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PALAEOLITHIC LOESS-SITE YEZUPIL ON DNISTER (UKRAINE) – STRATIGRAPHY, ENVIRONMENT AND CULTURES

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Abstract
Yezupil is the first Middle Palaeolithic site discovered in upper part of the Dnister River valley. It is situated in a set of sediments composed of loess and fossil soils lying on alluvia.
The results of geological and palaeopedological investigations are presented. They contain lithological and geochemical analyses (main components and trace elements), as well as micromorphological study. Palaeo- and petromagnetic record is presented too. Horohiv pedocomplex developed from the older, Wartanian loess. It is composed of luvisol originated during the Eemian Interglacial and chernozem soil – during the Early Vistulian interstadials. An subarctic brown Dubno soil dated to the Interplenivistulian (Middle Vistulian interstadials) separates two parts of the younger loess. Older assemblage of Middle Palaeolithic–Mousterian culture with Levalloisian technique was found in the E horizon of the luvisol and therefore it could be dated to the Eemian Interglacial. Younger Middle Palaeolithic–Micoquian-type materials were situated in partially redeposited by solifluction, Early Vistulian chernozem. Scanty and uncharacteristic Upper Palaeolithic assemblage was found in interstadial Dubno palaeosol.

Key words: Loess, paleosols, Palaeolithic, Ukraine

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INTRODUCTION

The multilayer Palaeolithic site in Yezupil situated in the Ivano-Frankivs'k province (Ukraine) allows us to make important progress in knowledge about the East European Palaeolithic. This site represents a new Palaeolithic region – the Halyč region. This region is situated in a transition zone between the Volyno-Podillja Upland and the Carpathian Foreland (Lencewicz 1937, Cys' 1962, Kravčuk 1999). Common Polish-Ukrainian studies of several typical profiles of the Quaternary deposits (Yezupil, Kozina, Halyč, Zahvizdja, Marynopil, Kolodiiv and other profiles) have been conducted in this area for the last years (Fig. 1). The results of these investigations are published successively (*e.g.* Boguckyj *et al.* 2000a, b).

A small clay-pit occurs in the northern outskirts of Yezupil. In 1990 A. Boguckyj found here two flakes and bifacial convex knife similar to some Middle Palaeolithic cultures in Central Europe. O. Sytnyk carried out archaeological excavations on the area of 10 m^2 at the same place in 1994–1997. These investigations resulted in determination of the site stratigraphy and finding of Middle Palaeolithic cultural layer in the distinct and well-developed Eetg horizon of the Horohiv paleosol. The preliminary results were published by Sytnyk *et al.* (1996, 1998a, b). During explorations conducted on a much larger area in 1999 two next cultural layers were found: Middle Palaeolithic one in the upper part of the Horohiv pedocomplex and Upper Palaeolithic one in the Dubno fossil soil. Thus, the previously described oldest cultural layer was marked as "III" and two newly discovered layers – as "II" (Middle Palaeolithic) and "I" (Upper Palaeolithic).

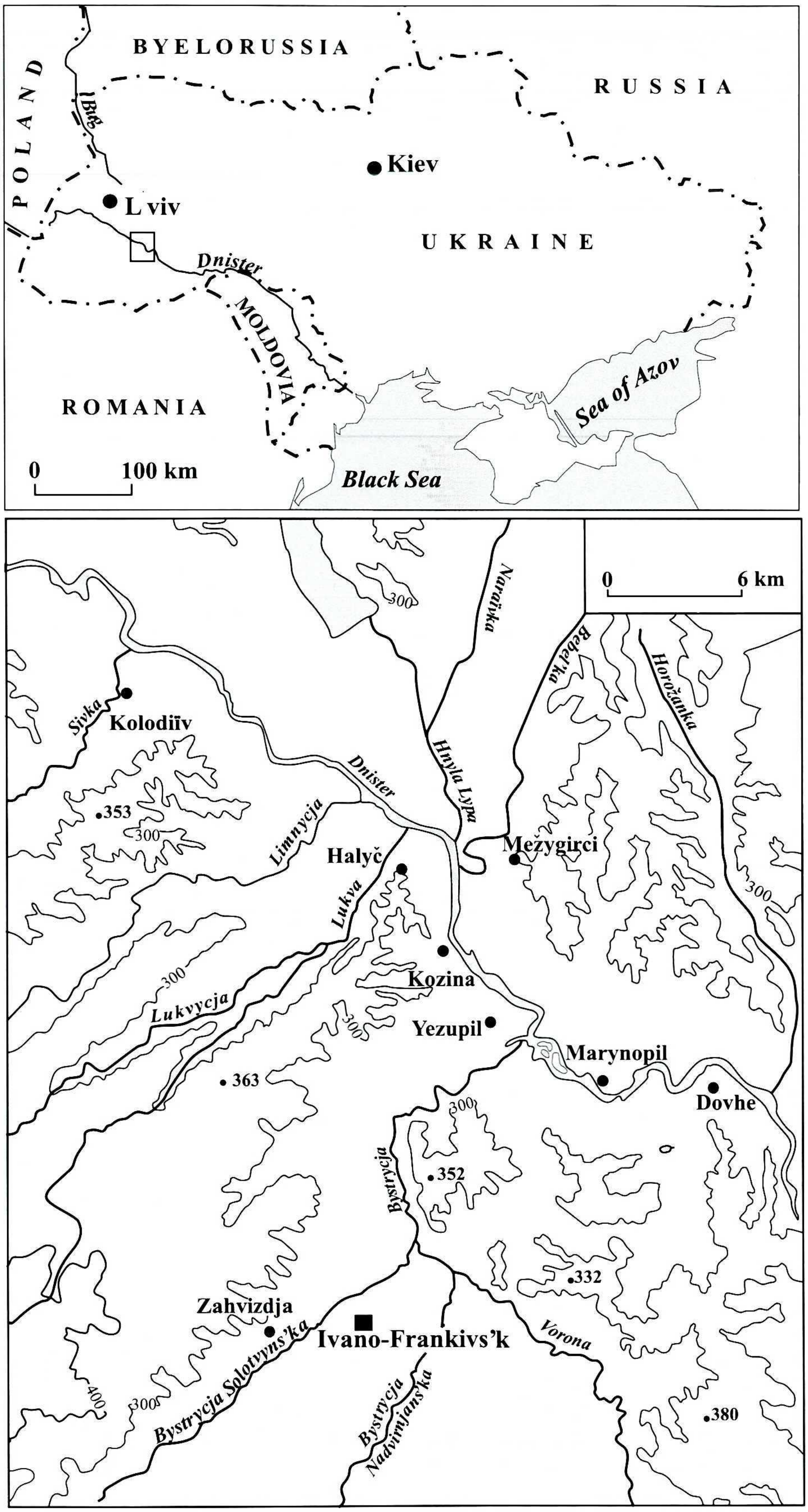


Fig. 1. Situation of the Palaeolithic site Yezupil and other loess profiles in the Halič region.

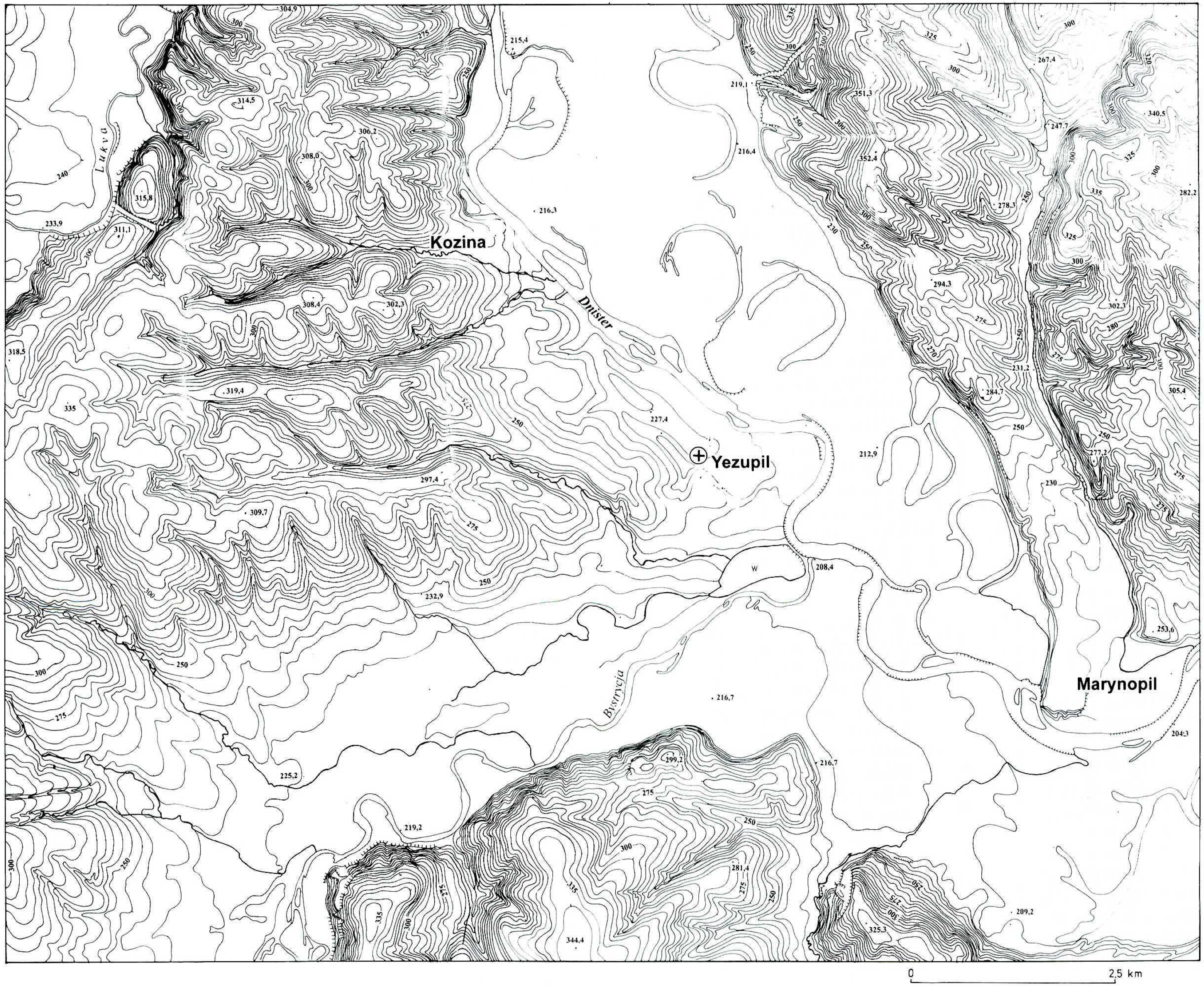


Fig. 2. Hypsometry of environs of the Palaeolithic site Yezupil.

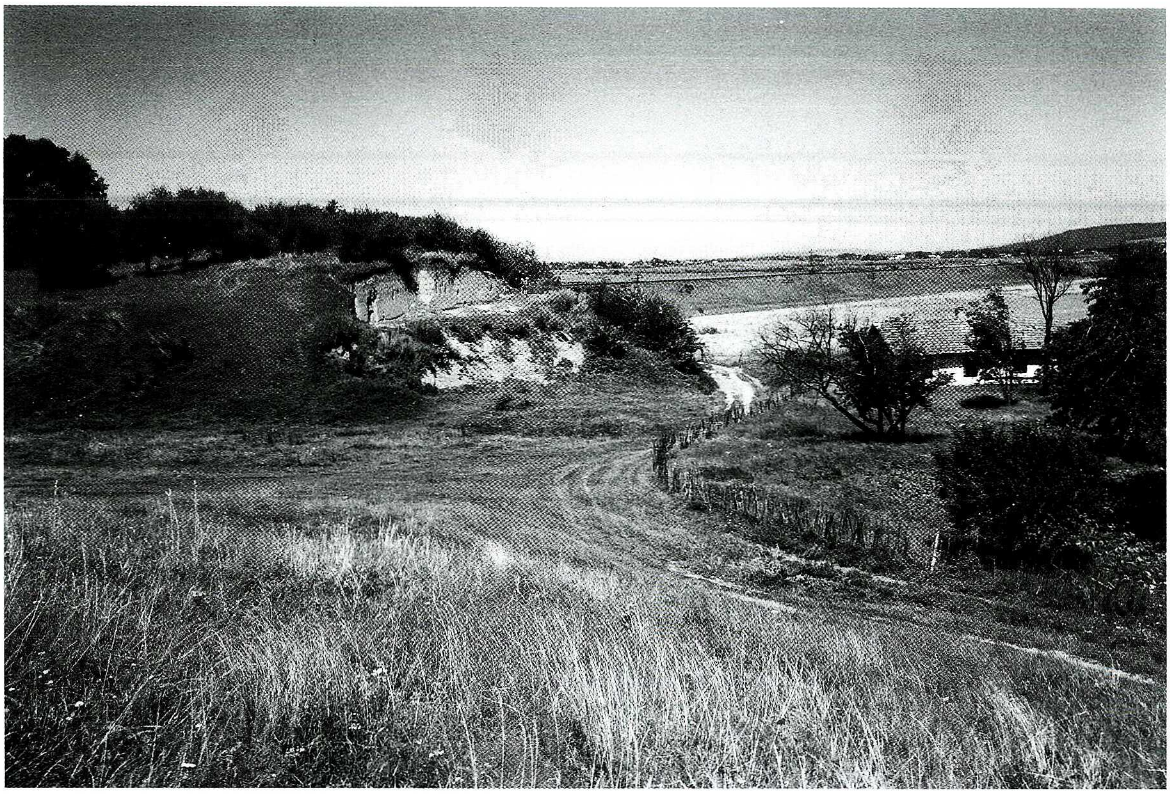


Fig. 3. Photograph of the Yezupil site.

