GEOMORPHIC PROCESSES AND GEOARCHAEOLOGY
From Landscape Archaeology to Archaeotourism

International conference
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GEOARCHAEOLOGICAL ISSUES OF THE UPPER DNIEPER – WESTERN DVINA RIVER REGION (WESTERN RUSSIA): FIELDTRIP GUIDE

Moscow-Smolensk, Russia

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ISBN 978-5- 91412-130-2

Geoarchaeological issues of the Upper Dnieper – Western Dvina river region (Western Russia): fieldtrip guide.

This is the guide of two field excursions that were held during the International conference "Geomorphic Processes and Geoarchaeology: from Landscape Archaeology to Archaeotourism" (Moscow-Smolensk, Russia, August 20-24, 2012) hosted by the Smolensk University for Humanities. Excursion to the Gnezdovo archaeological complex in the Dnieper River valley in the vicinity of the Smolensk city was managed by the cooperative team from Moscow University (Faculty of History and Faculty of Geography), State Historical Museum (Moscow) and Institute of Geography, Russian Academy of Sciences (Moscow). Excursion to the Serteya complex in the Western Dvina River region was conducted by the State Hermitage Museum (Saint Petersburg).

Moscow-Smolensk. “Universum”. 2012. 105 p.

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GNEZDOVO ARCHAEOLOGICAL COMPLEX IN THE UPPER DNIEPER RIVER VALLEY

CHAPTER 1.1.
GNEZDOVO ARCHAEOLOGICAL COMPLEX: HISTORY OF RESEARCH AND GENERAL CHARACTERISTIC

The Gnezdovo complex of the archaeological monuments

The Gnezdovo complex of archaeological monuments is a unique cultural landscape dated to the time of the formation of the Ancient Rus'. It covers an area of 207.4 hectares (about 5300 acres). Gnezdovo has the largest early medieval cemetery known today in Europe, with an extent of studied sites greater than such well-known Viking-period sites such as Birka in Sweden and Hedeby in northern Germany. In terms of its original scale and scientific significance, the Gnezdovo complex could be compared to ancient centres such as Kiev on the Middle Dnepr or Great Novgorod in northern-western Russia. Just as the latter sites, Gnezdovo reflects the process of formation of the Ancient Rus' state, people and culture.

The population of ancient Gnezdovo was formed by the members of different ethnic groups: Slavs, being incomers from Central Europe and the Middle Dnepr region; the next incomers from Northern Europe and local tribes "Krivichy" .The archaeological finds reflecting all features of the site of Gnezdovo are in the State Historical Museum in Moscow, the State Hermitage in St. Petersburg, and the Smolensk State Museum. Evidence and results of the archaeological studies of Gnezdovo have been presented in numerous scholarly and popular publications.

A brief history of the fieldwork

The first information on the archaeological monuments near Gnezdovo village dates from 1867 and relates to the accidental finds of the Xth century hoard of silver ornaments discovered during railway construction. The scholarly studies of Gnezdovo burial mounds were initiated by the President of the Moscow Archaeological Society, A.S. Uvarov. The archaeological excavations of the mounds were first carried out by M.F. Kustsinsky in 1874, and continued by the Scientific Secretary of the Russian Historical Museum, V.I. Sizov, from 1881 to 1901. It is difficult to estimate the exact number of mounds studied in the course of this fieldwork; by some estimates, there were about 400.

In 1898-1901, some excavations were carried out by C.I. Sergeev and sponsored by the Imperial Archaeological Commission, but those works had a rescue character made necessary by the widening of the railway embankment. At the end of the XIXth century and during the first decades of the XXth century, some local excavations were undertaken by S.P. Pisarev (Smolensk), G. Boguslavsky, V.A. Gorodtsov and E.N. Kletnova. In 1905 excavations of some burial mounds and of the Ol'shanskoye hillfort were carried out by I.S. Abramov (Russian Geographical Society). The first detailed description of the entire Gnezdovo archaeological complex was presented in 1923 by A.N. Lyavdansky who discovered the contemporary Central and Ol'shanskoye settlements located on the first terrace above the flood plain of the river Dnepr.

From 1949, complex studies of the Gnezdovo site are been carried out by the Smolensk archaeological expedition of the Moscow State University Lomonosov by

name which began under the directorship of D.A. Avdusin. In the years 1949-2012, about 700 burial mounds were excavated and complex studies were undertaken at the Central and Ol'shanskoye settlements. In order to trace the extent of the Central settlement cultural layer, trial excavations were carried out in 1995-96 in the area of the Dneper flood plain on the left bank of the river Svinets. These resulted in the discovery of cultural layers of the Ancient Rus' period at these new sites.

In 1967-1968, the Dnepr archaeological expedition headed by I.I. Lyapushkin studied the terrace part of a settlement on the right bank of the river Svinets. Since 1995, the Central settlement has been studied by the State Historical Museum expedition, with a particular focus on the flood plain zone.

A combined Smolensk archaeological expedition headed by T.A. Pushkina (Moscow State University) and V.V. Murasheva (State Historical Museum) has carried out complex fieldwork on the Gnezdovo site since 1998 in association with experts from the Institute of Geography (Russian Academy of Science) and the Geographical and Pedological Faculties of Moscow State University which had started work here in 1995.

As of today, some 1200 mounds in different parts of the ancient cemetery have been excavated and studied as well as nearly 7000 m² of settlement areas.

The main archaeological sites

The archaeological complex of Gnezdovo includes numerous sites with traces of various economic and manufacturing activities, defences of the central hillfort in a form of rampart and ditch, and a series of large mounds. These mounds are located in a semicircle around the central settlement and are concentrated in several groups to the east, west, north of the settlement on the right bank of the river Dnepr and to the south of it on the left bank.

The main, and most intensively studied, group of archaeological sites is situated on the right bank of the river Dnepr, near the confluence of the small river Svinets (Fig. 1.1). It is comprised of several groups.

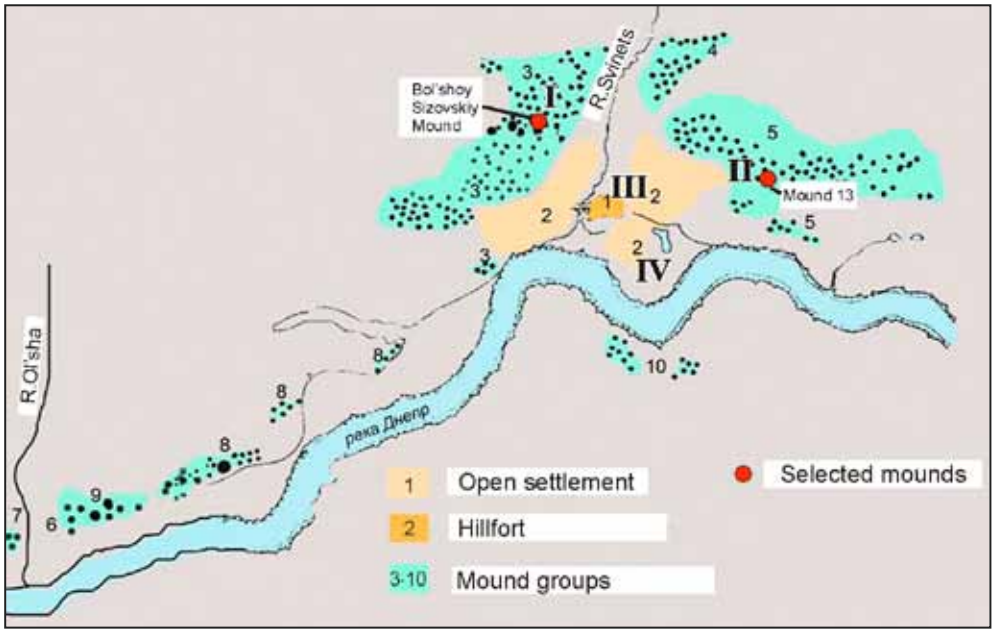

Figure 1. Location map.
Arabic numerals are mound groups; roman numerals are stops of the field excursion

(see Chapter 1.3).

