQG 1879-128	K-4	1.60	0.89	4.29	1.42	6.0 ± 0.6
5	RLQG 1880-128	K-5	1.80	0.98	4.79	1.40	6.3 ± 0.6
6	RLQG 1875-128	K-6	2.10	2.05	10.39	1.76	6.4 ± 0.7
7	RLQG 1874-128	K-7	2.30	0.59	3.31	1.81	7.0 ± 0.6
8	RLQG 1873-128	K-8	2.45	0.10	2.11	1.09	7.4 ± 0.6

Notes: U, Th and K are the uranium, thorium and potassium content in sediments. Uncertainties: U determination, ± 2-3%; Th determination, ± 3-4%; K determination, ± 1-2%; gamma irradiation, ± 3-5%

Above that 20 cm of gravel and pebble that changes into sand at 500 cm have been recorded. The upper most part of the section consists of very fine grained sand enriched by iron hydroxide.

Chronological framework

The following periodization arranged for Eurasian Late Palaeolithic is used: the middle Late Palaeolithic (24–15 ka BP); the latest Late Palaeolithic (15–10 ka BP); and Mesolithic (less than 10 ka BP) (Pushkina, Raia 2008). Discussing the environmental intervals the GRIP ice core event stratigraphy (Björck *et al.* 1998; Walker *et al.* 1999) is applied.

According to the result of ¹⁴C AMS measurement (Table 2), remains of the wild horse (*Equus caballus* L.) discovered in the lower cultural layer were dated back to the onset of Late Glacial Interstadial (Bølling–Allerød) or GI-1 event (Björck *et al.* 1998; Walker *et al.*

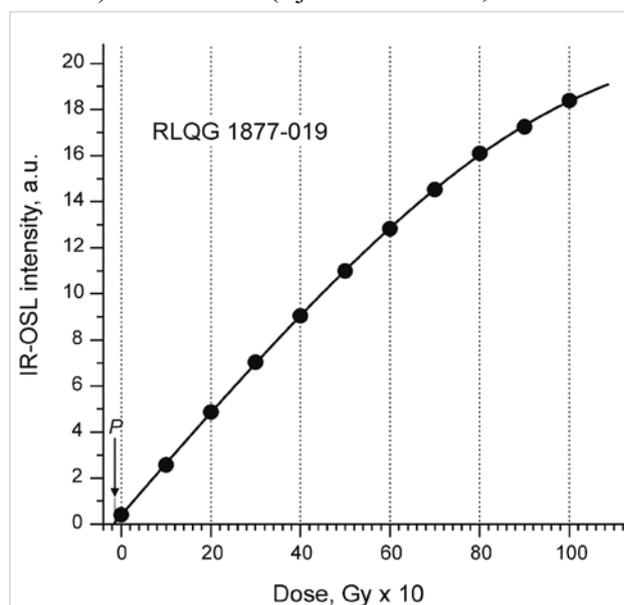


Fig. 7. Typical dose–response curve for the sediment samples from the Kovaltsy site. Each point in the dose–response curve is the average from six aliquots. Compiled by A. Molodkov, 2010.

1999) that correspond with the latest Late Palaeolithic (15–10 ka).

IR–OSL age of eight samples varies between 7.4 and 6.0 ka BP (Table 3). The following qualitative conclusions can be made: 1) the ages obtained for the samples increases with depth following a regular pattern; 2) in samples 1–4 the age differences are small and are characterized by a certain scattering of dating results around the value of about 6.1 ka; 3) judging from identical thermo–luminescence curves obtained for the samples dated, the examined sediments originated from one and the same source area.

Grain size composition

Results of the grain size distribution analysis (Fig. 8) suggest three depositional stages throughout the formation of the investigated profiles. The lowermost part of the test-pit No. 3 is composed of horizontally stratified very fine grained glaciofluvial sand (test-pit No. 3, 270–212 cm). Samples 7 and 8 represent this interval (Fig. 5). Alluvial sediments are separated from the overlying strata by reddish brown clayey sand (200–212 cm) with scattered small patches of black organic material (sample 6) that is interpreted as buried soil or cultural layer. The lower boundary of this horizon is distinct but somewhere merging into a 1–2 cm thick pebble layer containing worked flint and bone finds. Though the sand of the cultural layer contains small inclusions of various grained sand it is obviously dominated by the particles of 0.16–0.08 mm (62.42 %). Increasing representation of coarser grained sand in this layer may have been resulted by aeolian processes when small particles (0.125–0.08 mm) have been blown out from alluvial bed. The rather homogeneous uppermost interval of the sediments sequence (200–14 cm, test-pit No. 3) is distinguished by the predominance of 0.16–0.08 mm particles (Fig. 8) that varies from 69.09–81.94%. Though predominating amount of the particles (0.125–0.063 mm) are attributed to the very fine-grained sand, particles of fine-grained sand and silt are presented as well (Fig. 8).