GEOMORPHOLOGICAL CHARACTERISTICS OF THE YEZUPIL REGION

The Yezupil region is composed of several morphologically differentiated units (Czyżewski 1925, Ochocka 1931, Teisseyre 1933) separated by the valleys of the Dnister River and its major Carpathian tributaries (Fig. 2). These rivers form free meanders within wide and flat valley bottoms in which also numerous and variously preserved ox-bow lakes occur. Loesses, several to several tens of meters thick, occur in the whole region except the valley bottoms.

Mountainous area on the left side of the Dnister River rises to over 350 m a.s.l. and its relative heights exceed 120 m. Long meridional ridges are separated by a narrow and deep tributary valley which meets the Dnister river valley near Marynopil'. Similar but more uniform relief of wide and high interfluve ridges with steep slopes characterizes area on the right side of the Dnister River and southwards of the Bystrycja River. These both parts of the discussed region are separated from the valleys of the Dnister and Bystrycja Rivers by high erosion scarps. Bottom parts of these scarps are built of Upper Cretaceous limestone in which flint concretions occur. These flint nodules are very common in secondary bed, *i.e.* in channel gravels of the Dnister River.

Wide and asymmetric plateau-ridge spreads out northwestwards of the Bystrycja River. It is dissected by the trough-like valleys of small streams, running evenly with a parallel of latitude to the Dnister River. Distinct steps of Pleistocene terraces of different ages are visible exposed eastwards and southwards on long and gentle slopes of the plateau-ridge.

LOCATION OF THE YEZUPIL SITE

The studied site is situated on the right/western side of the Dnister River, about 10 km SE of Halyč and about 1.5 km N of Yezupil which is located near the confluence of the Bystrycja and Dnister rivers. Flood plains of the both river valleys are here up to 2.5 km wide. The site occurs near an edge of a small nose connected with the Pleistocene lowest terrace, which rises about 15 m over the bottom of the Dnister river valley. This fragment of the terrace is distinctly isolated; rather shallow but branched dry valley borders it from the west. Landscape features of the described site indicate that it was well and safely situated from the point of view of the Palaeolithic settlers (Fig. 3).

DESCRIPTION OF THE PROFILE

Profile description (Table 1) was compiled from the data found in the exposure to a depth of 6.30 m (Fig. 4), and below – in the core taken with use of hand-auger. This profile was sampled many times and complex analyses such as paleomagnetic, micromorphological, geochemical and others were made. The results are presented in Figs. 5, 6, and 7. Numbers of stratigraphic units used in the description are related to the stratigraphic scheme of the Ukrainian loesses by Boguckyj (1986, 1987, Boguckyj *et al.* 2000 a).

Table 1

Description of the Yezupil profile

Depth (m)	Description
0–1.40	**Recent soil (1)** with very well differentiated genetic profile. Anthropogenic layer 0.20 m thick. Humus horizon (A) 0.40 m thick – dark-grey loamy sand, macroporous, slightly anthropogenically transformed in the top part; HCl–. Gradual transition. Traces of soil fauna activity (crotovines, tubes), and also plant root traces are numerous. Lightened colour of deposit (leaching processes and formation of Eet horizon) is visible in the bottom part, and below it gradually changes into brown colour of the B horizon. A cultural layer with numerous flints, probably connected with settlement of Bronze Age, was found in the bottom part of the A horizon. Bt horizon 0.80 m thick – brown-reddish silty loam of prismatic structure, with ferruginous streaks/pseudofibres, contains up to 4.5% of Fe_2O_3; HCl–. Distinct lower boundary expressed by a decrease of deposit compactness, appearance of carbonates and change of deposit structure.
1.40–1.85	**Upper layer of the Upper Pleistocene loess (2) – Upper Plenivistulian** Grey-yellow silt, uniform, macroporous, with secondary carbonates of pseudomycelia shape, and with distinct vertical fractures; HCl+ ($CaCO_3$ content < 4%). Rather high (about 3.5%) content of Fe_2O_3. Distinct lower boundary. Content of silt in this loess and in recent soil developed on it is about 30–40%; content of clay fraction (<0.002 mm) in soil is 10–15% higher than in unweathered loess (about 20%). Sand content increases in the bottom layers of loess. According to granulometric indices (Falk and Ward system) this deposit is fine-grained (Mz: 6.87 phi in the soil and 6.52 phi in the loess), and very weakly sorted (δ_1: 2.88 and 2.30, respectively).
1.85–2.75	**Soil of Dubno type (3) – Interstadial(s) of the Interplenivistulian (Denekamp and Hengelo)** Genetic profile of this soil is visibly differentiated. Humus horizon (A) with variable thickness of 0.20–0.30 m – grey-brown silt rather rich in humus (0.43%), cut by tubes (traces of soil fauna) up to 2.0 cm in diameter and recent crotovines up to 10 cm in diameter filled with material from the loess layer (2) and from the A horizon of the recent soil; HCl+ ($CaCO_3$ content about 3%), carbonates are secondary, from the overlying loess. Gradual transition to the lower horizon. Bbr horizon with variable thickness of 0.60–0.70 m – compact silt, yellow-brown with reddish tint, macroporous, with numerous black iron-manganese concretions 3–4 mm in diameter, cut by tubes formed by soil fauna but less intensively than in the A horizon; HCl–, but secondary carbonates (pseudomycelia, concretions) are found near fractures. Gradual transition of colour. Thin lenses of darker, brown material are present in the bottom part of the layer. Humus content in the Bbr horizon is also high (0.40–0.50%). Content of Fe_2O_3 is rather high in both horizons (>4%). Loess containing about 30–35% of silt fraction (0.05–0.02 mm) is substratum of this soil. Content of clay fraction in humus horizon reaches 20%, two times higher than in the Bbr horizon. This fact is evidenced by the Mz index (6.78 phi in the A horizon and 6.22 phi in the Bbr horizon). The deposit is characterized by weak to very weak sorting. Lithological and chemical features suggest that this is a pedocomplex of two soils; the younger of them developed directly on the older one. These soil-forming processes could occur during warmer climatic fluctuations within middle and younger parts of the Interplenivistulian. Warmer conditions are also indicated by palaeomagnetic analyses. First cultural layer (I) from the Upper Palaeolithic occurs in the middle part of the A horizon of the Dubno soil.
2.75–3.90	**Lower layer of the Upper Pleistocene loess (4) – Middle and Lower Plenivistulian** Light-brown silt, yellow in places, uniform, compact but macroporous, with carbonate pseudomycelia more and more abundant downwards; HCl+, but weakly. Distinct lower boundary. Streaks and small solifluction tongues 5–7 cm thick, built of the material from the A horizon of the Horohiv pedocomplex. This loess contains 40–42% of silt fraction and 10–16% of clay fraction. The deposit is weakly sorted. In the middle part of this layer (about 0.4 m over its bottom) within uniform loess, a 0.15 m thick insert of strongly gleyed material occurs, with numerous black iron-manganese concretions up to 4 mm in diameter and thread-like pseudomycelia. It is the layer of carbonate illuviation ($CaCO_3$ content is almost 3%), and it is enriched in iron oxides (> 4% of Fe_2O_3) in comparison with the under- and overlying layers. This layer is also distinguishable by its grain size composition. It can be considered as a weathering horizon in a stratigraphic boundary between Middle and Lower Plenivistulian. This insert may be probably correlated with one of the black layers (Ivanova 1982) found in many Mousterian sites by Molodova in the Middle Dnister River valley.
3.9–5.7	**Horohiv fossil pedocomplex (5) – the earliest Vistulian interstadials and Eemian** Genetic profile of this pedocomplex is well differentiated. Humus horizon (A) with variable thickness of 0.50–0.60 m – dark-grey sandy silt with brown tint, spotty; HCl–. It is characterized by very numerous iron-manganese concretions up to 3 mm in diameter, and also secondary carbonates in the shape of film on fissure walls and neighbouring pseudomycelia. The uppermost part of the humus horizon is slightly deformed by solifluction. Distinct boundary expressed by change of colour and structure. Second cultural layer (II) occurs in the uppermost part of the Horohiv pedocomplex and in that part of the layer (4), which was deformed by solifluction. Eluvial horizon (Eetg) 0.30 m thick – light-brown, light-grey and whitish sandy silt, spotty, gleyed, with subtle precipitations of iron compounds and numerous black iron-manganese concretions up to 3 mm in diameter; HCl–. Distinct boundary expressed by change of colour and compactness.

Table 1 (continued)

Description of the Yezupil profile

Depth (m)	Description
3.9–5.7	Third cultural layer (III) is connected with the eluvial horizon. Illuvial horizon 1.10 m thick is composed of two subhorizons. Bt-1 (upper) subhorizon 0.60 m thick – red-brown silty loam, compact, impregnated with iron compounds, of prismatic structure, with spots of iron-manganese compounds up to 1–2 cm in diameter, fractured, with secondary carbonates precipitated on fracture walls and in their neighbourhood. Typical lightened colour of the deposit caused by leaching is visible in the fractures and along the surfaces of textural jointing. Gradual transition to Bt-2. Bt-2 (lower) subhorizon 0.5 m thick – light-brown sandy silt with greenish tint, compact, with traces of strong gleying, and faint stratification (probably connected with cryogenesis). Gradual transition to loess. Vertical profile of the Horohiv soil is characterized by a rather constant grain size composition; content of silt fraction is little differentiated (33–35%), that of clay fraction is somewhat more differentiated (from 15% in the Eetg horizon to 22% in the Bt-2 horizon). Granulometric indices are undifferentiated (Mz = 6.2–6.4 phi; δ_1 = 2.0–2.2; Sk_1 = 0.41–0.45). Humus content in the A horizon is high (0.6%); content of translocated iron oxides reaches 4.7% in the Bt-2 horizon, while in the A horizon it is 3.1%, and in the Eetg horizon – 2.1%.
5.7–10.8	**Upper layer of the Middle Pleistocene loess (6) – Wartanian** 5.70–7.50 m – yellowish-gray sandy silt, spotty gleyed, with greenish tint in places, uniform, with faint stratification; HCl–, or very weekly. Transition expressed by a change of colour, decalcification boundary. 7.50–10.40 m – yellowish-grey loess-like silty sand, with carbonate concretions up to 3 cm in diameter, more and more strongly gleyed and spotted downwards; HCl+. Gradual transition. 10.40–10.80 m – grey and bluish-grey silty sand (in the bottom part of the layer – loamy sand), gleyed; HCl+. Distinct boundary, on which sandstone gravels occur, up to 3 cm in diameter, mainly flat, well rounded. Deep influence of the Eemian pedogenesis is visible in the upper part of this loess. It is expressed by finer mean grain size (Mz = 6.28 phi) and weak sorting (δ_1 = 2.3) of the deposit which is weathered and strongly decalcified (content of $CaCO_3$ is <1%). Impregnation of the deposit with iron compounds may be also connected with the Eemian pedogenesis. Unweathered layers of the Wartanian loess are distinguishable in the whole Yezupil profile by grain size (Mz = 5.6–5.9 phi); these layers show typical features of proper loess (Mz in the interval 5–6 phi). The unweathered Wartanian loess is weakly sorted (δ_1 = 1.5–1.7) but distinctly better than the Vistulian loess. Graining features of the described layers are constant. All these facts seem to evidence a high and constant dynamics of sedimentation environment. Carbonate content in the unweathered Wartanian loess (up to about 6%) is higher, and humus content (0.1–0.2%) distinctly lower than in the Vistulian loess; it is probably caused by cooler and dryer accumulation conditions.
10.8–11.0	**The Middle Pleistocene alluvia** Gravel with grey-brown silty loam, impregnated with iron compounds, very wet; HCl+. This deposit is most probably connected with channel alluvia of the Dnister River. Occurrence of gravels made deeper hand boring impossible.