The first (central) group consists of the Central hillfort and the open settlement (Fig. 1.1, *1-2*), the latter being located on both banks of the river Svinets banks at its confluence with the Dnepr. This group includes also the Central mound group (Fig. 1.1, *3*), the Glushchenkovskaya mound group (Fig. 1.1, *4*) and the Lesnaya mound group (Fig. 1.1, *5*). These groups enclose the settlement on the north-west, the north, north-east and the east.

The second (western) group of monuments is also limited to the right bank of the Dnepr but is further downstream. It consists of the Ol'shanskoye hillfort (Fig. 1.1, *6*) located at the promontory of the river Ol'shanka, and the Dnepr mound group (Fig. 1.1, *8*), the latter located nearly half way between the Ol'shanskoye hillfort and the central settlement. On the right bank of the Ol'shanka river, further downstream the Dnepr, another two mound groups are known within the western group. Those are the Transol'shanskaya group (Fig. 1.1, *9*) and the small Nivlenskaya group (Fig. 1.1, *10*). Close to the Ol'shanskoye settlement, there existed the Ol'shanskaya mound group, but it was destroyed in 1975 in the process of road building.

The third (southern) group of monuments consists of a number of mounds located on the left bank of the river Dnepr bank, above the confluence with the river Svinets (Fig. 1.1, *11*).

Mounds

The central and eastern parts of the site of Gnezdovo appear to form a peculiar settlement centre (a "core") which is characteristic of proto-urban structures of Eastern and Northern Europe in the IXth-XIth centuries. The special features of such settlements could be described by the following topographical scheme: a large open settlement with traces of economic and manufacturing activities; a small fortified centre; a necropolis consisting of several nearby cemeteries; and small satellite settlements. All these elements are present in the Gnezdovo archaeological complex, in contrast to other well-known archaeological sites of the period of early state formation of the Ancient Rus'.

The Central hillfort occupies a promontory of the first terrace above the flood plain on the left bank of the river Svinets. The open settlement is located on the terrace and on the adjacent part of the flood plain. The ditch which encloses the defended area to the east of the settlement is distinctly marked, as is a group of ramparts along its northern and part of its eastern sides. The hillfort encloses an area of 1 hectare (2.5 acres), and the total area of the central settlement is about 30 hectares (75 acres).

The thickness of the cultural layer in the terrace part of the open settlement varies from 0.2 to 0.8 m, while in the hillfort it is in the range of 0.5 to 1.5 m. Ploughing of the area in the late 1940^{s} and 1950^{s} resulted in extensive destruction of the stratigraphy of the cultural layer: in several places of the settlement, it has been completely ploughed up. Numerous war trenches as well as building pits of the 1950^{s} also damaged the occupation layers of the settlement. Flood plain settlement was preserved much better because it was covered by alluvial sediment in the XVIIIth century or later. This specific "blanket" with a thickness of 0.7 up to 3.0 m is responsible for the unique preservation of the cultural layer and protected it against anthropogenic factors. The thickness of the cultural layer on the flood plain is estimated to be 0.2 up to 0.8 m. One of the most effective peculiarities of the flood plain zone is the remarkably good preservation of organic remains, and wood fragments allowed to obtain samples for dendrochronological analyses.

The beginning of the Gnezdovo settlement is dated to the transition from the IXth to the Xth centuries, its peak development to the middle and second half of the Xth century. Its active period ended in the first half of the XIth century, but human activity in the area did not cease. Traces of a feudal residence of the XIIth – XIIIth centuries were uncovered in the area of the central hillfort and in the settlement located on the first terrace above the flood plain. Later, at the time of Polish power over the region in the XVIIth century, the area of the central settlement was occupied by the mansion of the Catholic bishop Peter Parchevsky; remains of this building were recently discovered by the Smolensk archaeological expedition. A small settlement also existed in the area of the Ol'shanskoye hillfort in the XVIth – XVIIth centuries.

Several monuments of the XVIIth century found on the left bank of the river Dnepr in the vicinity of Smolensk are closely associated with the later period of Gnezdovo history.

The results of archaeological research at Gnezdovo

The scale of Gnezdovo and its role in the early stage of the Ancient Rus' state formation was greatly determined by its geographical position at the 'apex' of the river systems linking Kiev and Novgorod. The existence of Gnezdovo opened up the possibility of the development of the Upper Dnepr region either to the west along the West Dvina river up to the Baltic, or to the east along to the Oka and Volga river basins.

The preservation and the evidence of the cultural layer at Gnezdovo varies greatly differs across the site, but we have basic data on the main types of dwelling, manufacturing and economic buildings, and have ascertained some clear trends of the site development.

Wood remains are practically absent within the cultural layer at Gnezdovo, thus the data on the house building system and corresponding architectural traditions are very scanty. The places of buildings, their size as well as the existence of hearths could be approximately identified by the location of dark, nearly black areas with coal inclusions and accumulation of burnt stones and clay within a layer. There are two distinct types of houses: one built entirely above ground, the other one with a sunken floor. Both types could be identified in the area of the settlement, but their functions were different. They were used for living, manufacturing and economic functions. The outlines of building remains and the features of the cultural layer distribution suggest the existence of some sort of tenements over a considerable extent of the eastern and flood plain parts of the settlement. The tenement borders could be traced by the distribution of boundary trenches, lines of fencing post-holes and unoccupied areas, the latter indicated by the absence of an occupation layer. An accurate estimate of tenement sizes is difficult, but it is evident that they included dwellings as well as related economic and manufacturing buildings.

Plotting the finds indicating manufacturing showed that they occur throughout the settlement area. The peculiarities of such finds and their distribution allowed the identification of several economic and manufacturing zones. Two of them were specialized metalworking zones located on the flood plain. Others (perhaps three) are associated with the terrace part of the settlement including the hillfort where raw materials, moulds and waste products of jewellery production and blacksmithing as well as traces of boneworking were identified.

The fieldwork revealed the wide range of metalworking including the production of tools, weapons and implements of ferrous metal as well as jewellery production of

precious and base metals, the existence of pottery production and boneworking, and the use of silver coins as the means of payment.

The Gnezdovo craftsmen produced high-quality ferrous goods, using a complicated technology of multi-layer welding. The jewellers cast composite female ornaments in stone and clay moulds, and applied techniques of stamping and engraving. It should be pointed out that the local crafts of the 10th century provide evidence of the coexistence of different manufacturing traditions, such as southern Slavic and northern Scandinavian traditions. The types of Gnezdovo pottery suggest that this settlement was a key production centre of wheel-thrown Slavic ceramics in the Upper Dnepr region.