Osteological analysis

143 fragments of the bones have been all together recovered in the lower cultural layer during the 2007–2009. The majority of the discovered bones is highly corroded suggesting long-lasting deposition of the material on the surface of the terrain. Moreover part of the discovered fragments has been humanly-predated, as is shown by abundant cut-marks and signs of burning.

Identified bones have proved a rich vertebrate fauna, e.g. mammals, birds and fishes existed in area. Frag-

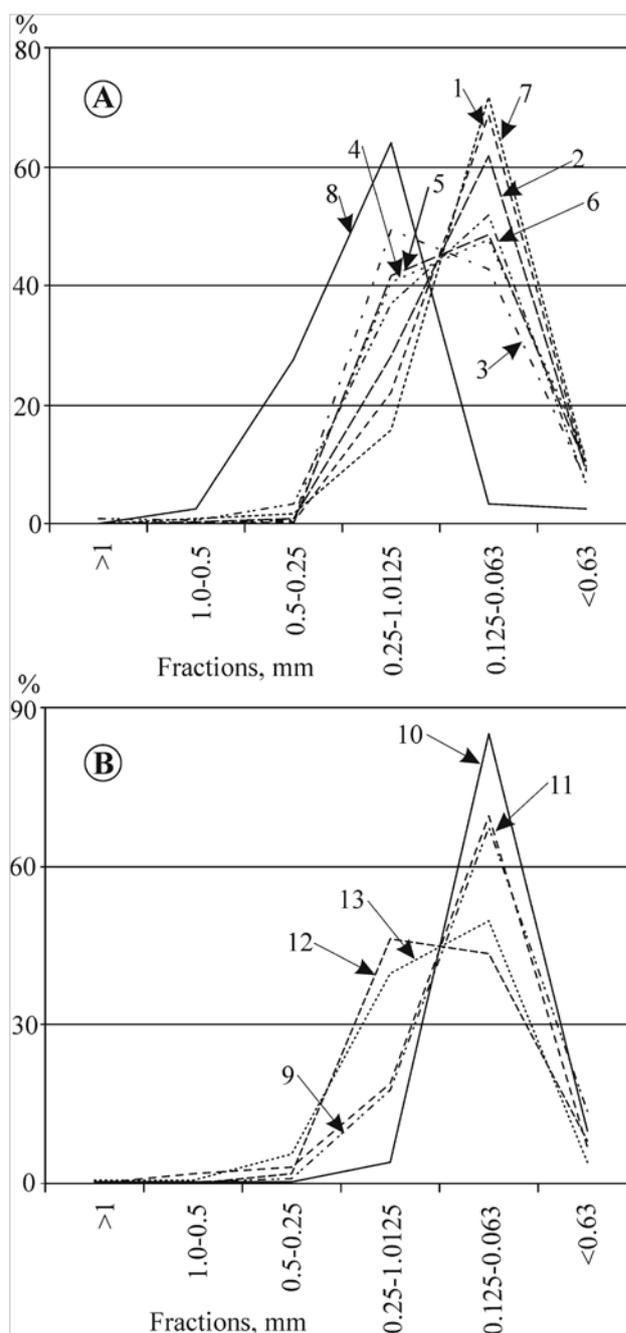


Fig. 8. Grain size distribution curves of examined samples: A – samples from the test-pit No. 3; B – samples from out-crop No. 2. Compiled by B. Karmaza, 2010.