FOSSIL SOILS

Introduction – analysis

Fossil soils in the Yezupil site were distinguished during the field observation, basing on their morphological characteristic and analogies to other loess with fossil soil profiles of the Podillja and Volyn region (Fig. 5).

The research carried out till now revealed typical features of the Horohiv fossil pedocomplex. It corresponds well to the Mezin pedocomplex distinguished in central part of the East-European Plain (Veličko 1973, 1990). The Horohiv pedocomplex consists of two superimposed soils (Bezus'ko, Boguckyj 1986, Boguckyj 1986, 1987, Morozova, Boguckyj 1981). It is very well visible in loess profiles owing to dark-grey colour (with brown tint) of the thick (0.5 m and more) humus horizon of steppe soil and light-russet to orange colour of the illuvial horizon of the forest (lower) soil with thickness up to 1.0 m, and sometimes more. Light-grey eluvial (Eetg) horizon 0.2–0.3 m thick is rather frequently found in the forest soil. This forest paleosol developed during the Mikulino (Eemian, R/W) Interglacial, and the steppe paleosol was formed during the early interstadials (Brörup or Amersfoort) of the Vistulian. Therefore, it could be stated that the lowest cultural layer III of the Yezupil site was formed during the R/W Interglacial, near its latter part. Climate at that time was generally similar to the modern one (Bezus'ko, Boguckyj 1986). The forest soil of the Horohiv pedocomplex should be correlated with the oxygen isotope substage 5e of marine sediments, and the steppe soil – with the substage 5c.

We have now about 20 TL dates of the deposits being the parent material formed during the second stage of the Horohiv pedogenesis in western Ukraine. The obtained dates (made in the Institute of Geological Sciences of Ukrainian National Academy of Sciences) cover wide interval – from 80±7 ka BP to 143±13 ka BP. It is unquestionable that the cultural layer II in Yezupil was connected with the final stage of the steppe soil development during the Horohiv pedogenesis.

The Upper Pleistocene/Vistulian loesses are divided by the stratigraphically important Dubno soil which was ^{14}C dated in the Institute of Geological Sciences of Ukrainian National Academy of Sciences at 28 400±180 BP in Volyn and 29 400±100 BP in Podillja. In the eastern part of the Polish Carpathian Foothills, a parallel horizon was dated at

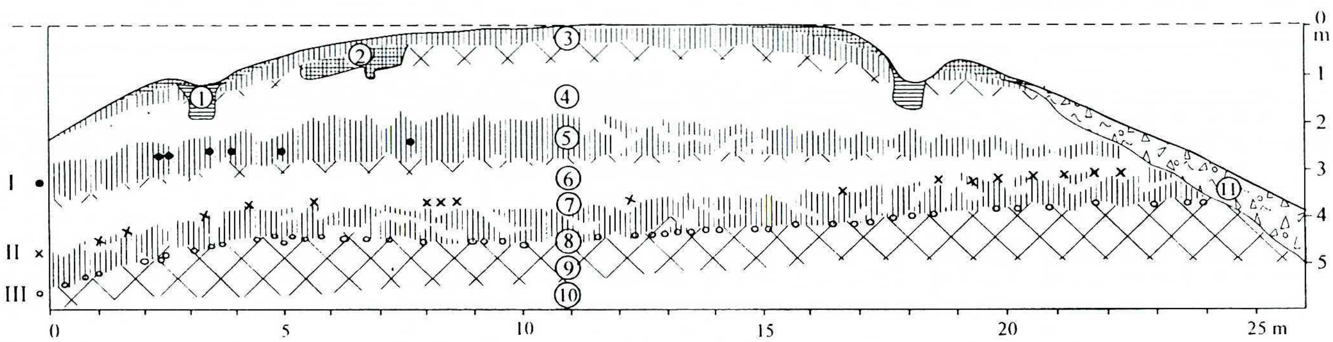


Fig. 4. Stratigraphic section of the Palaeolithic site Yezupil. I–III – cultural layers. Numbers in circlets: 1 – trenches from the I World War; 2 – settlement of the Bronze Age; 3 – recent soil 4 – upper layer of the Upper Pleistocene loess; 5 – Dubno soil (in the middle part of the A horizon – the cultural layer I from the Upper Palaeolithic); 6 – lower layer of the Upper Pleistocene loess; 7 – A horizon of the Horohiv pedocomplex (in its upper part – the cultural layer II); 8 – Eetg horizon of the Horohiv pedocomplex – the cultural layer III; 9 – Bt horizon of the Horohiv pedocomplex; 10 – upper layer of the Middle Pleistocene loess.

28 200±500 BP (Łanczont 1995). The Dubno paleosol is largely correlated with the Briansk paleosol (Veličko 1973, 1990) found in central part of the East-European Plain, and with so called Komorniki paleosol (Jersak 1976) occurring in Polish loesses. They all correspond to younger interstadials of the middle Interplenivistulian, *i.e.* to Denekamp and Hengelo in the West-European terminology. The cultural layer I in Yezupil is connected with this Dubno paleosol.

For detailed description of particular soils and soil complexes of Yezupil site, the results of micromorphological and chemical analysis as well as grain size composition were used. The FAO (1990) terminology of soil systematics was applied. Micromorphological analysis performed in thin sections of samples with undisturbed structure (Figs. 8, 9) give information concerning fabrics and composition of soil matrix, as well as diagenetic, cryogenic and weathering processes. But first of all it is used for determination of succession and intensity of soil development. The terminology of Kubiena (1956), Brewer (1972) and Bullock *et al.* (1985) was used.

Grain size composition of sediments shows for small admixture of fine sand fraction in several horizons and not very important increase of clay fraction in soil horizons (Fig. 5).

Calcium carbonate content varies along the profile. Important decalcification is to be observed in interglacial – Horohiv soil and in recent soil, that probably has Late Glacial origin. Less important decalcification is connected with Dubno interstadial soil. Fable increase of humus content is to be found in A soil horizons, most important in the recent soil.

Quantitative changes of so called "free iron", (*i.e.* iron hydroxides – determined using Jackson method) are clearly connected with soil – forming processes (Fig. 6) because this is the form of iron liberated from primary minerals and accumulated in sediments on contemporary surface.

Chemical composition (analysed with the AAS method) is not very differentiated in the whole profile. Such major components as: SiO_2, Al_2O_3, CaO, Fe_2O_3, MgO, MnO (Fig. 6) as well as some trace elements reflect to some degree the primary composition of loess depending on source of material transported by wind. On the other hand, it depends on secondary changes of particular, more mobile elements' contents resulted from diagenetic, weathering and soil-forming processes (Catt 1990). In the Yezupil profile, concentration of trace elements in soil horizons is not so important as in *e.g.* Hungarian profiles (Hum 1997). Concentration of Li and Co in B horizons of all the three fossil soils is marked in Fig. 7. In B horizons of only interglacial luvisols, an increasing amount of Cu and Zn is marked. Increased Cu content in fossil soil has been already described in Polish loess profiles (Łukaszew, Mojski 1968). On the contrary, irregular increases of Sr, Rb, Cd, Cr and Ni in loess layers are seen. Ba concentration is remarkable in the older loess.

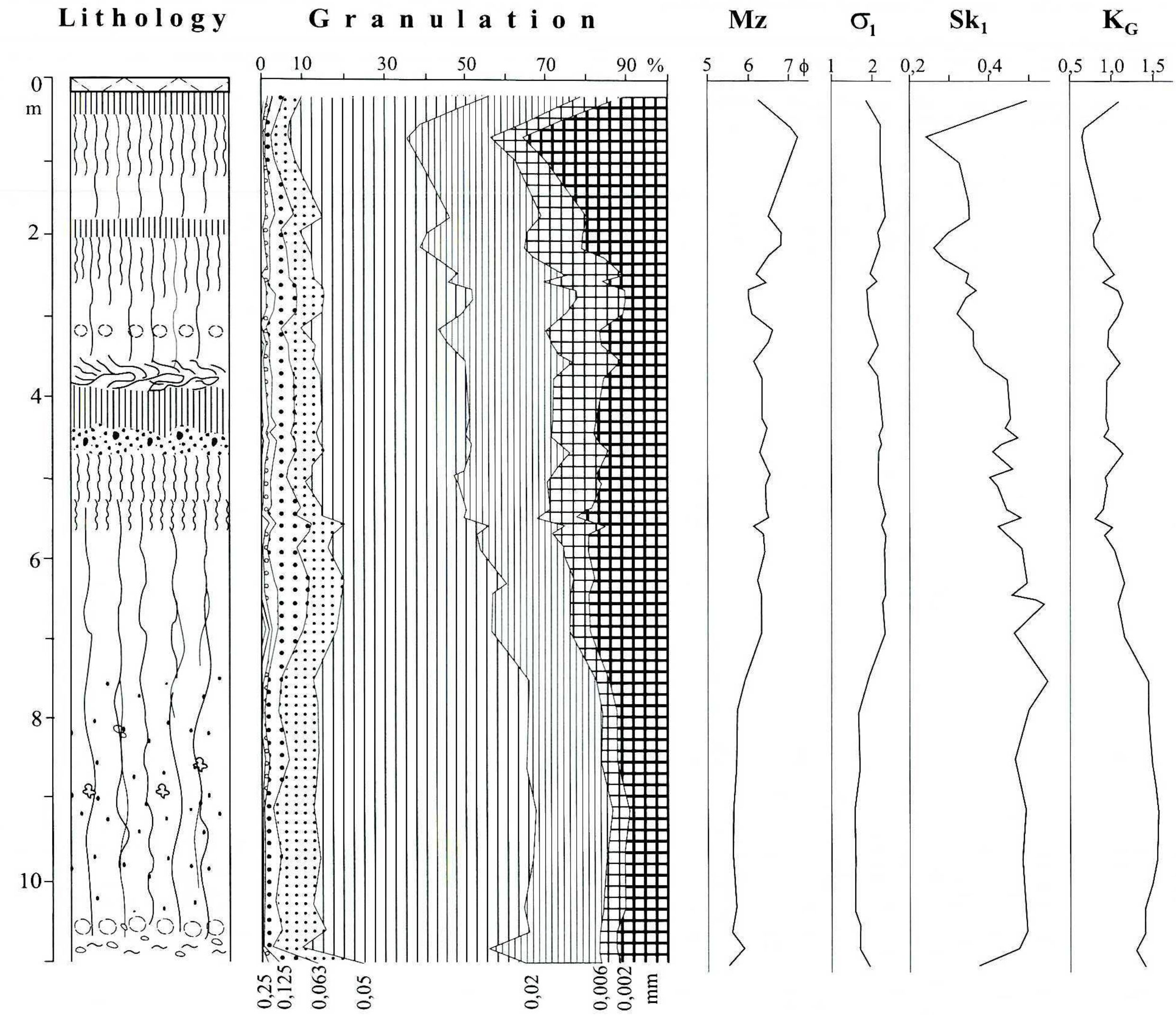
Characteristic of soil horizons

Horohiv set of fossil soils (pedocomplex)

Older part of the Horohiv set of fossil soils, luvisol type (*lessivé,* brown leached forest), originated during the Eemian Interglacial from the older loess. Thin section analysis suggests clay illuviation – leaching down the colloidal clay (soil "plasma"), before the destruction or truncation of the upper part of the soil. Characteristic horizon of colloidal clay accumulation – *argillic* Bt originated as a result of clay illuviation. This clay (*vosepic* plasma), together with iron hydroxide lines up soil voids.

Soil pores in the upper part of Bt (Bt-1) horizon (Fig. 9e, f, g) formerly were filled with coating clay, then they underwent truncation, so in several places it is destroyed and disrupted. Development of permafrost was probably the reason of that destruction. New organisation of plasma indicates plastic redeposition of sediments after decay of permafrost.

In the lower part of the Bt horizon (Bt-2), *vosepic* plasma is developed weaker, and a clay coats the coarse grains of parent material as *skellsepic* plasma (Fig. 9h). Small amount of scattered *latisepic* plasma ("randomly oriented domains packed between silt particles" after Catt 1990) is to be found there. It documents existence of brown soil (cambisol after FAO 1990) originated during the interglacial optimum, under deciduous forest. After the optimum, the process of illuviation started, when mixed forests have formed. At the time of cooling, pseudogley formation often took place. Traces of gley development in similar stratigraphical situation were



described in several loess profiles of Southern Poland (*e.g.* Konecka-Betley, Maruszczak 1976, Konecka-Betley, Straszewska 1977, Konecka-Betley 1994).

In the Yezupil profile, above compact, well preserved, typical *argillic* Bt horizon of the eemian soil, loose Eetg eluvial horizon is present. It is devoid of colloidal fraction by leaching, and has traces of pseudogley formation. It is preserved *in situ*, with admixture of younger loess.