Interdisciplinary work of archaeologists with experts from the Institute of Geography (Russian Academy of Science) and the Faculty of Soil Science (Moscow State University) uncovered ancient plough marks beneath the edges of the Dnepr mound group. The ash layer of the cremation fires at several mounds was found to be superimposed on an ancient plough horizon which could be traced as a series of distinct grey stripes against the background of the pale yellow subsoil of sandy clay sediments. Evidently some Dnepr-group mounds were erected on a previously ploughed area with the area at least 0.5 hectares (1.25 acres). The Dnepr mound group is located on a low, narrow elongated ridge along the edge of the first terrace above the flood plain. This circumstance as well as the nature of the mound distribution allowed to estimate the ancient ploughed land area to be as much as 1.5 hectares (4 acres). We suppose that this area makes up only a small part of the arable land used to supply the Gnezdovo population with grain during the IXth to early XIth centuries. Palaeobotanical analysis of the soil filling the furrow on the surface of the excavated plough surface showed the presence of wheat and weed pollen. Thus the inhabitants of ancient Gnezdovo were engaged in agricultural activities. This conclusion is supported by finds of some iron ploughshares within the cultural later dated to the late Xth – first quarter of the XIth century in the flood plain part of the settlement. The existence of a wooden plough, in turn, suggests the use of draught animals.

A large number of archaeological finds from Gnezdovo indicate links to Byzantium. These finds include coins and lead stamps, complete and fragmentary amphora, white clay glazed pottery, fragments of glass vessels and ornaments, textiles and gilded threads, horn and bone items, and ornaments and utensils made of base metals. Byzantine stamps of the IXth – first half of the XIth century are rarities in Ancient Rus' contexts; they are known only from Kiev and two sites located on the "Road from the Varangians to the Greeks". The Gnezdovo finds include some early Christian attributes of personal piety: cross pendants made in Byzantium Their owners evidently were inhabitants or visitors of Gnezdovo in the second half of the Xth – beginning of the XIth century.

One of burials contained an amphora from the Black Sea region with a unique Ancient Rus' inscription dated to the second quarter – middle of the Xth century. The burial may be that of a person of high social rank, e.g. a Varangian warrior who was engaged in trade or military service in the Byzantine Empire.

The Gnezdovo finds of Byzantine origin are the most representative collection of such artefacts from all Ancient Rus' sites of the Xth – beginning of the XIth centuries. The inhabitants of Gnezdovo who were buried in mounds with objects of Byzantine origin may have been members of the military, merchant or diplomatic elite. The concentration of Byzantine finds at Gnezdovo suggests that it played a special role in communications with Constantinople from from the first decades up to the last quarter of the Xth century. The finds of lead stamps indicate direct communications with Greek officials.

The Gnezdovo burial mounds and settlements produced the largest number of finds of Scandinavian origin among all sites considered to belong to the regions of the Ancient Rus'. These finds include attributes of pagan cult, parts and ornaments of male and female dress, weapons and items of horse harness as well as domestic utensils. The majority of Carolingian swords of the Xth century found in the Ancient Rus' originate from Gnezdovo. Swords of this type would have been a valuable part of the professional warrior's equipment.

In addition, the Gnezdovo finds include numerous ornaments of types known from archaeological sites of the Upper Dnepr and Dvina regions, West Slavic lands, the Middle Dnepr region and from Volga Bulgaria.

According to the types and origins of finds, the first inhabitants of Gnezdovo were Scandinavians, Slavs and local Krivichi. This suggestion is based on the data of burial rituals, types of armour, tools and pottery. The population of the Gnezdovo settlement is estimated at 800-1000 people at the peak of its development. Thus, the size of the settlement is well above that of previous settlements and of contemporary rural settlements.

The distribution and specificities of the archaeological finds indicate the gradual development and growth of the Gnezdovo settlement, as does the development of the cemetery areas and their mound groups. The oldest dwellings and manufacturing buildings are found at the promontory parts of the terrace as well as on the Dnepr flood plain.

In the first half of the Xth century, the zone of dwellings already occupied both promontories of the Dnepr terrace. A kind of 'harbour zone' emerges on the Dnepr bank from the second quarter to the middle of the Xth century. The settlement area of increased markedly in the middle to second half of the Xth century through the spread of buildings along the edges of the flood plain and through the development of vast areas along and inside the first terrace above the flood plain on both banks. Buildings were erected even on former wasteland, e.g. in a boggy depression near the terrace on the left bank of the river Svinets which was filled with sand. The oldest grave-mounds are situated in Lesnaja group. The overwhelming majority of all burial mounds are dated to the period termed "Late Gnezdovo". The first burials of the Central group of mounds belong to the middle of the Xth century; contemporary mounds are known from the Lesnaya group. The oldest mounds of the Dnepr, Ol'shanskaya and Transol'shanskaya groups are dated not earlier than the middle of the Xth century.

All archaeological evidence of Gnezdovo suggests a multi-ethnic settlement with a highly developed social structure, and an active participation in the international trade along the "Road from the Varangians to the Greeks". Numerous objects of Byzantine import (silver and gold coins, silk textiles, glazed pottery) and 11 hoards of Arab coins and silver ornaments are strong arguments to compare Gnezdovo in the IXth – Xth centuries with settlements such as Kiev, the capital of the Ancient Rus'.

CHAPTER 1.2.
GEOMORPHOLOGY AND LATE VALDAI (VISTULIAN) – HOLOCENE HISTORY OF THE UPPER DNIEPER RIVER VALLEY

General overview

The Dnieper River valley at its upper course was formed in the end of OIS-6 after the territory was left by the Moscovian (Late Saalian) ice sheet. In the Early Valdai (Early Vistulian, OIS-4) epoch the ice margin was far from the valley, but during the Late Valdai (Late Vistulian, OIS-2) time valley was subject to direct influence of the ice sheet. During the Last Glacial Maximum (LGM, 20-23 ka BP (cal)) the ice margin was located in the vicinity of the upper Dnieper valley (Fig. 1.2). Upstream from Smolensk it stayed 50-70 km to north/north-west from the valley. Glacial melt waters were transported to the Dnieper valley via its right tributaries - rivers Vop', Hmost', etc. and contributed much to both water and sediment discharge of the Dnieper River. At that time the river upstream from Smolensk had wide braided channel 15-20 times as wide as the modern river. Glacial melt water input to Dnieper during LGM is estimated at 40 km³/yr [Sidorchuk et al., 2011], which is 13 times as great as recent river runoff at Smolensk. Input of glacial melt waters lasted for about 3 thousand years: since the maximum (Bologoye) stage of the Late Valdai glaciation (21.5 ka BP cal.) till the Vepsovo stage (18.5 ka BP cal.).

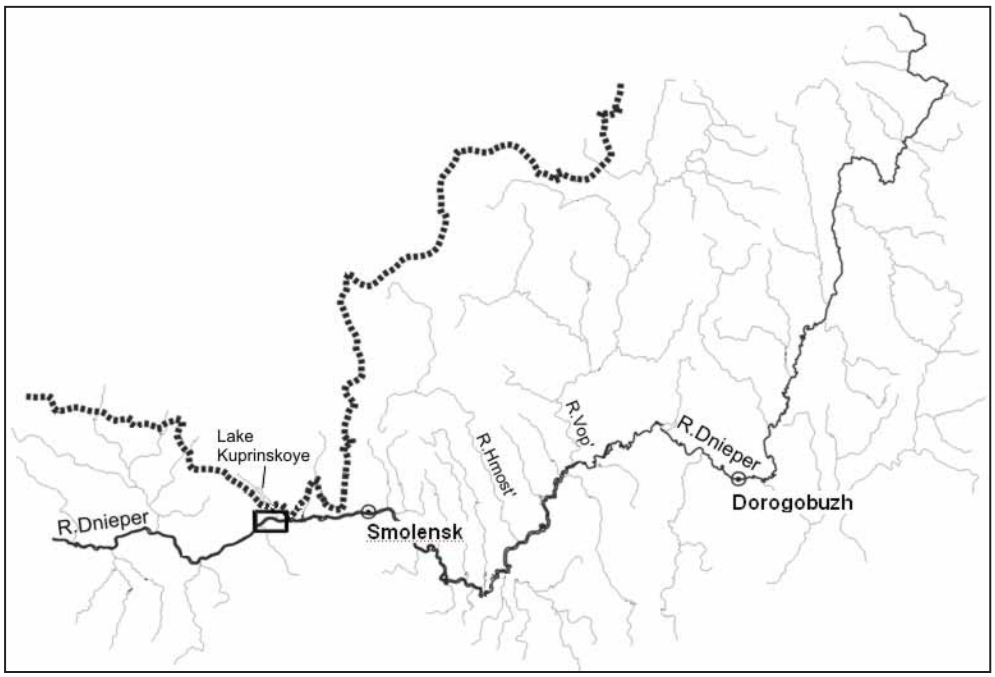

Figure 1.2. Map of the Upper Dnieper River system.
Dashed line – ice shet margin during LGM [after: Map …, 1998].
Rectangle west from Smolensk – area shown in Fig.1.3.