ments of mammals, including mammoth (*Mammuthus primigenius* Blumenbach), predominate in material whereas number of fish (*Pisces*) and bird (*Aves*) bones is low. Only remains of northern pike (*Esox lucius* L.) and ptarmigan (*Lagopus* sp. cf. *L. mutus* Mon.) have been discovered. Together with the fragments of the mammoth's tooth and tusk, which are the most representative among mammals', remains of the wild horse (*Equus caballus* L.), reindeer (*Rangifer tarandus* L.), arctic fox (*Alopex lagopus* L.) and ground squirrels or souslik (*Spermophilus superciliosus* Kaup) have been recovered. Alongside with the mentioned individuals scattered founds of *Ochotona* spp. (pika), *Dicrostonyx*

spp. (collared lemmings), *Microtus (Stenocranius) gregalis* Pallas (narrow-headed vole) and *Mustela* sp. cf. *M. nivalis* L. (least weasel) occurred.

Discovered bones can be roughly separated into two groups. In first one the representatives typical for steppe, e.g. pikas, suslik and narrow-headed vole are included. The second group of individuals e.g. reindeer, ptarmigan, arctic fox and collared lemmings, are closely connected to tundra environment. Such a pattern of discovered bones confirms existence of the open tundra-steppe landscape with particular fauna that was typical for the areas 200–300 km south of the Late Weichselian ice sheet edge (Velichko *et al.* 2009).

Pollen analysis

Scattered pollen grains of *Pinus* and *Betula* have been identified in the investigated samples. Most of them are highly corroded suggesting re-deposition of the discovered specimens or destruction of the pollen grains during the sedimentation process. Furthermore scarcity of the pollen grains as well as predominance of arboreal ones may have been related with the long distance transport of the discovered specimens. In any case no reliable conclusions concerning the vegetation pattern can be based on the collected data.

DISCUSSION

Archaeoenvironmental setting of the area. Geological–geomorphological information collected from the W Belarus suggests this territory was partly covered by ice during the Late Weichselian Glaciation (Makhnach *et al.* 2004). The environmental reconstruction shows that investigated territory consisting of morainic ridges, hills and plains of the Middle Pleistocene age, developed as a typical periglacial zone until the final stages of the Late Glaciation (Makhnach *et al.* 2004). As the margin of the Last Glaciation began to retreat from its maximum extent at 17.7 ± 2.0 ¹⁰Be kyr BP in Belarus (Rinterknecht *et al.* 2007) formation of two periglacial terraces laying on the left bank of the Neman River valley (~119–122 m a.s.l.; Fig. 6) could be related with the earliest stages of the ice melting. Further marked environmental changes occurred in the area in relation with the formation of so-called ‘sandur’ (the Icelandic plural for ‘sandur’) when deposits of glaciofluvial origin covered the considerable part of the region. Later these formations were cut by Neman River valley forming the basement of the fourth terrace. Horizontally stratified very fine-grained sand of this origin has been discovered in the lowermost part of the test-pit No. 3 (Table 1). Development of the fourth terrace was related with the recession of the Late Weichselian ice sheet from the Middle Lithuanian marginal formations (Dvareckas 2001)

dated back to about 13.5 ± 0.6 ¹⁰Be kyr BP (Rinterknecht *et al.* 2008) suggesting the similar age of the terrace and the earliest population of the area. Due to the predominance of terrigenous matter in the sediments both biostratigraphical and chronological attribution of the Stone Age sites representing the earliest Late Glacial intervals is rather complicated in the periglacial zones of the Late Weichselian ice sheet. Moreover due to the presence of the radiocarbon plateaus (Ammann, Lotter 1989) large standard errors appear after the calibration of obtained dates decreasing the precision of available information even more. All these indications should be taken into account discussing the age of the cultural layers in the Kovaltsy archaeological site. Radiocarbon date obtained from the lower cultural layer implies deposition of the investigated bone of the wild horse (*Equus caballus* L.) at about ~14 500 cal. yr. BP, or during the earliest stages of the Late Glacial that is in a good correlation with the increasing population density in this part of Europe dated back to 16–14 cal. yr. BP (Dolukhanov *et al.* 2001). Most probably, territory was settled shortly after the formation of the fourth terrace and stabilization of the environment situation or during the earliest stages of Bølling-Allerød Interstadial. Although the separated finds or features of tools discovered in the lower layer of Kovaltsy site are known from the territory covering the northern part of the Western Europe and the basin of the Volga River and dated back to the Late or Final Palaeolithic (Kozłowski, Kozłowski 1977) more precise cultural and chronological attribution of investigated archaeological complex is rather tentative. Generally archaeological data suggests the Late Palaeolithic age of the discovered items and cultural layer respectively.