Climatic cooling coming after the Eemian Interglacial usually generates destruction of humus or even truncation of contemporaneous surface and the upper part of the soil, and then, younger loess accumulation. Afterwards, according to vegetation development, first steppe-tundra and then steppe chernozem soil developed. Fossil chernozem usually differs from the recent one by much lower content of organic matter, because of advanced diagenesis and humus mineralization.

In the feebly developed Early Vistulian chernozem soil of Yezupil, humus is weakly decomposed and exists as *mulliskel* or *mullicol* (Fig. 9b, c), while in typical recent chernozem it is in form of *mollic*. In this horizon of Yezupil an increase of coarse quartz particles content and feldspars admixture is seen, which documents eolian accumulation. Small concretions of iron and iron-manganese oxide are common (Fig. 9c) as well as secondary calcite. In some destroyed voids another form of carbonates – lublinite appears (Fig. 9d). Such form was also present in profile from Sandomierz (Konecka-Betley *et al.* 1987). In Yezupil one more kind of plasma existed composed of calcite in form of micrite with clay minerals (*cristic)*. In loess, plasma of randomly orientated clay particles prevails, characteristic for lithogenesis (Fig. 8h, Fig. 9a).

Dubno fossil soil

At the end of the older period of Upper Pleistocene loess sedimentation, vegetation development and pedogenetic processes started, resulting in so called Dubno fossil soil formation. In its A/Bbr horizon humus is present in a form of weakly visible *mullicol* (Fig. 8f). Iron and iron-manganese oxides concretions are common in this horizon. They document wet and cold conditions of the soil development. Beneath, *lattisepic* type plasma prevails with sporadic clay flakes coating the quartz grains. That horizon could be defined as *cambic* horizon Bbr (Fig. 8g), diagnostic for cambisols – brown soils with intensive chemical weathering. This interpretation is confirmed by increase of iron hydroxides ("free iron") in the profile (Fig. 6). It indicates accumulation of free iron without leaching down, characteristic for short

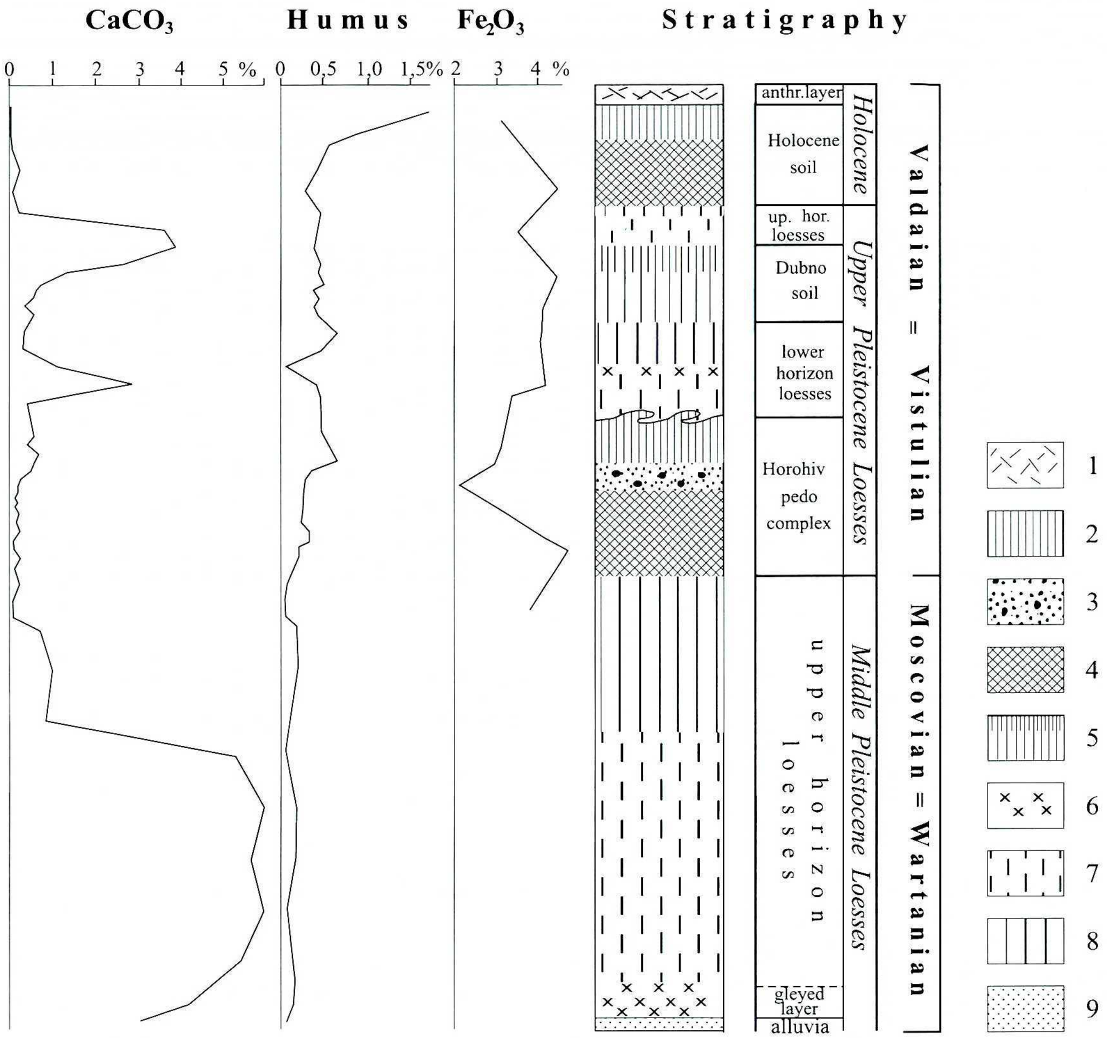


Fig. 5. Loess profile in the Yezupil site. Granulation – grain size distribution; Mz – mean grain diameter; δ_1 – standard deviation; Sk_1 – skewness index; K_G – kurtosis index; $CaCO_3$ – carbonate content; Humus – humus content; Fe_2O_3 – iron oxides content. Stratigraphy – columns show main loess stratigraphic units according to Boguckyj (1987). Signatures: *1* – anthropogenic layer; *2–4* – Holocene and Eemian soils: *2* – A horizon, *3* – E horizon, *4* – B horizon; *5* – interstadial soil; *6* – traces of initial pedogenesis; *7* – carbonate loess; *8* – decalcified loess; *9* – alluvial sands.

lasting pedogenesis, connected with interstadial periods.

The lowest part of the soil is represented by loess with amount of calcium carbonate increasing downwards. Secondary carbonates leached downwards from the overlying sediments occur scarcely in voids (Fig. 8h). In these sediments, being the parent material of the Dubno soil, *argillasepic* plasma, characteristic for lithogenesis, is present (Fig. 8h, Fig. 9a). Lamination of loess, existing on places and marked by clusters of iron compounds, could result from water conditions changes or existence of seasonal ground freezing.

Recent (Holocene) soil

Formation of recent soil started during the Late Vistulian, and lasts over the Holocene. Basing on thin section analysis the soil is found similar to the older part of the Horohiv pedocomplex. It is a luvisol with Bt *argillic* horizon well developed (Fig. 9a, b). *Vosepic*-type plasma coating oval biopores and root channels is common, and sparsely *skallsepic* plasma is present. In partly destroyed A horizon, humus is present in form of well humificated *mullikol* and rare *mulliskel* with fragments of plant tissues. Traces of frost activity are not significant and pores are not disturbed. Secondary carbonates concentrated in a form of micrite in the lowest part of the youngest loess (C_{Ca} horizon) are genetically connected with this soil development. Carbonates fill also the pores, in form of big or small crystals of calcite (Fig. 8c, d, e).

Conclusions

Pedogenic processes in both interglacial-type soils (Eemian and Holocene) are clearly marked. However micromorphological observations indicate higher degree of pedogenesis in the Eemian soil in comparison with the Holocene one. Both of them are luvisols, with well-developed *argillic* Bt horizon and mainly *vosepic*-type of plasma. Characteristic is decalcification of upper parts of the soils. The soil profiles are composed of A – Eet or Eetg – Bt -C - C_{Ca} horizons.

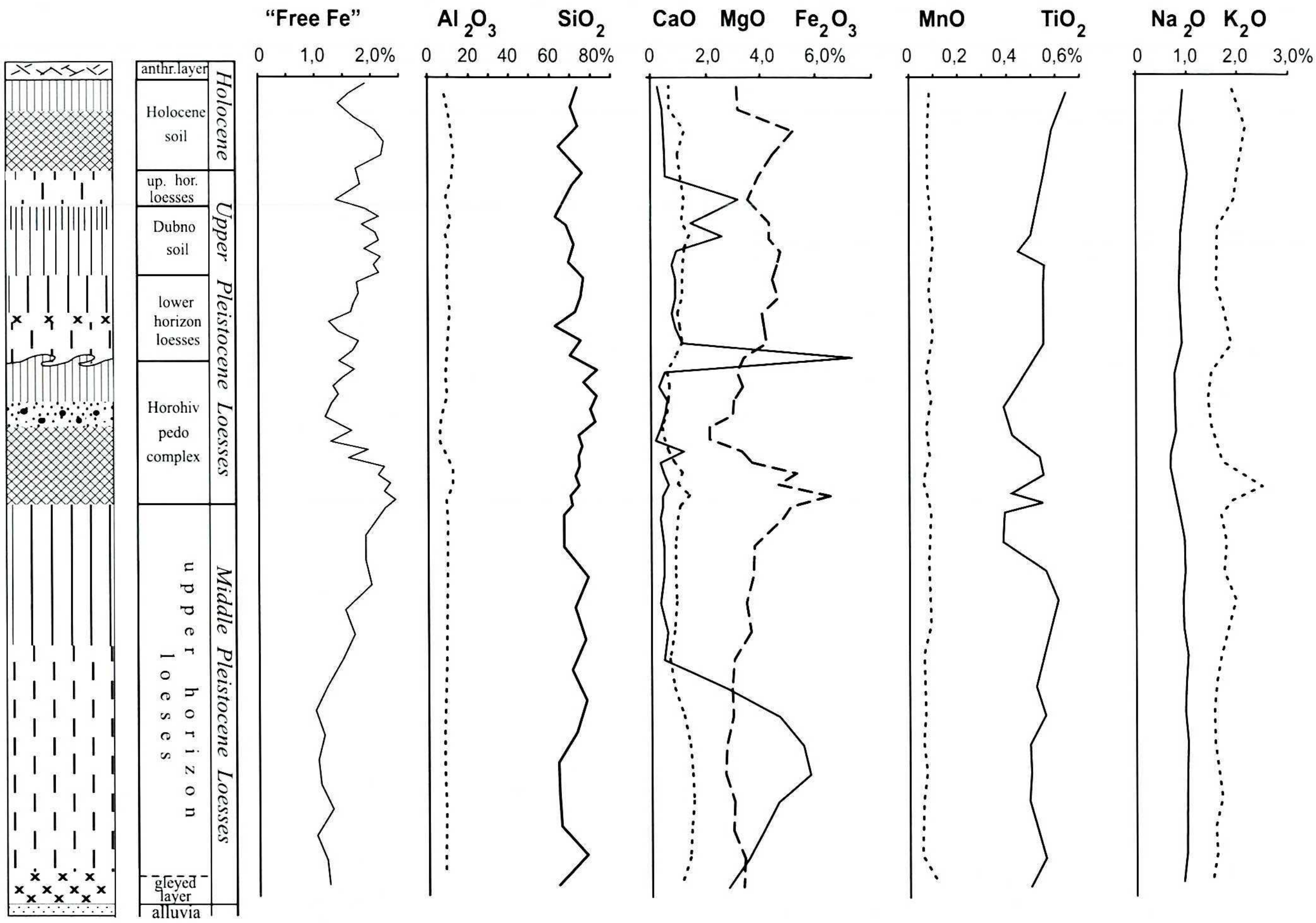


Fig. 6. Distribution of major components (per cent) in the Yezupil profile.

In the Yezupil profile, a very important sign of pedogenesis – *vosepic* plasma is clearly seen. It is created as a result of leaching and transportation of clay material from upper horizons (A, Eet) to *argillic* Bt horizon of luvisol. This clay lines the voids and root channels, part of them being completely colmatated (Fig. 8a, b; Fig. 9e, f, g, h). Such kind of soil develops under coniferous or mixed forest. In soil substratum *skelsepic*-type plasma originates as a result of intrasoil (mainly chemical) weathering of alumosilicates. It surrounds mineral grains or forms "bridges" between grains (Fig. 9h). Such feature is characteristic for brown soils. In illuvial horizon Bbr *cambic* clay appears in form of randomly oriented domains packed between silt particles (*lattisepic* – type plasma), which is characteristic for weakly developed brown soils, originated during interstadials. Such forms are connected with intensive mechanical and chemical weathering (Fig. 8f, g). This process takes place under steppe-tundra or tundra type of vegetation.