Several alluvial terraces are found within the valley bottom. Elevation interval 10-15 m is occupied by Late Valdai (OIS-2) terraces that are divided into two levels: 12-15 m (T1b) and 10-12 m (T1a). They are composed of sandy alluvium with no loess or sheet loam cover on the surface. Valley bottom width at the 15-m elevation level is 1.2-1.5 km of which terrace T1 occupies approximately one half (from ¼ to ¾ from place to

place). Holocene floodplain has changeable width from <200 m to >700 m and usually differentiates in morphology with rather smooth Early-Mid Holocene parts and high-relief areas formed in the Late Holocene. River channel is 80-100 m at bankful stage. The channel has irregular pattern: long straight stretches alternate with short series of 2-3 meander bends with varying curvature.

Problem of erosion remnants

Characteristic features of the Upper Dnieper valley are erosion remnants with flat or gently sloping top surfaces rising to 25-35 m above the river. Usually they resemble islands in their planform, with typical length and width 1-3 km and 0.5-2 km respectively. They are usually separated from valley sides by huge fluvioglacial channels. Such forms are found in a long section of the valley: from River Vop' downstream to the Russia / Byelorussia border and in Byelorussia between Orsha and Shclow cities where they were studied by Kalicki [1995], Kalicki and San'ko [1998]. Parameters of erosion remnants and related palaeochannels are much larger than fluvial features of modern river, i.e. the modern river underfits (term by Dury, 1964) its valley. Different types of such underfitness are widely found in river valleys because of high amplitude runoff oscillations in the past. Underfitness is most often indicated by meandering palaeochannels. Specific erosion remnant – large palaeochannel morphology of the Dnieper valley gave rise to suggestion by Kalicki [1995] to distinguish “Dnieper-type underfitness”.

Age and mechanism of development of Dnieper-type erosion remnants is still unclear. Example is given by the site at Katyn-Pokrovskoye village, 10 km downstream from Gnezdovo (Fig. 1.3). Erosion remnant here is an elongated hill 30-33 m high (above the river), 3.0 km long and 1.2 km wide with long axis directed along the valley. In the south it is undercut by a large single-thread palaeochannel 400-500 m wide, which is 7-8 times as wide as the modern channel. Paleochannel is filled by 15-m thick alluvial sands with coarse-grained basal horison at the base. The erosion remnant is composed of morain (most probably, Moscovian epoch – OIS-6) covered by a 1-2-m thick cover of fine to medium sand. This cover has probably aeolian origin. The modern Dnieper River channel located north from the hill is incised into morain. Both floodplain and 15-17-m terrace have only 2-4 m of alluvium over the morain basement. These features are indicative of spillway origin of this stretch of the modern channel, but mechanism of channel jump over a 30-m hill is problematic both in this and in other examples of erosion remnants as well as remnant age. Direct influence of Late Valdai (OIS-2) ice sheet in the form of glacial damming an / or glacioisostatic crustal movements can not be universal mechanism of development of erosion remnants because they are found both in the vicinity and far away from ice boundary. Ice sheet direct influence may be taken into account only for the Katyn-Pokrovskoye site.

Large palaeochannels are most probably Late Valdai (OIS-2). If remnants had the same age and were formed due to incision of fluvioglacial flows, there must be wide sandur plain in the valley at elevations corresponding to remnant tops. No such geomorphic level exist in the valley. Late Valdai (OIS-2) terraces are only 10-15 m high and thin covers of fine to medium sand on tops of remnants can hardly be interpreted as deposits of fluvioglacial flows. These sand covers have most probably aeolian origin with large palaeochannels as sources of sand. Elevation of highest remnants corresponds to the level of 30-40-m fluvioglacial terrace (“third terrace”) formed during melting of the Moscovian ice sheet (end of OIS-6). Therefore the dissection of the valley could occur in

Late Moscovian (end if OIS-6) epoch due to incision of Moscovian fluvioglacial flows. On the other hand, the third terrace and watersheds beyond the limits of the Valdai ice sheet are covered with thin (1-2 m) cover of homogenous loams called "cover loams". Younger elements of the valley such as low terraces and floodplain are devoid of cover loams. No cover loams is also found on remnant tops which may be indirect indicator of their younger age. Irrespective of the time of incision, question is also whether the incision occurred in both branches simultaneously or the modern (Holocene) channel had been cut separately – in the latter case mechanism of channel jumping over high hills is problematic.

To summarize, initial formation of the remnants relates most probably to action of fluvioglacial flows in the end of OIS-6 when the Upper Dnieper valley began to form after the territory was released of the ice sheet. Branches of wide flow deepened to form incised braids. It is unknown whether these branches functioned continuously since the end of OIS-6 till the end of OIS-2.

Problem of ice-dam lake and river development in the Late Valdai (OIS-2) epoch

Downstream from Smolensk the LGM ice margin reached the Dnieper valley. One of discussionable questions of local geomorphology is whether the river was dammed by the glacier. According to Salov [1972], one ice tongue that moved through the valley occupied now by Lake Kuprinskoye and River Katynka (flows from the lake and tributes to Dnieper) dammed the river and forced it to shift to the south. Kvasov [1975] suggested that due to this glacial barrier a huge dammed lake was formed with the level up to190-195 m a.s.l. (30 m above the modern Dnieper at Smolensk). He proposed that water of this lake overflowed to the Volga River basin and was one of sources for the Khvalyn' transgression of the Caspian Sea. On the other hand, no geomorphic traces of this overflow exist and no lake shorelines or lacustrine deposits are known in the Dnieper valley which makes the hypothesis of high damming doubtful. Nevertheless, valley lake of lower level seems to have existed in LGM time: its sedimentological indicators were found at the Gnezdovo section of the valley.

Data from boring and examination of bank exposures at Gnezdovo show that both floodplain and low terrace alluvium is underlain by silty clays with microlamination structure. At places they contain sand both dispersed and in the form of lenses. These deposits are interpreted as sediments of a semi-closed valley lake. The base of lacustrine unit was detected at 6.0 m below the river low water level. They are underlain by alluvial or fluvioglacial coarse sands with fine gravels. The roof of lacustrine clays is variable depending on the depth of channel erosion. Maximum elevation of lacustrine clays was detected on terrace T1b: their roof was found under 7.5 m of alluvium (medium to coarse sand) at +6.5 m above the river. Initial thickness of lacustrine clays is therefore not less than 13.5 m (lower estimation).