Whereas results of IR–OSL dating appear inconsistent with the above archaeological information, geological interpretation and ¹⁴C data suggesting the early Holocene age for the lower cultural layer and underlying strata (Fig. 4, Table 3). These differences may be explained by repeated re-deposition of the IR–OSL dated material due to aeolian activity or deflation and solifluction processes. According to IR–OSL data the last sediment deposition as a result of these processes has occurred between 7.4 and 6.0 ka BP ago. Therefore, application of the above mentioned IR–OSL data for the reliable time control of the Kovaltsy archaeological site are very limited at the moment.

The sediment stratigraphy at Kovaltsy archaeological site comprises two principal cultural layers along with fine or very fine-grained sand between them (Fig. 2). Indicated interlayer without archaeological finds is interpreted to represent a habitation hiatus. Formation of these sediments as well as abandonment of the territory may have been related with the environmental instability typical for the Late Glacial. The comparison of the grain size and structural features of sediments representing the test-pit No. 3 (samples 1–5, Fig. 5A)

with the lithofacial features of the aeolian sediments (Zieliński, Issmer 2008; Zieliński *et al.* 2008) allow assuming that the described sediments are of the same lithofacies of horizontal lamination type (code of depositional environment HL: horizontal layer), i.e. vertical deposition from air of fine and silty sand grains on a dry or wet ground of a flat surface. The sediments are characterized by horizontal and wavy lamination originated under windless conditions (wind velocity 0–4 m/s). In the lower part of sand bed (Fig. 6A, 152–200 cm depth) the sediments are slightly ripple laminated. The ripple marks were formed under the conditions of low wind velocity (4–6 m/s) through deposition from saltation transport (Zieliński, Issmer 2008; Zieliński *et al.* 2008) on the surface with ripples (RC) generating the climbing ripple laminated lithofacies. In the neighbouring Lithuania aeolian activity was rather intensive talking about the Late Glacial and the Younger Dryas especially (Blažauskas *et al.* 1998; Bitinas 2004) suggesting the similar situation in the W Belarus including Kovaltsy area.

Discussing the history as well as chronological and cultural attribution of the upper cultural layer, possible re-deposition of the material should be stressed. Structure of the layer suggests possible landslide activity including transportation of the cultural strata. As no organic material or animal bones suitable for the isotope survey have been discovered within the sediments, chronological interpretation was based on typology of the discovered tools entirely. Flint tools, cores and debitage suggest the upper cultural layer formed at about 11 500–11 000 cal. yr. BP and could be attributed to the local “non-Swiderian” Late Palaeolithic cultures e.g. so-called Baltic Magdalenian, Vilnius group, Lyngby, Eastern Ahrensburgian and Krasnoselye (Rimantienė 1971; Sulgostowska 1989; Zaliznyak 1999). This stage of the human occupation was coincided with the onset of the Holocene, when prominent climatic changes in Northern Hemisphere started (Vandenbergh *et al.* 2001).

Environmental studies carried out in the W Belarus (Zernitskaya 1997; Novik *et al.* 2010), eastern Poland (Kupryjanowicz 2007) as well as in Lithuania (Stančikaitė *et al.* 2004; Šeirienė *et al.* 2006) have shown the initial stages of the Holocene period, when the upper cultural layer of the Kovaltsy archaeological site deposited, to be characterized by unstable climate, changing vegetation structure and water level. Nevertheless human groups remained in surroundings of Kovaltsy site for rather long time, only occasionally abandoning it. Such a long-lasting occupation of the same place could be determined by the remarkable shift in the adaptive strategy when human adaptation took manifested itself predominantly in the improvement of hunting weaponry, the development of dwellings, storage facilities, etc. (Velichko *et al.* 2009).