As a result of pedogenetic decalcification and intensive secondary accumulation of carbonates, *cristic* plasma comes into being. It fills the pores partly or completely, forming big calcite crystals (Fig. 8c, d, e) or needles of lublinite (Fig. 9d).

PALAEO- AND PETROMAGNETIC RECORD

82 orientated samples for palaeomagnetic studies were taken in 10 cm or 5 cm intervals. The natural remanent magnetization was measured by means of JR-5 spinner magnetometer, and the low-field susceptibility was determined using a KLY-2 susceptibility bridge. Each sample was subject of alternating field demagnetization experiments. Isotermal remanent magnetizations were acquired in the field of 3 Tesla. Results of palaeomagnetic studies are presented in Fig. 10.

All samples revealed only normal polarity directions. Alternating field demagnetization did not show any palaeomagnetic excursion, which might be used for correlation. Plots of volume magnetic susceptibility (K) and isotermal remanent magnetization (IRM) are very similar. Hence, the susceptibility depends mainly on concentration of ferrimagnets. Stratigraphic subdivision of investigated section and correlation with the deep-sea oxygen-isotope stages is based on magnetic susceptibility regarded as a proxy climate indicator (see *e.g.* Evans, Heller 2001). In the studied section several oscillations of magnetic susceptibility are visible. Strong magnetic enhancement can be especially observed in the lower part of the Horohiv pedocomplex. High values of magnetic susceptibility (up to 500 x 10^{-6} SI) indicate significant warming of interglacial type, responsible for high input of pedogenic ferrimagnets. Therefore, correlation of this part of the section with the Eemian oxygen stage 5e is very probable. Moderate values of magnetic susceptibility (up to 283 x 10^{-6} SI) with several minor oscillations are observed in the part of section containing the Dubno soil. These oscillations can be

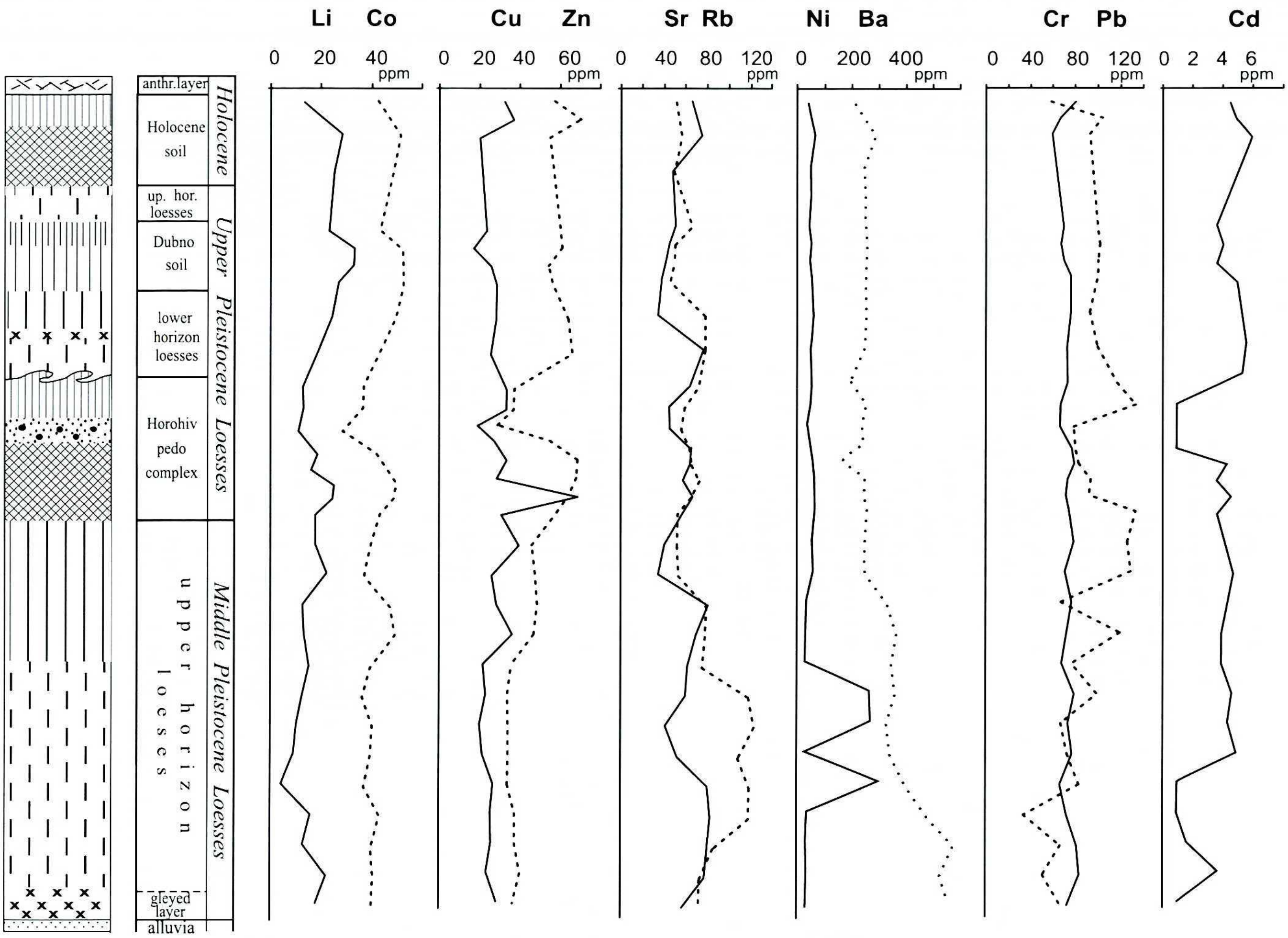


Fig. 7. Distribution of trace elements (ppm) in the Yezupil profile.

related to minor climatic changes that occurred during oxygen isotope stages 2 and 3. The magnetic susceptibility and inclination/declination curves from Yezupil show very good correlation with those obtained earlier for the sections from Bojanice in Ukraine and Obrowiec in Poland (see Nawrocki *et al.* 1999).

An attempt of geomagnetic palaeointensity reconstruction was not successful. There is a negative correlation between the RM/IRM and the intensity decay (after AF demagnetization in the field of 23 mT). This indicates that the RM/IRM ratio reflects changes of magnetite grain size as well. In order to reconstruct real changes of relative geomagnetic paleointensity, the RM/IRM curve should be additionally normalised.

ARCHAEOLOGICAL MATERIALS

Three Palaeolithic cultural layers were found in the Yezupil site. The oldest one, Middle Palaeolithic III is connected with the Eetg horizon of the Horohiv pedocomplex. It is worth to note that the preserved part of paleosol, the older one in the pedocomplex, is only slightly disturbed and artefacts are not vertically scattered there, so this cultural layer 15–20 cm thick is characterised by an exceptionally clear stratigraphical position.

The artefacts of the second Middle Palaeolithic cultural layer II were found in the uppermost part of the Horohiv pedocomplex, deformed by solifluction together with loess that covered it. Few Upper Palaeolithic artefacts forming cultural layer I were found in the Dubno fossil soil.

Cultural layer III

The cultural layer III is placed in the Eetg horizon of the Horohiv soil complex (Mezin/Eem Interglacial). The excavation covers 110 square meters. Within this area, in a layer 10–20 cm thick, 403 flint artefacts were found, along with several washed-out spots of charcoal and ash lenses. As animals' remain, only one fragment of bovid horn with traces of cuts made with a flint tool can be mentioned.

Planigraphy shows that the cultural remains occur irregularly. They were concentrated in the southeastern corner of the trench (closer to the river), around the relics of a fireplace of a diameter of 1 m. Traces of fire remain as oval, 1–2 cm thick spots of loess containing ash, charcoal and burned animal bones.

Majority of flint artefacts was placed around the fireplace, however no defined pattern of their placement can be found. A relatively small number of chips (despite washing the excavated material) confirms that the site has not been a

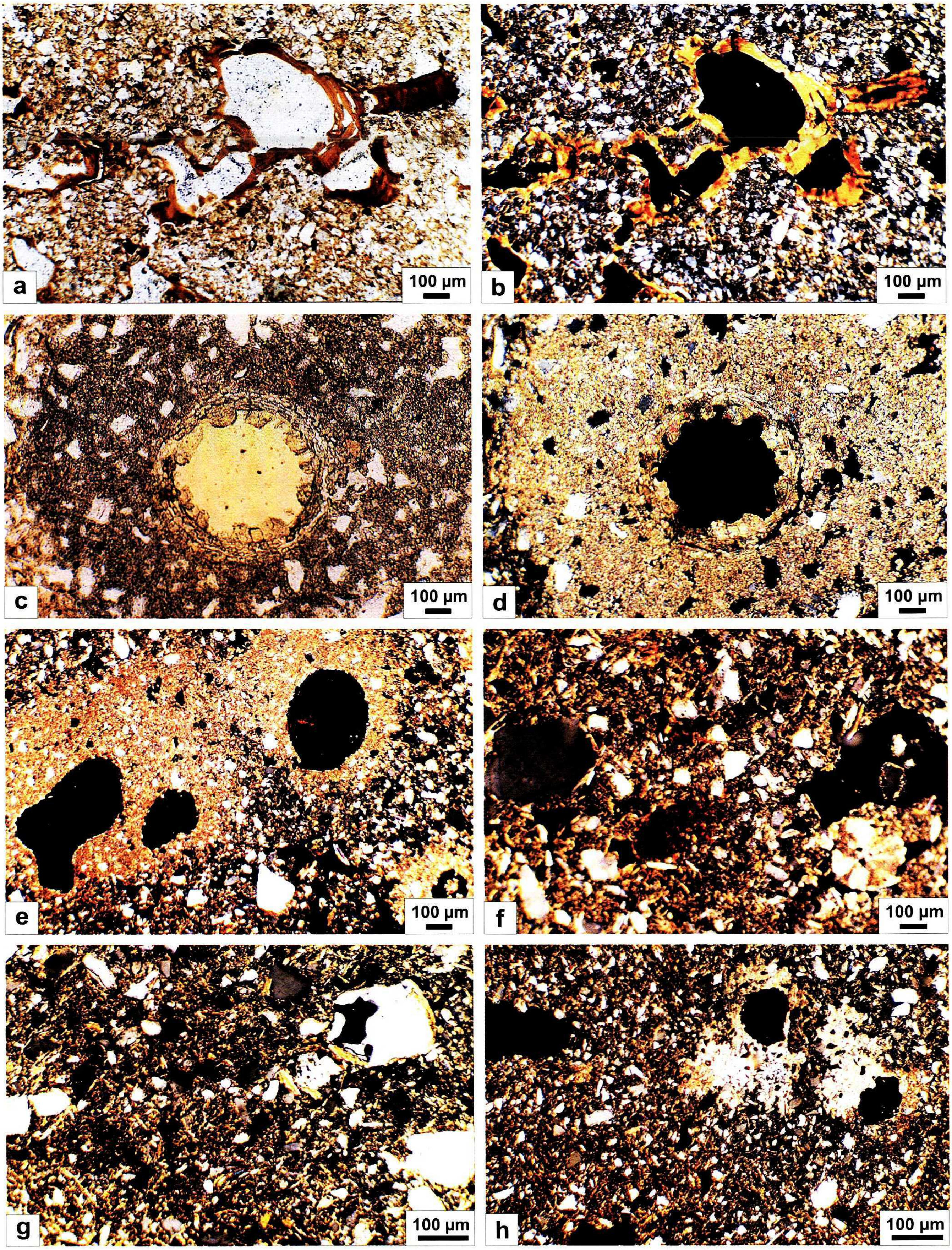


Fig. 8. Photographs of thin sections illustrating the micromorphology of fossil soils in the Yezupil site: **a**, **b** – Bt horizon of the Holocene soil, **c**, **d**, **e** – C_{Ca} horizon of the Holocene soil, **f** – A/Bbr horizon of the Dubno fossil soil, **g** – Bbr horizon of the Dubno fossil soil, **h** – C horizon of the Dubno fossil soil (b, d, e, f, g, h – crossed polarizers).