Given high potential sedimentation rates due to high turbidity of water, total time needed for accumulation of the whole lacustrine unit must have not exceed few thousand years. As the middle of the lacustrine unit was OSL dated to 21-22 ka BP cal. (see Stop 4 in Chapter 1.3 for details), the whole period of lacustrine sedimentation probably occurred within LGM (20-23 ka BP cal.). Given that, formation of this lake may be forced by some impact of the ice sheet. Two mechanisms are possible. First, glacial damming at the Katyn-Pokrovskoye section (see Fig.1.3). The following facts are in favor of this mechanism: (a) absence of lacustrine clays at this section, (b) modern river cutting into morain deposits while 10 km upstream at the Gnezdovo section alluvial fill exists

under lacustrine unit. Weak point of this hypothesis is that glacial advance across the river valley has not been proved yet by any argument other than valley morphology.

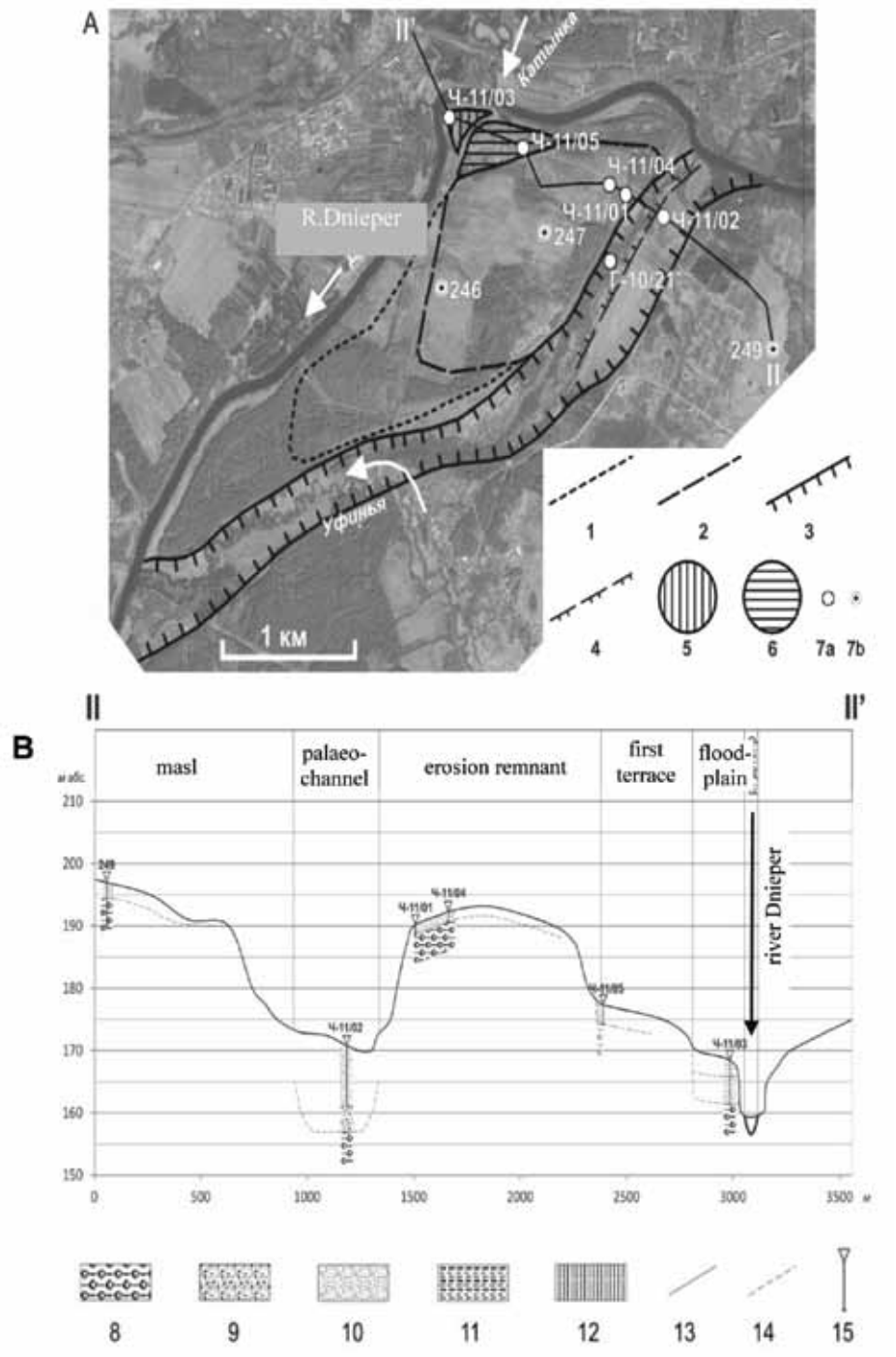

Figure 1.3. Map (A) and geological profile (B) across the erosion remnant in the Dnieper River valley at the Katyn-Pokrovskoye village (see Fig. 1.2. for location). 1 – foothill (about the 175 m contour line); 2 – edge of hill top; 3 – borders of the Late Vistulian paleochannel; 4 – borders of different levels of the palaeochannel; 5 – floodplain (8-10 m); 6 – 15-17-m terrace; 7 – cores (a – made by authors, b – Abramzon et al., 1981). Legend for profile: 9 – glacial till; 10 – coarse sand with gravel; 11 – fine and medium sand; 12 – silty sands and sandy loams; 13 – cover loam; stratigraphic boundaries: 14 – reliable, 15 – probable; 16 – cores.

Second possible mechanism is occurrence of glacioisostatic crustal movements around the edge of the Katyn glacial lobe. Local depression several tens of kilometers in diameter formed around the maximal glacial advance could promote formation of semi-closed basin within river valley. Occurrence of compensating uplift after glacial retreat may be evidenced by relative hight of large fluvioglacial palaeochannels at Katyn-Pokrovskoye section and at River Vop' 100 km upstream: in both cases palaeochannel surface lies at the same absolute height of 170-172 m a.s.l. while the modern channel falls by 7 m within this 100-km stretch. On the other hand, this hypothesis can not explain absence of lacustrine sedimentation in the centre of depression – at the Katyn-Pokrovskoye section (Fig. 1.3). Both hypotheses are favored by the fact that lacustrine clays disappear not farther than 100 km upstream, i.e. the lake was only several tens kilometers long. Probably combination of both hypotheses would explain all facts in the best way.

Both the glacial damming and erosion remnants problems will be advanced after establishing absolute chronology of large fluvioglacial palaeochannels and sand covers (OSL dates are coming soon from the GADAM Centre, Silesian University of Technology).

River development in the Holocene

During the Early and Mid Holocene the Dnieper River in the vicinity of Smolensk did not demonstrate active dynamics. Only two palaeomeanders are found at the 20-km valley stretch downstream from Smolensk (Fig. 1.4).