Vegetation and faunal history. Palaeobotanical records representing the neighboring areas (Stančikaitė *et al.* 2008; Novik *et al.* 2010) suggest the existence of

open tundra-steppe landscape with some sparse *Betula nana* L. and *Betula* sect. *Albae* during formation of the lower cultural layer in Kovaltsy site. Predominance of terrigenous matter in the cultural layer confirms scarcity of the vegetation cover and intensive erosion taken place in area. Alongside with the changes of the environmental situation mammals, birds and fishes migrated to new habitats. Osteological data gives a broader picture of the mammal species existed in area and the food consumption of the Late Palaeolithic population. Remains of herbivorous e.g. mammoth (*Mammuthus primigenius* Blumenbach), wild horse (*Equus caballus* L.) and reindeer (*Rangifer tarandus* L.) are the most common in the material from Kovaltsy site. Of course the discovered bones may have partly indicate hunting objects or local trends in the specialization of hunting amongst Late Palaeolithic population rather than species diversity and abundance in the investigated area, however regular high occurrence of mammoth bones in the Upper Palaeolithic cultural context was noted from the archaeological sites in the central areas of the Eastern Europe (Velichko *et al.* 2009) including Yurovichi situated in the southern part of the Belarus (Chernjavski, Shtyhav 2000). Collected data confirm the presence of mammoth population in the circum-Baltic region during the Middle Weichselian, 44 000 to about 26 000 cal. yr. BP (Ukkonen *et al.* 2007) including Lithuania territory where the oldest remains have been dated back to 46 300±1 100 and 30 350±250 ¹⁴C kyr BP (Daugnora 2004). Post Glacial re-colonization of this area started immediately after the ice retreat, e.g. at about ca 15 790±800 cal. yr. BP in southern Sweden (Liljegren, Ekström 1996; Ukkonen *et al.* 2007) and Denmark (Aaris-Sørensen *et al.* 1990) and at about 17 050–14 250 cal. yr. BP in Lithuania (Daugnora 2004). Mammoths followed the retreating ice front very closely and re-colonized recently deglaciated areas very fast (Liljegren, Ekström 1996; Lõugas *et al.* 2002) as well as reindeers (Ukkonen *et al.* 2006). In the eastern Baltic the ages of the reindeer (*Rangifer tarandus*) bones range between 12 085 and 9 970 ¹⁴C yr. BP (14 180–11 280 cal. yr. BP), and cover the Late Glacial and early Holocene (Ukkonen *et al.* 2006). As the oldest date of the reindeer bone (12 085±100 ¹⁴C yr. BP or 14 180–13 900 cal. yr. BP) representing the eastern part of Lithuania territory (Ukkonen *et al.* 2006) corresponds with Bølling-Allerød Interstadial these herbivorous may have established in Kovaltsy area even earlier. All together mammoths and reindeers should be indicated as the main mammal recourse to the Late Palaeolithic population of the Kovaltsy site while birds and fishes played a marginal role in the human diet. Talking about the ethno-cultural peculiarities of the Upper Palaeolithic communities intensive exploitation of mammoth's was typical for the population of Middle Dnieper River basin, situated south-eastwards from investigated area, while reindeer was the most important for European Magdalenian hunters (Abramova *et al.* 2001).

CONCLUSIONS

Interdisciplinary studies including geological–geomorphological, lithological, palaeobotanical and zoological data as well as ¹⁴C and IR–OSL dates, have produced new information concerning the environmental and human history of the Kovaltsy Late Palaeolithic site, W Belarus.

After the recession of the Late Weichselian ice sheet the territory previously developed as the periglacial zone was partly re-worked by glaciofluvial processes. Formation of the periglacial as well as the uppermost terraces of the Neman River took place during the earliest stages of the Late Glacial. Kovaltsy archaeological site with two cultural layers have been discovered on the fourth terrace of Neman River. Topographical situation, typology of the discovered items and results of AMS ¹⁴C dating suggest the early Late Glacial occupation of the site (~14 500 cal.yr. BP). At that time open tundra-steppe vegetation dominated the area and fauna were concordant with it, dominated by large herbivorous e.g. mammoth (*Mammuthus primigenius* Blumenbach), wild horse (*Equus caballus* L.), and reindeer (*Rangifer tarandus* L.) which were intensively exploited by people. Climatic and environmental changes may have been the decisive factor for the abandonment of the territory during the final stages of the Late Glacial when sediment bed without the cultural signals deposited. Archaeological evidences suggest the next stage of the site occupation corresponded in time to the onset of Holocene, 11 500–cal. yr. BP when a new stage of a human expansion was determined by the ameliorating environmental situation recorded all around the Northern Europe.

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