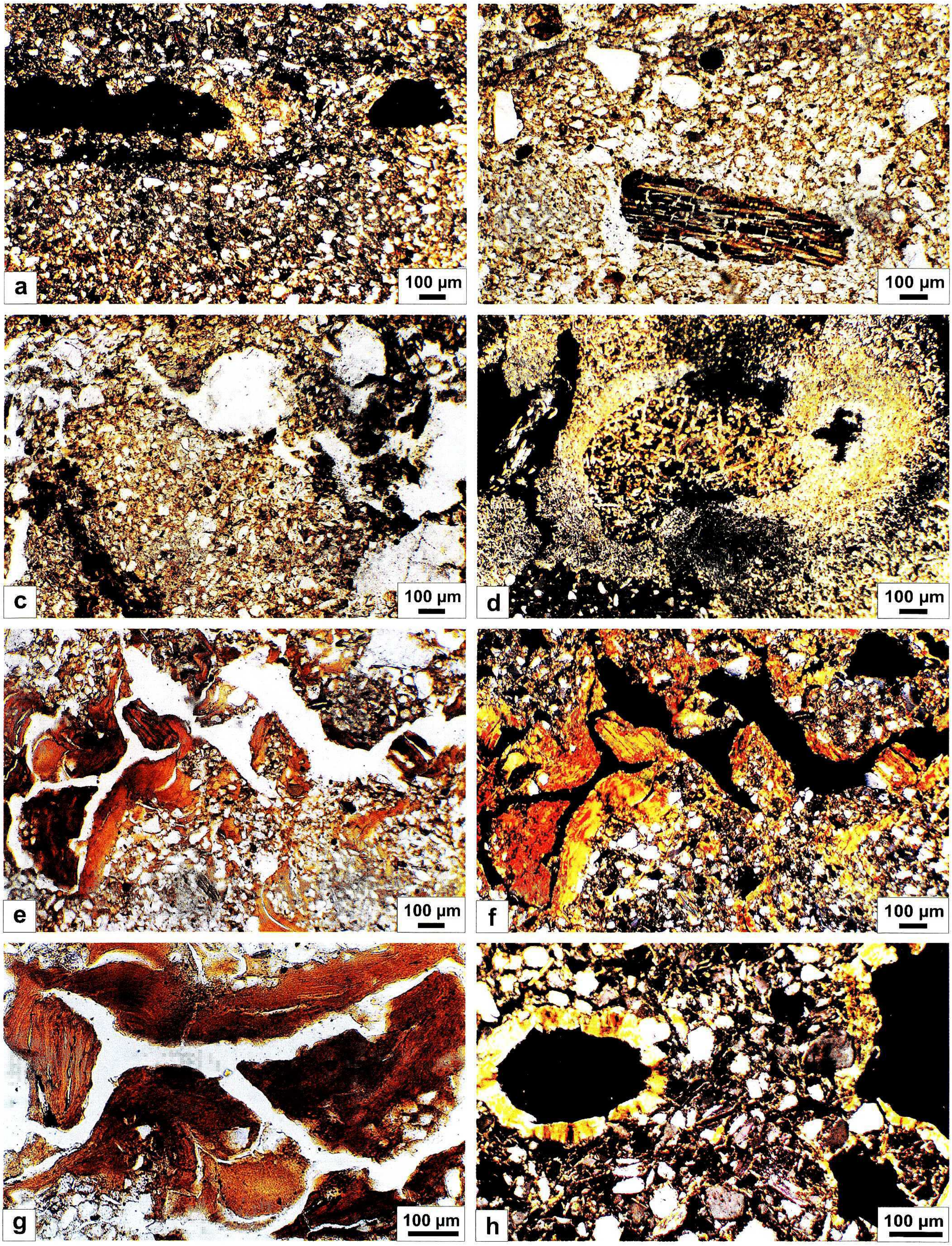


Fig. 9. Photographs of thin sections illustrating the micromorphology of fossil soils in the Yezupil site: **a** – C horizon of the Dubno fossil soil, **b**, **c**, **d** – A horizon of the Horohiv chernozem, **e**, **f**, **g**, **h** – Bt horizon of the Horohiv luvisol (a, d, f, h – crossed polarizers).

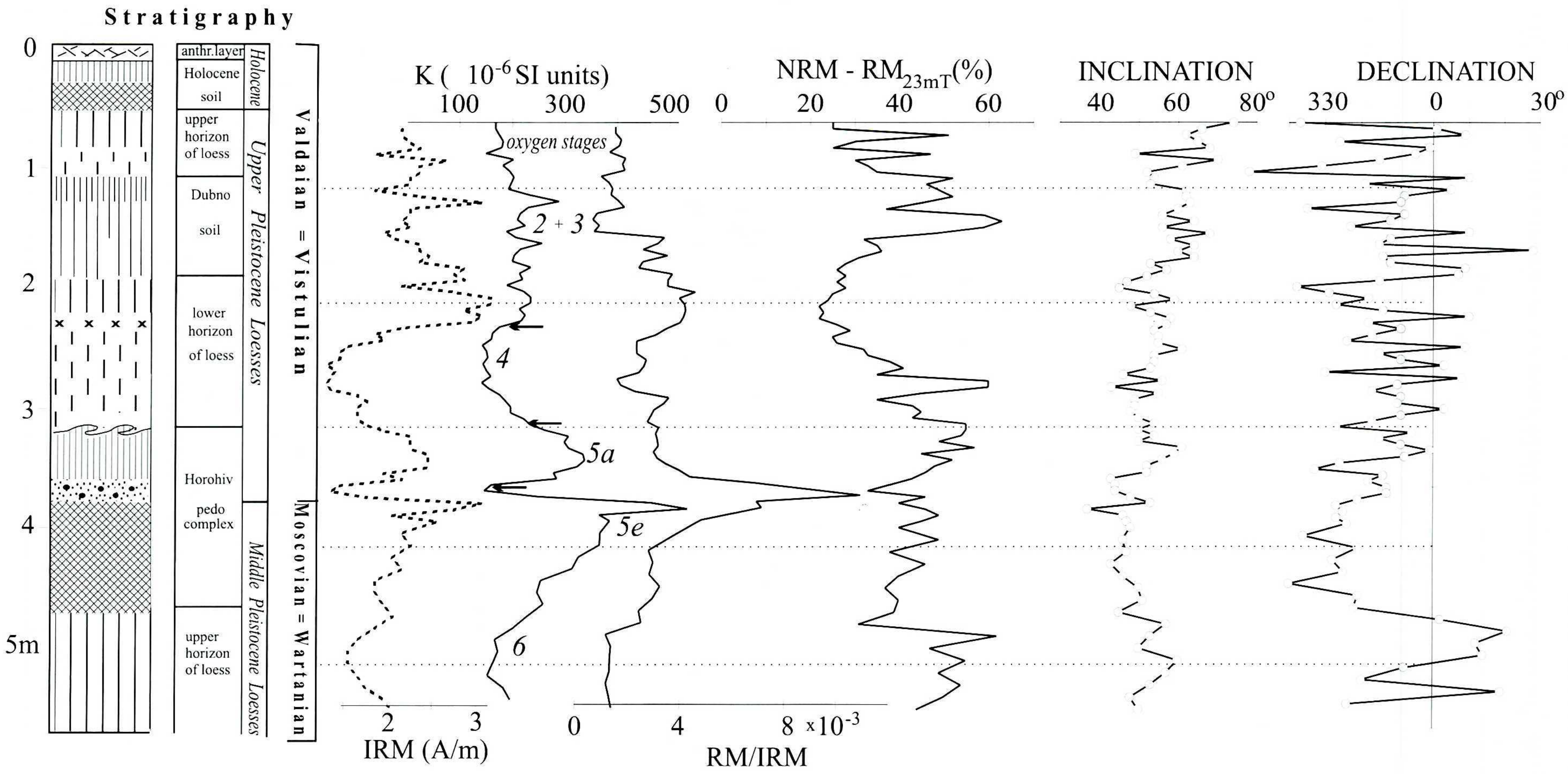


Fig. 10. Palaeomagnetic records of the Yezupil profile. IRM – intensity of isothermal remament magnetization acquired in 3 T, K – low-field magnetic susceptibility, RM – natural remanent magnetization after demagnetization in 23 mT, NRM – natural remanent magnetization, D, I – declination and inclination after demagnetization in 23 mT. Susceptibility curve was subdivided into segments related to the oxygen-isotope stages.

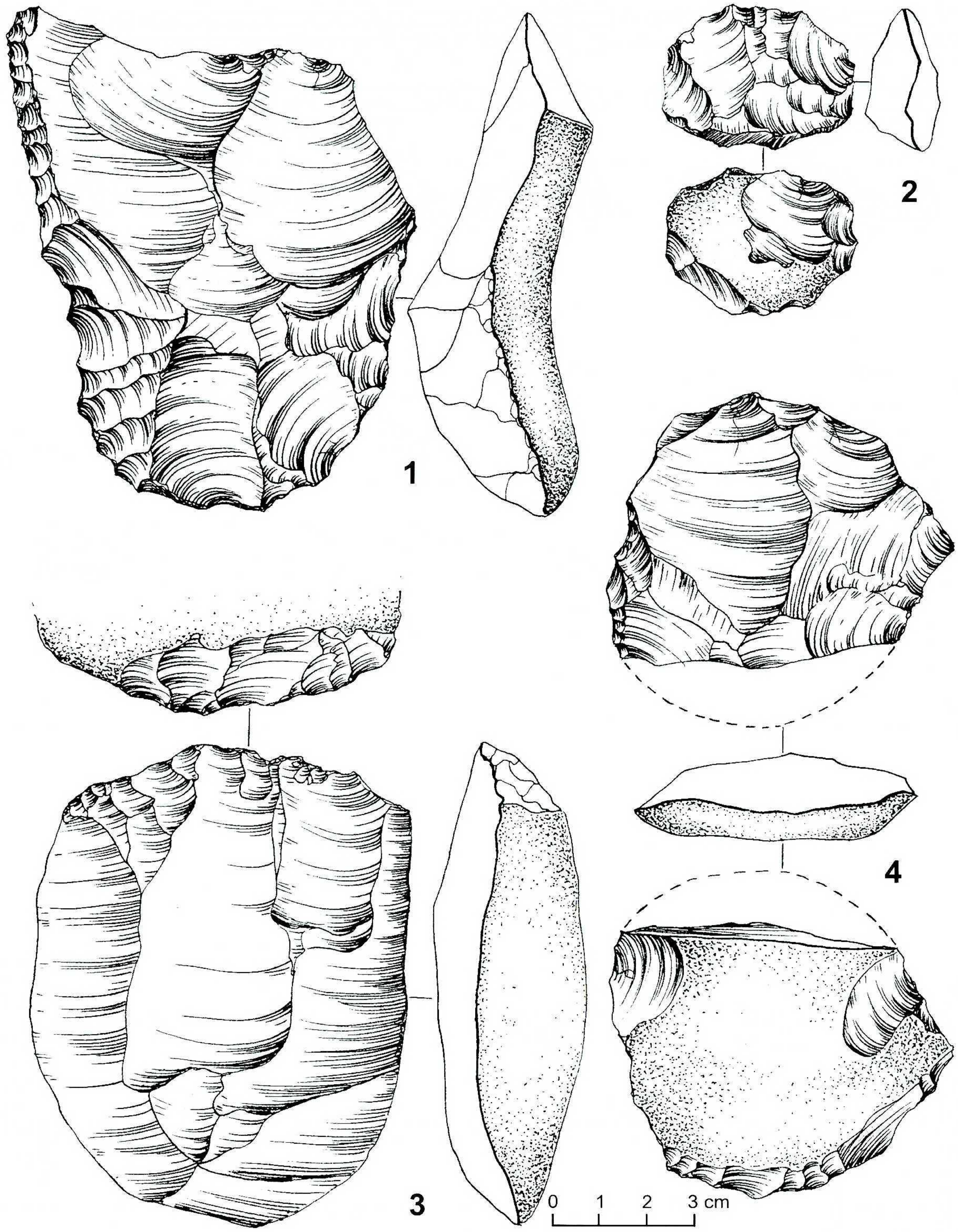


Fig. 11. Cores from the cultural layer III at the Yezupil site.

flint workshop. One can assume that the flint material found at the site had been prepared in the vicinity, probably on the upper part of the slope above the central part of the settlement.

Such a hypothesis is also supported by the structure of the assemblage source material. It consists mainly (90%) of a high-quality local Upper Cretaceous flint, which occurs in the Upper Dnister area in outcrops at the valley banks. This is the material most of the Levalloisian forms and tools are made of. All the cores, chips and waste are also of this flint. About 8% of implements (points, knives and scrapers) are made of greenish-gray, fine-grain, Carpathian sandstone. These tools were probably made somewhere in the vicinity, as no waste fragments of sandstone were found on the site.