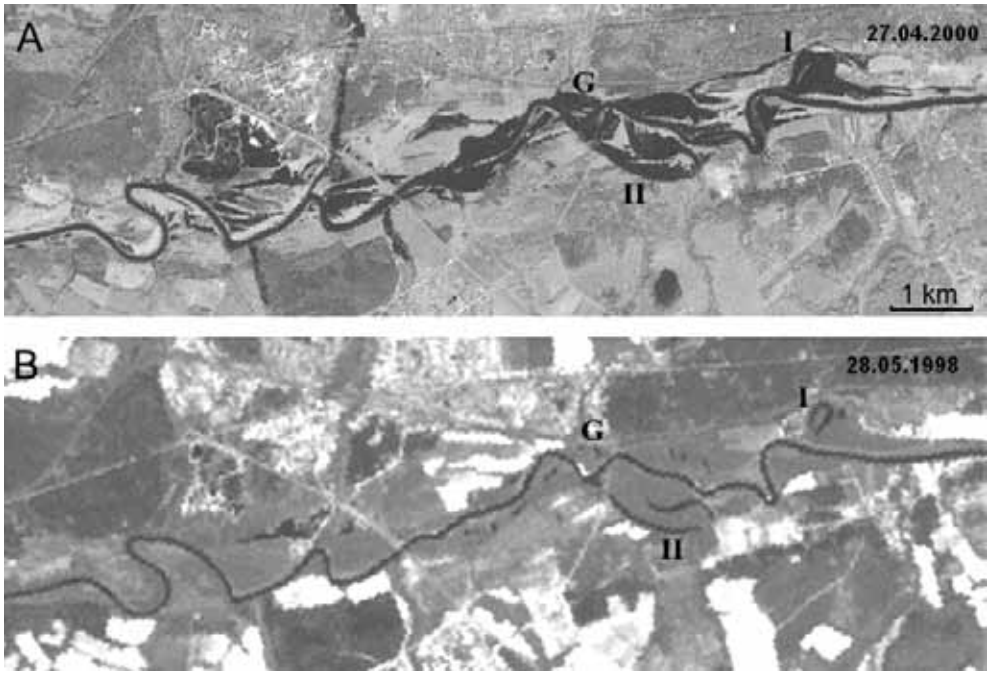

Figure 1.4. The Dnieper River valley downstream from Smolensk: A – at high water stage (spring flood), B – at low water stage. I, II – Palaeomeanders (see text). G – Gnezdovo settlement.

Palaeomeander I at the right river bank 2.5 km upstream from Gnezdovo is a loop developed since the Early Holocene and abandoned due to neck cutoff some 3.5 ka BP cal. (Fig. 1.5). Development of such sinuous channel is possible if floodplain

inundation is too shallow to maintain flow velocities necessary for surface erosion and creation of a straightening channel. Relatively low channel-forming discharges during the Palaeomeander I development are indicated also by bankfull width: in the palaeochannel it is lower than in the modern channel (60-70 m versus 90-100 m).

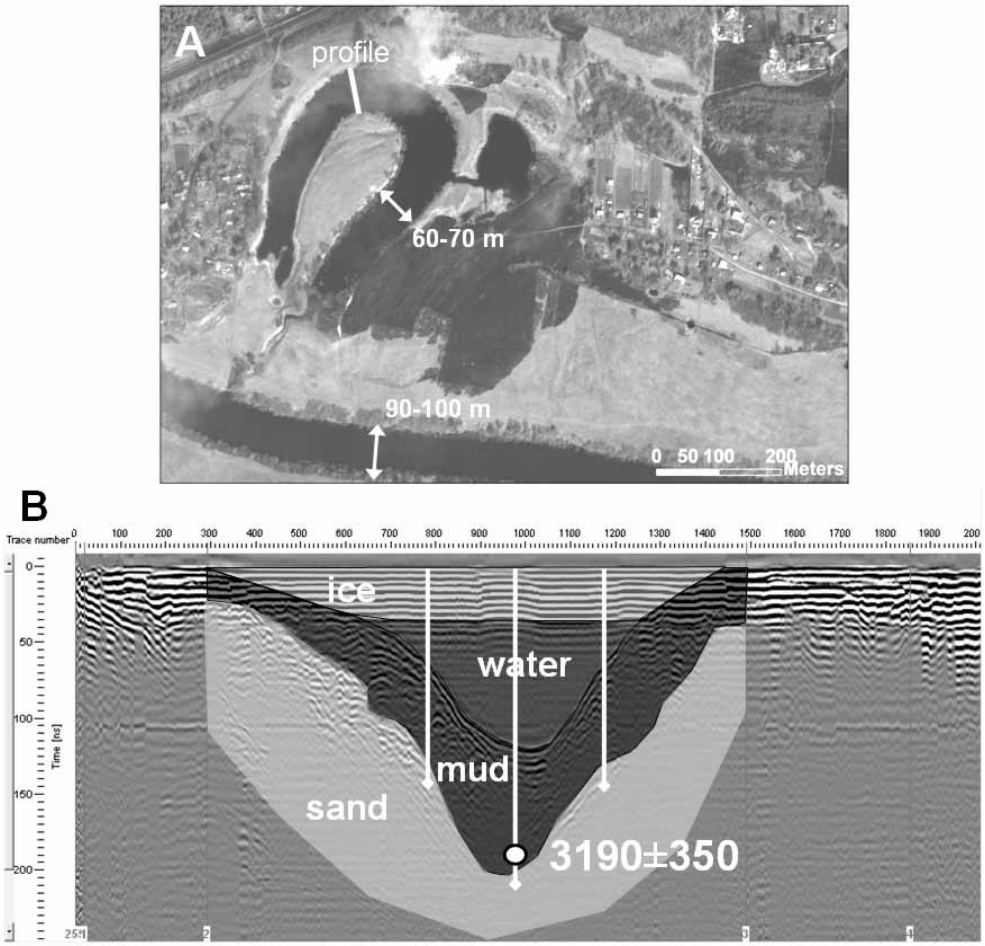

Figure 1.5. Palaeomeander I (neck cutoff): Space image (A) and GPR profile (B)

Low flood activity in the Early/Mid Holocene is indicated also by buried floodplain soils dated to the second half of the Atlantic period. One of such soils dated at 5200±130 (IGAN-3891) was found at the left bank 1.2 km upstream from the Gnezdovo site. The other Atlantic soil dated at 6540±70 (IGAN-3835) was found at the Gnezdovo site and will be shown during the field excursion (see Stop 4, section 07-03 in Chapter 1.3). These soils on the left and right bank formed on different parent materials. On the left bank these are re-deposited red colored material, extremely rich in oxalate and dithionit extractable iron oxides, on the right bank (section 07-03) these are ordinary floodplain silt loams. General processes of Atlantic soil formation are the same: lessivage (less intensive comparatively to Subatlantic buried soil), redoximorphic procceses related to periodical water stagnation mostly in eluvial part of the profiles and along biogenic channel and segregation of iron oxides, gleization of borrom horizons.

The Late Holocene was characterized by high amplitude oscillations of flood activity.

Low flood activity characteristic for Early / Mid Holocene was interrupted by extreme floods in the beginning of the Late Holocene. It is evident from chute cutoff of Palaeomeander II which developed through the most part of the Holocene (Fig. 1.6).

Dating of sedimentary fill of palaeochannel gives the time estimation of meander avulsion: >2.0 ka BP cal. More precise dating of extreme flood period will be given in the floodplain part of field excursion (see Stop 3 and Stop 4, next chapter): between 2.4-2.7 ka BP.

Low flood activity was characteristic for the next time interval between 2.0 (2.2?)-0.8 ka BP. End of this interval corresponds to the Medieval Warm Period (MWP). Low frequency of floodplain inundation promoted formation in the floodplain of well developed Albeluvisols which are typical loamy zonal soil of boreal forest ecosystems.