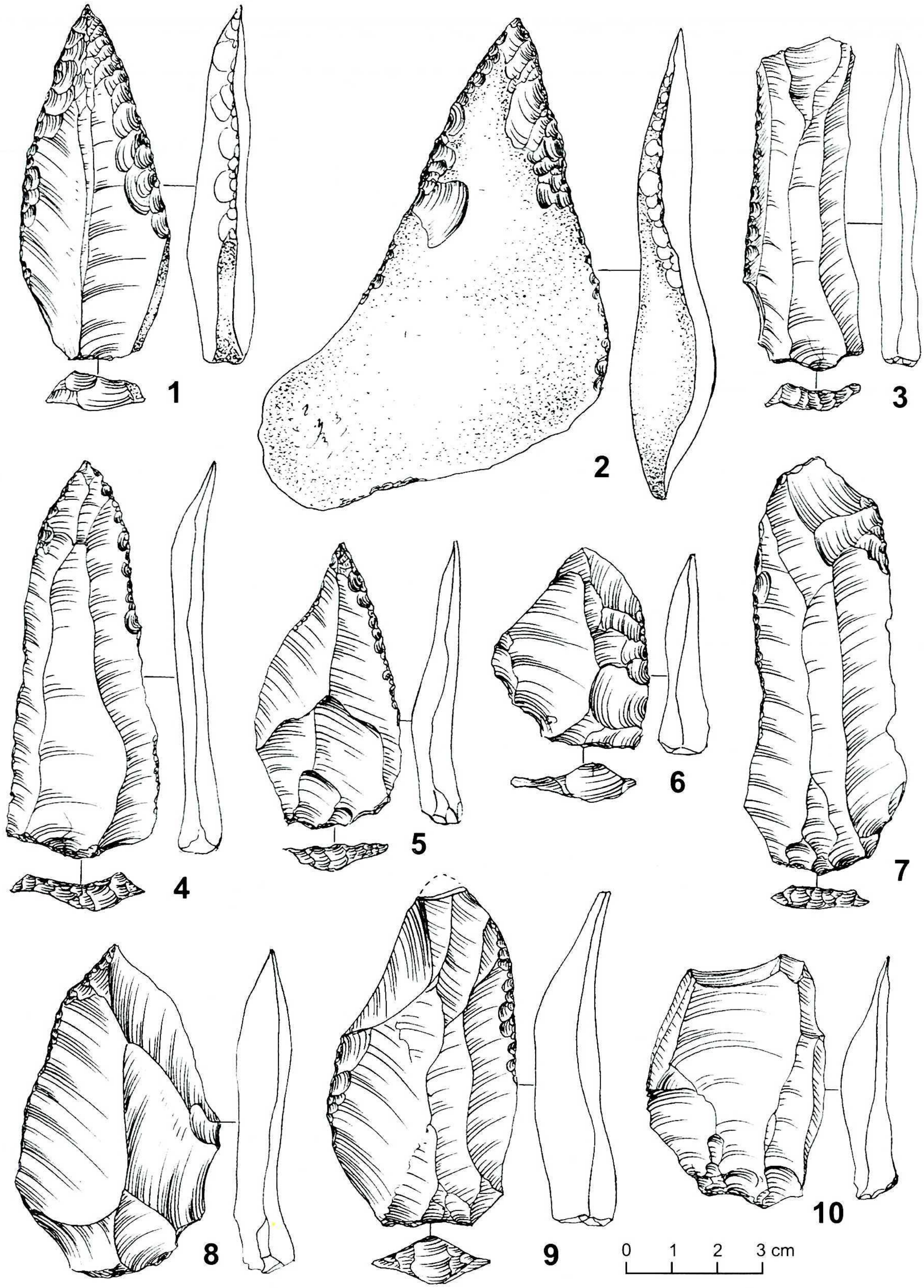


Fig. 12. Flint implements from the cultural layer III at the Yezupil site.

The remaining 2% of raw stone material consist of alluvial, Dnister pebbles, used as hammerstones.

The flint objects are exceptionally well preserved. They bear no patina and have sharp edges. Traces of intentional strokes, as well as special actions like truncation and fine retouch, can be easily identified. Most likely, sedimentation over the discussed objects was rapid. The cultural stratum is undisturbed. It is confirmed by the traces of the fireplace, the presence of large number of small artefacts and concentration of the implements around the mentioned fireplace.

The structure of artefacts assemblage (403 specimens) consists of pre-cores (2 specimens), cores (10), exploited micro-cores (3 – Fig.11: 2), retouched tools (63), Levallois flakes (32), blades (65), regular flakes (113), undefined trimmers (6) and chips (109).

Among different types of cores, an example of one-side, parallel core, Levalloisian in type, with convex striking platform was found (Fig. 11: 3). A second, similar one differs from the former with presence of two striking platforms (Fig. 11: 1). Negatives of typical Levallois flakes can be seen on it. Oval Levallois cores are typical for the industry of cultural layer III (Fig. 11: 3, 4). Such differentiation of cores points to use of several methods of flint artefacts production (Boëda, Genste, Meigen 1990).

Among 63 tools, the following categories can be distinguished: Levalloisian points – 11, Mousterian points – 4, scrapers – 5, knives – 29, niche tool – 1. The points are most characteristic artefacts for the assemblage, these are the Mousterian points (Fig. 12: 1; Fig. 13: 1, 4), atypical Mousterian points (Fig.12: 2) and Levalloisian ones (Fig. 12: 4, 5, 8; Fig. 13: 6, 8). Scrapers (Fig. 12: 6, 9; Fig. 13: 3, 7) are prepared from blades, two of them are made from Carpathian sandstone (Fig. 13: 3, 7). Knives are the most numerous group, they can be divided into two sub-groups: 16 specimens are backed (Fig.12: 3; Fig. 13: 2, 5) and 13 without a back. They are formed on flakes or blades (Fig. 12: 3, 7).

Flake tools constitute about 40% of all retouched forms, blade ones – about 50%, and 10% are made from raw fragments of stone. Typological structure of tools inventory is as follows: points – 26%, scrapers –12%, knives – 47%, other tools – 15%.

The general picture of the assemblage proves to be macrolithical, one-sided, Levalloisian, blade, facetted, with knives and points prevailing and smaller percentage of scrapers.

Parallels can be found among the classical Levalloisian assemblages such as these from Molodova I and V (Černyš 1965, 1982, 1987, Ivanova 1982), partially Kietrosy (Anisjutkin 1981), and Proniatyn (Sytnyk 1985, 1992, 1994, 2000, Stepančuk, Sytnyk 1999). However it should be mentioned that the Levalloisian blade elements of the artefacts including also Mousterian and Charentian features, pushes the Yezupil assemblage towards classical assemblages from Northern France (Boëda, Genste, Meigen 1990). Among the Levallois-Mousterian sites from Poland partial analogies in the area of primary processing of the material can be found in assemblages from Zwierzyniec I point P (Chmielewski 1975) and Sowiniec I (Kozłowski J.K., Kozłowski S.K. 1977). These materials are also dated to the Eemian interglacial. Similar industry can be found also in the collection of artefacts of the A horizon from Königsaue in Germany (Mania, Toepfer 1973, taf. 18, 19). Levalloisian technique of a parallel-convergent variant is clearly visible there. However it includes also two-sided forms, Levalloisian and Mousterian points and other types of tools like for instance knives.

It is certain that such comparisons must be treated as conventional ones. They do not fully reflect all the technical and typological features of particular assemblages. They show, however, possible cultural links between the Dnister and Central European stone industries.

Cultural layer II

The cultural layer II is situated in the accumulation horizon of the upper soil of the Horohiv soil complex. It is partially disturbed by solifluction, together with the lower part of the loess lying above. Archaeological material was found about 1 m above the former cultural stratum III. The excavated surface of this horizon is smaller – 60 square meters. Vertical distribution is about 20 cm. 107 flint objects were recorded here.

In the southern part of the excavation a flint workshop is recorded. Washing of the excavated sediments revealed concentration of dozens of small chips and undetermined forms – typical remains of a "local" flint production. The materials used are Upper Cretaceous flints, the same as in the lower layer, and no other kind of raw stone material have been discovered apart of alluvial pebbles.

The set of flint artefacts consists of: raw pre-cores (2), cores (1), core remains (3), retouched tools (7), blades (6), flakes (51), small flakes (34), natural pieces of sandstone (3).

The only core is of a typical discoid form. However the whole assemblage is of a non-Levalloisian character – only single flakes can be defined as such.

Blades are morphologically prolonged flakes. Flakes present a group of typical production waste, either thick or thin, of a bent profile, in majority partially with cortex.

A crescent-shaped bifacial knife (9.0 x 5.7 x 2.0 cm) made from dark Cretaceous flint is a very interesting form (Fig. 14: 1). It is probably made of a massive flake and has traces of cortex and faceted striking platform. The tool has been formed from both sides, with wide and small strokes, which can be defined as scale, sharpening retouch. The strokes converging in the upper part create a penetrative point. The tool can be classified as a "knife of a Central European type" (Grigor'ev 1990, pp. 97, 102), or as a Micoquian knife "Suchaja Meczetka type" (Kulakowskaja *et al.* 1994). In Poland similar knives are described from Wylotne Rock Shelter as belonging the Micoquo-Prondnikian Culture (Chmielewski 1969).

Unfinished bifacial tools seem to be an important find (Fig. 14: 2–5). One of them is a fragment of a Micoquian knife (Fig. 14: 3), the other one is a two-sided, subtriangular tool made of a massive flake (Fig. 14: 4). Another triangular specimen bears traces of small splits on the upper side that can be interpreted either as actions forming a two-sided tool or as exploitation of a core.

Considering the investigated materials, the cultural layer II can be defined as non-Levalloisian, non-blade, non-facetted, bifacial and macrolithic, with links to the Micoquian technology.

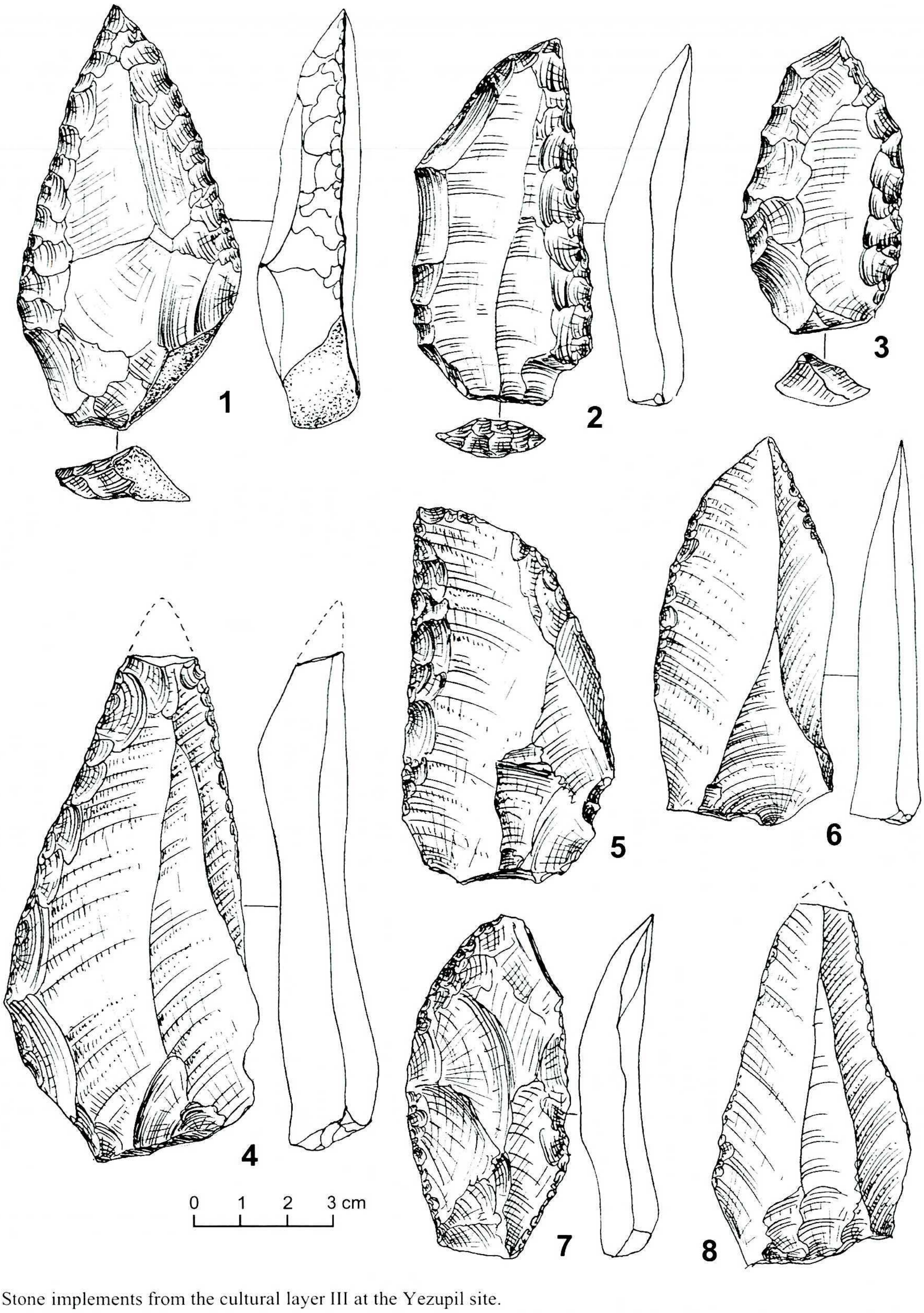


Fig. 13. Stone implements from the cultural layer III at the Yezupil site.