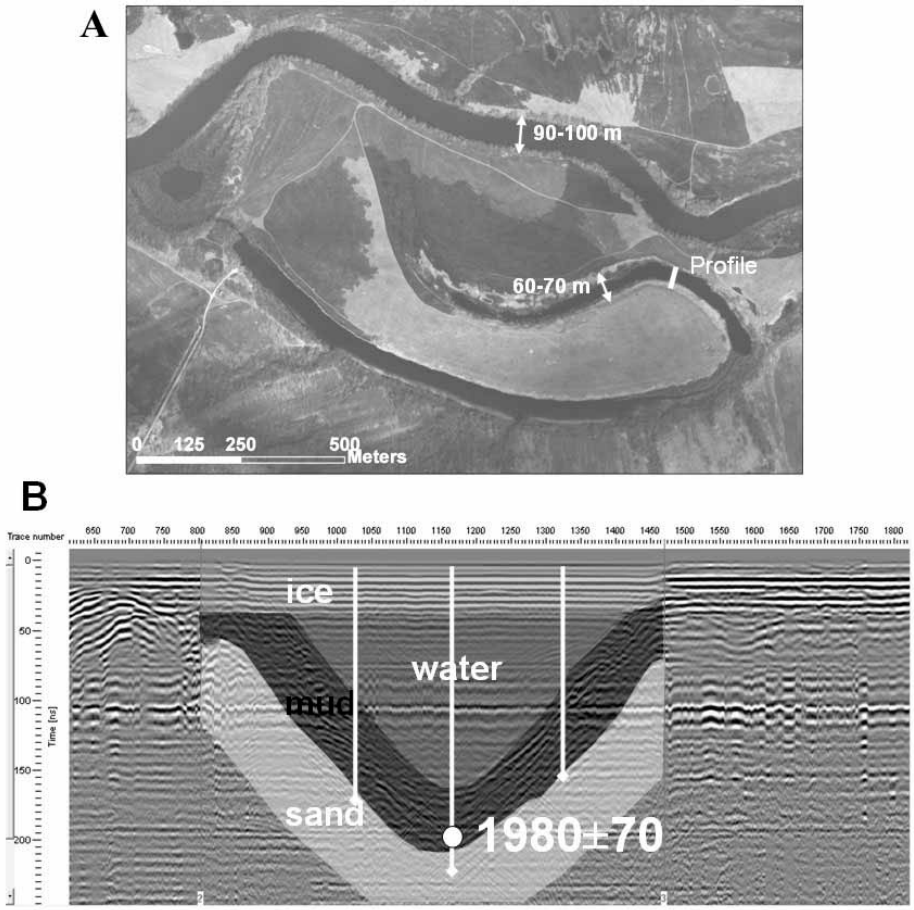

Figure 1.6. Palaeomeander II (chute cutoff): Space image (A) and GPR profile (B)

High floods, deep and frequent inundation of floodplain resumed some 800 yrs BP. Period of relatively high floods lasts since early XIIIth century till now. Within this interval, two phases of highest flood activity occurred that are detected by high sedimentation rates and increasing grainsize of overbank deposits. First phase dated to the XIV / XVth centuries boundary is visualized by clearly laminated sand layers in overbank alluvium at Gnezdovo. Second phase of highest floods occurred probably in the middle of the XVIIth century. This phase has been detected at the left bank on the floodplain segment between the modern river and Palaeomeander II (see Fig. 1.6). In 1631, during the siege of Smolensk, the military camp of Polish king Vladislav was located here. Archaeologists V. Kurmanovskiy and V. Nefiodov (personal communication) found several fortification structures of this camp (ditches, ramparts) buried under 1-1.5 m of alluvial sands. Surface of artificial structures is not reworked by pedogenic processes which evidence that the burial occurred shortly after their construction.

On the other hand, two periods may be characterized as intervals of relatively low flood activity – beginning of the XVIIth century and XXth century – nowadays. Recent situation may be illustrated by a relatively high spring flood in 2000 (Fig. 1.4 A). This flood was one of the highest in the last decades, the topmost areas of floodplain were not inundated, though clearly laminated overbank alluvium of previous centuries is found there. Some lowering of flood activity in early XVIIth and XXth centuries resulted in formation of a variety of Fluvisols wich are typical sin-sedimentary soils of regularly inundated floodplains.

Synthesis of river history during OIS-2 - OIS-1

Graph of the Dnieper River aggradation/incision during OIS-2 based on the above data is shown in Figure 1.7.

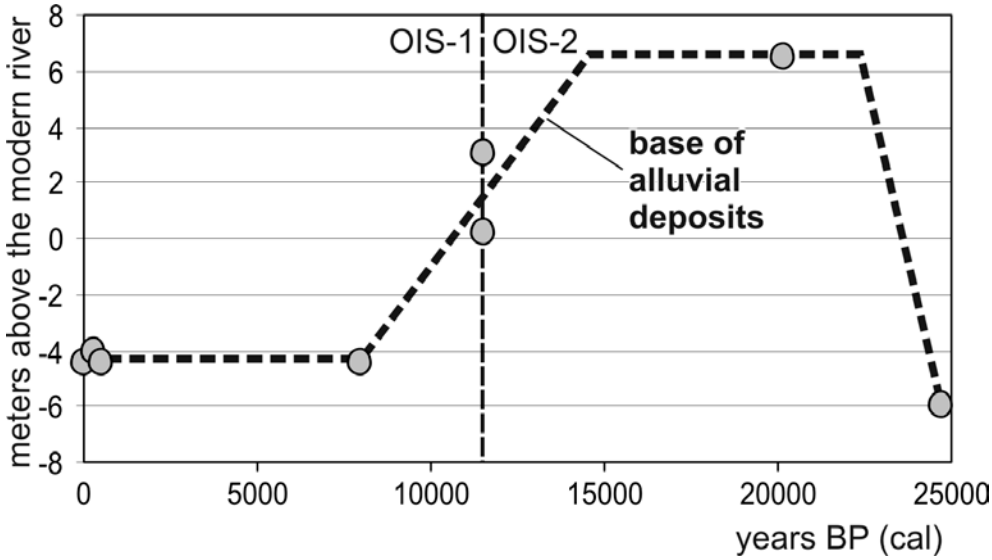

Figure 1.7. Dnieper River incision / aggradation dynamics during OIS-2 – OIS-1 epochs

The fact that lacustrine clays are underlain by alluvium and base of lacustrine infill lies deep under the modern river (6 m below low water level, 1-2 m below channel floor) indicates that prior to LGM the river was incised 1-2 m deeper than it does at present. Lacustrine / alluvial accumulation during LGM may be estimated minimum at 12-13 m as during formation of the T1b terrace (12-15-m terrace) alluvial base and its contact with lacustrine clays lied already at 6.5 m above modern river. Given that this contact is an erosion-type boundary, the above estimation of total value of deposition is minimal. During formation of the 10-12-m T1a terrace alluvial base was at about 3.5 m above the modern river, i.e. incision by about 3 m took place compared to the T1b terrace, but the channel still was 7-8 m above the modern channel (alluvial base of modern channel is 4-5 m below low water level). The T1a terrace was radiocarbon dated to the Pleistocene/Holocene boundary (see Stop 4 in Chapter 1.3 for details). Morphology of the terrace evidence that the river channel was split into multiple braids, which is responsible for low thickness of alluvial series characteristic for both T1b and T1a – 6-8 m.

River incision proceeded in the Early Holocene. Not later than by 7-8 ka BP cal. the river had incised to its present position and preserved it by present. Variations of floodplain inundation in the Mid- and Lat Holocene detected from sedimentology of

overbank alluvial facies (for example, buried soils) are therefore induced by changes of hydrological regime only. Incision in the Early Holocene had in a large part proceeded due to river concentration in single channel: deepening of channel bottom by 7-8 m was followed by considerable rise of seasonal amplitude of water levels. Therefore topmost parts of the Late Holocene floodplain rise at almost the same elevation as the T1a terrace and thickness of Holocene alluvial series is 12-13 m (against 6-8 m in the Late Valdai).