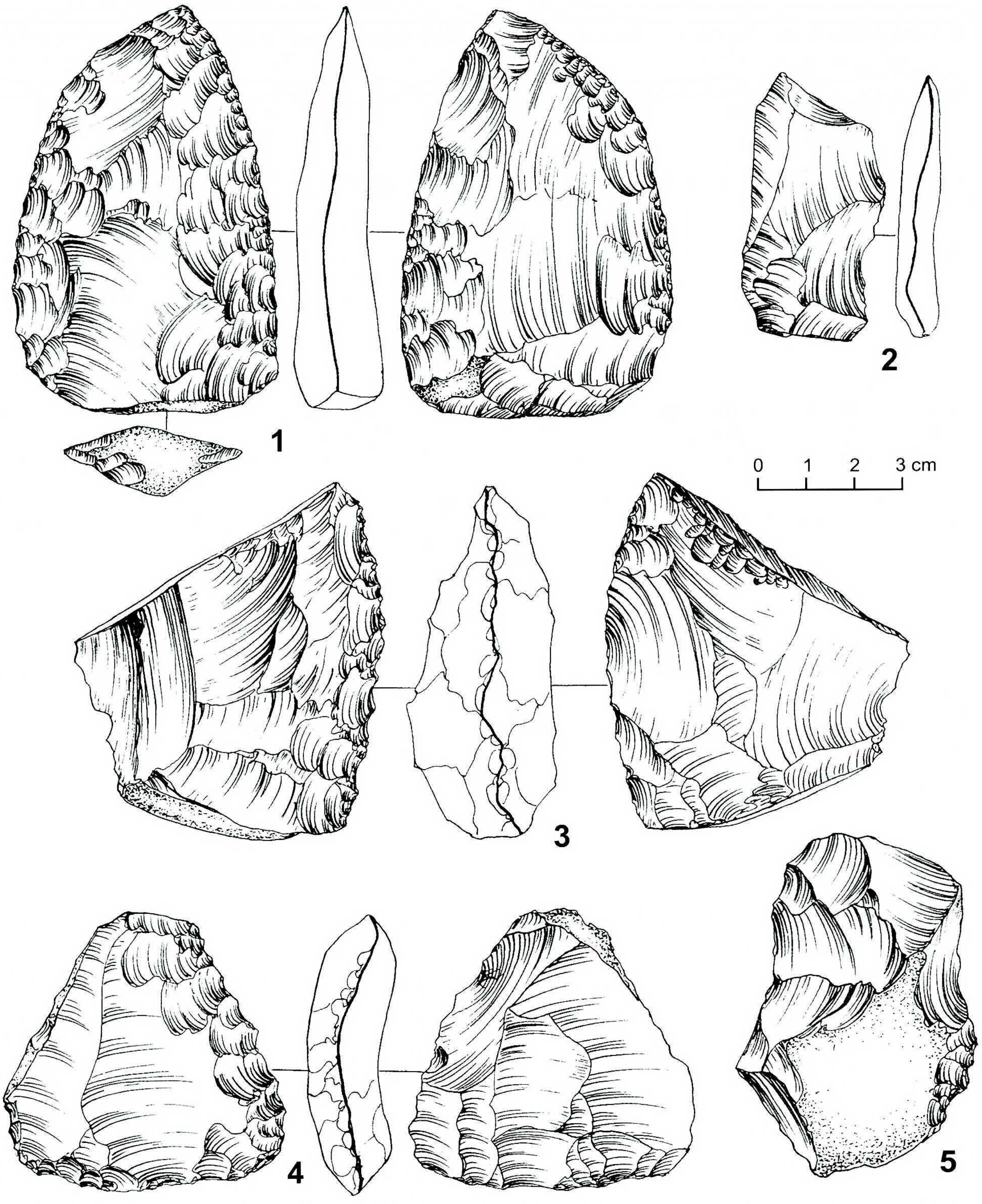


Fig. 14. Flint implements from the cultural layer II at the Yezupil site.

Cultural layer I

Cultural layer I is located in the Dubno fossil soil at the depth of 200–270 cm. One should note that only a surface of 20 square meters was explored (three times smaller than for the cultural stratum II). It was caused by the presence of a steep slope in the upper part of the explored area (level of the cultural stratum I) and a gentle slope in the lower part (strata II and III).

Only five artefacts were found during the 1999 field survey (and one retouched form in 1998). In 1998 also a large rib fragment, probably of an eastern reindeer was found. Three blades discovered in 1999 were clearly of Upper Palaeolithic character.

DISCUSSION AND CONCLUSIONS

The sequence of Yezupil contains loess with palaeosols series lying on the Dnister River alluvia. The Horohiv pedocomplex developed on the Wartanian loess. It is composed of two main fossil soils, the older one corresponding to the Eemian Interglacial and the younger – to Early Vistulian interstadials. Middle Vistulian (Interplenivistulian) Dubno fossil soil divides the Upper Pleistocene loess series into two parts corresponding to Lower and Upper Pleniglacial. Lithological and palaeopedological analysis allows making diagnosis of stratigraphical situation of two different Middle Palaeolithic cultures and one Upper Palaeolithic assemblage found at the site.

From the stratigraphical point of view the Yezupil profile have analogies in several Upper Pleistocene loess profiles in Volyn and Podillja studied by Boguckyj (1986, 1987). The Horohiv pedocomplex corresponds well to the Mezin pedocomplex distinguished in the central part of East-European Plain (Veličko 1973, 1990) as well as to similar soils in many profiles in Poland (Maruszczak 1994, 2001). Clear correlation is possible also with West European profiles (*e.g.* Haesaerts *et al.* 1999). Composition of Eemian Interglacial soil with Early Vistulian interstadial or interstadials ones is very common, though typological differentiation of particular soils is important according to geographical situation (Catt 1990, 1991, Kemp 2001, Veličko, Morozova 1982, 1987).

No dating has been made for the Yezupil site till now, but some information existed thanks to analogies with other neighboring Podillian profiles which were dated. These dates range from about 140 ka in the lower soil, to 80 ka in the upper one. It means that the Wartanian loess was a substratum of the Horohiv pedocomplex and that the Upper Pleistocene loess deposited in places, was a parent material for the younger soil. Some TL and radiocarbon dates for charcoals from the Dubno fossil soil (28–29 ka) point that this soil originated in younger part of the Interplenivistulian. The shape of magnetic susceptibility curve enables correlation of the profile with the oxygen isotopic stages (Fig. 15).

Flint artefacts of the oldest cultural layer (III) were found in the Eetg horizon of luvisol – the older part of the Horohiv pedocomplex. Palaeolithic people left them on the contemporaneous surface. Micromorphological analysis documented two stages of the soil development. The older one – cambisol type originated under deciduous forest during the interglacial optimum. In the younger one – the illuviation processes transformed that cambisol into luvisol at the time of mixed or coniferous forest development, *i.e.* during the post-optimum period of the interglacial. The A horizon of that soil is not recognizable now because of humus mineralization and oxydation. Destruction of upper portions of the soil (*i.e.* of accumulation horizon and partly Eetg horizon) was also probable, as the result of deflation. It could be supposed that fine sediments were blown away with wind, while flint artefacts have remained on place. However, occurrence of fine charcoal and ash at original fireplaces makes the first possibility more probable.

In both situations it is clear that Middle Palaeolithic people of the Mousterian culture with Levalloisian technique of

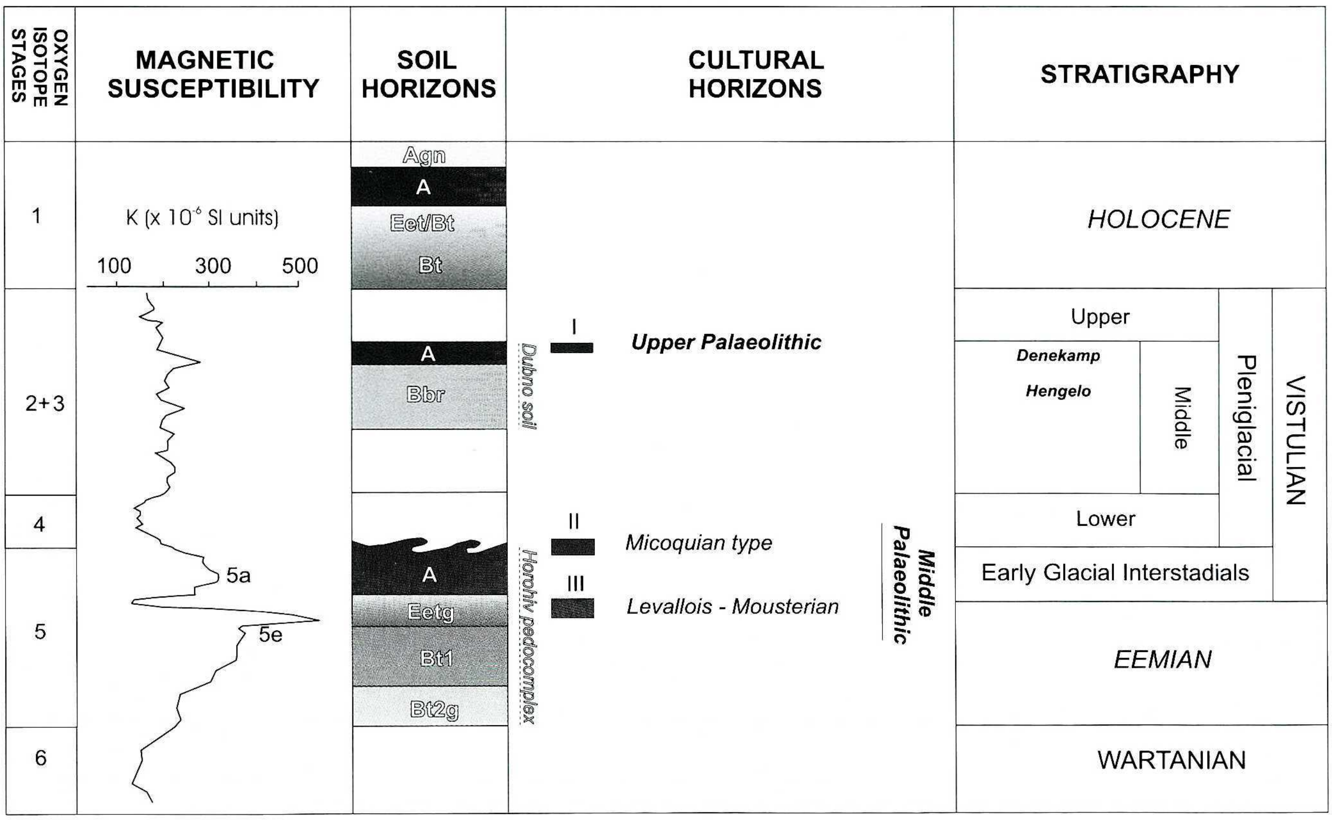


Fig. 15. Pedostratigraphy, palaeolithic cultures and magnetic susceptibility of the Yezupil section correlated with oxygen-isotope stages.

implements production, were living in the Halič region in forest environment of the last interglacial.

The artefacts assemblage of cultural layer II typologically differs from that of layer III. It is characteristic by presence of bifacial forms of Micoquian character. The cultural layer is situated in solifluction layer that has gathered upper part of the younger, chernozem component of the Horohiv pedocomplex. The upper part of the chernozem and the lowest part of loess were transformed by solifluction together with the cultural layer. It proves that Middle Palaeolithic people employing bifacial tools were living in this region during Early Vistulian interstadials. At that time, continental steppe or dry tundra-steppe was the most characteristic environment in the region.

Poor Upper Palaeolithic assemblage was found in Dubno fossil soil that originated in cold and humid conditions in wet tundra or steppe-tundra environment (Bezus'ko *et al.* 1989).

Stratigraphical position of both the Middle Palaeolithic assemblages corresponds to the position of cultures of similar tradition in Poland (Chmielewski 1969, 1975, Kozłowski, Kozłowski 1977, Madeyska, Cyrek in press, Madeyska 2001, in press). The Mousterian cultures with Levalloisian technique are dated there mainly at the Eemian interglacial and at the beginning of the Vistulian. The Micoquo-Prondnikian assemblages, with characteristic bifacial implements are younger. They developed at Early Vistulian till the beginning of the younger loess accumulation.

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