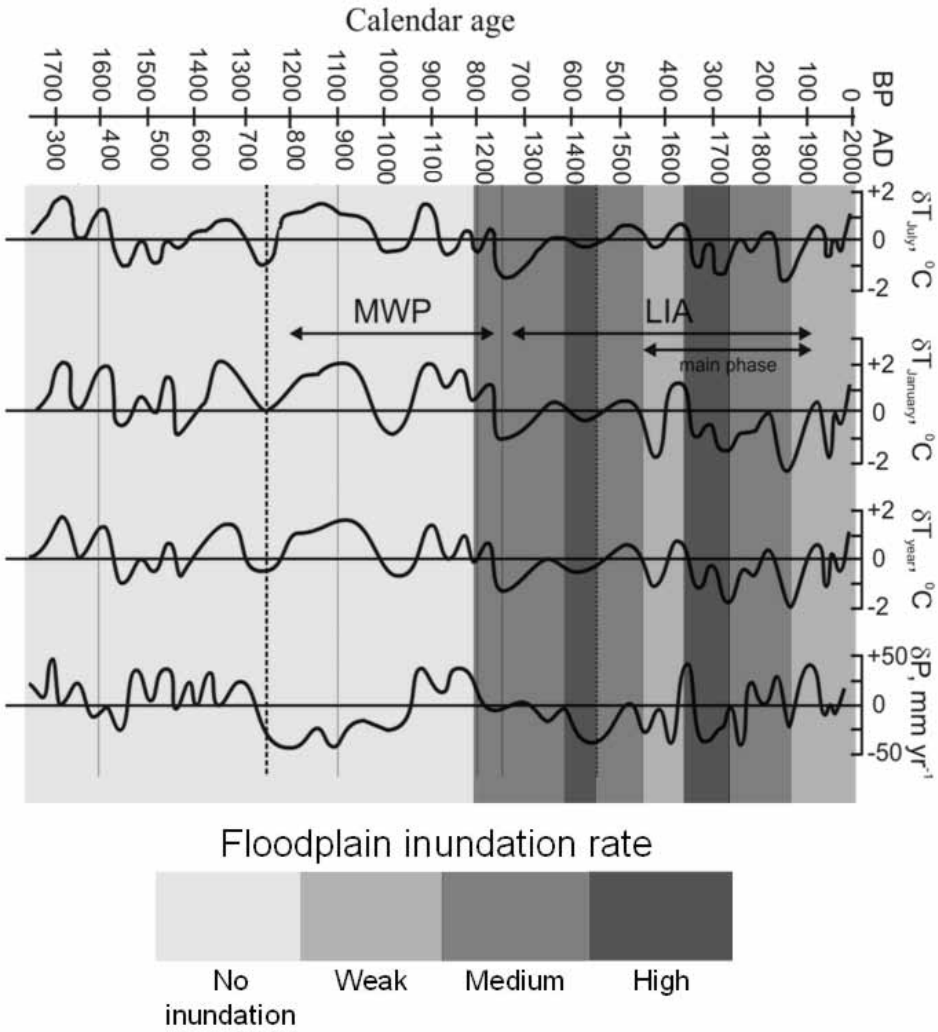

Figure 1.8. Climate change in the center of the Russian Plain in the last two millennia (after Klimanov et al., 1995) and palaeohydrology of the Dnieper River

Most reliable palaeohydrological data exist for the Late Holocene and reveal clear correlation with climate dynamics (Fig. 1.8). In general, rise of flood activity corresponds usually to climate cooling. Intervals of warming are usually marked by low floods or even interruption of floodplain inundation. For example, extreme floods at the start of the Late Holocene (avulsion of Palaeomeander II, scouring on floodplain at Gnezdovo – see Chapter 1.3) correspond to the 2.6 ka cooling event. Interruption of floodplain inundation in the first millennium AD coincides with relative warming, and its final phase – with MWP. Floodplain inundation resumed together with beginning of LIA. The XVIIth century most active flooding corresponds to the Maunder minimum of Solar activity and recent lowering of inundation rates are related to pass to modern warm epoch after the finish of LIA. Such kind of correspondence follows from the Dnieper type of

hydrological regime typical for rivers in the centre of the Russian Plain. Highest floods are related to spring snowmelt. Spring flood runs usually between 50-70 % of annual runoff. During cooling climate phases duration and severity of winters rise which results in higher storage of snow and higher spring floods. In opposite, during warm epochs snow storage drops and spring floods become weak. This is clearly observed during the last 10-15 years of global warming.

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CHAPTER 1.3.
GEOARCHAEOLOGY OF THE UPPER DNIEPER RIVER VALLEY AT GNEZDOVO: FIELD EXCURSION

The Gnezdovo archaeological complex is located at the Gnezdovo village 10 km west from the city of Smolensk ($54^0$46.6'N $31^0$52.3'E). Territory of archaeological monument occupies different geomorphic elements of the Dnieper River valley.

Stop 1. The "Bolshoj Sizovsky mound"

The Central group of mounds occupied most of the slope on the right bank of the river Svinets, and it spread nearly to the edge of the first terrace terraced above the flood plain. The mounds consist of sandy clay and sand, sometimes containing fine gravel. These mounds were very badly damaged during the railway construction in the XIXth and the beginning of the XXth centuries. Most are 1.0-1.2 m high but it is here that we find the largest barrows. Two large mounds more than 6 m high have been preserved between two old quarries. These mounds were excavated and found to contain a rich pair of Scandinavian cremations dated to the middle – second half of the Xth century. One of these cremations included a unique sword with a handle manufactured by a master from the island of Gotland. The "Bolshoj Sizovsky mound" was partly excavated at the end of the XIXth century by Vladimir Sizov; it is 9 m high and has a diameter of about 40 m. Two pyres at the base of the barrow included the following finds: sword, helmet, hauberk, two shields, spear-head, a broken Byzantine dish with an image of the fantasy creature Senmurv (Simurgh), fragments of a richly decorated horse harness, silver mounts of a drinking horn, gaming pieces, an Arab silver coin from the beginning of the Xth century, carnelian and glass beads and many other objects. Several small barrows surrounding this large mound also contained cremation burials but were accompanied by poorer assemblages.

In the course of the 1976 excavations near the Bolshoj Sizovsky mound, several chamber graves were discovered which are dated not earlier than the second half of the Xth century.

Stop 2. Forest ("Lesnaya") group of mounds

The Lesnaya mound group occupies the southern part of the slope, a section of the terrace above the flood plain; some barrows are found at the base of the terrace and on the Dnepr flood plain. Some mounds located along the edge of the terrace were separated from the main group by the railway.

The burial mounds are usually found in compact groups. They are up to 1.5 m high but several barrows of the Lesnaya group reach 2.0-2.5 m. The barrows consist of pale yellow sandy clay and sand. It had been thought that the site had to be "cleansed" before mound building by setting fire to the grass or burning some straw or brushwood. This was the common explanation for a 5-10 cm thick layer of mottled pale grey sandy clay under the mounds. However, recent studies by a soil scientist from Moscow State University showed that this layer is made up of buried sod and cannot be a product of ritual burning. The majority of mounds contained cremations. Usually a dead body had been burned at the place of burial; the cremated remains and objects which had survived the fire were collected into urns which were similar to ordinary pottery. As a rule, a mound covered a single burial, but sometimes there were double burials of a man and a woman, or a

woman with a child. Many burials included remains of horses and dogs which had served as sacrificial animals.

The oldest mounds of the Lesnaya group are dated to the first quarter of the Xth century. One of the most interesting mounds (№ 13) was excavated in 1949. It had been erected over a pyre where a Scandinavian warrior and two women had been cremated. The rich and distinctive assemblage included: a Carolingian sword, an iron necklet, Arab silver coins, carnelian and crystal beads, silver temple-rings, an amphora and a Byzantine pitcher. The amphora had been ritually broken during the funeral; one of fragments had a Slavonic inscription which read “Goroun”. Presumably this was the name of the amphora owner. The funeral conformed to Scandinavian rite of cremation, and it was for a member of the Gnezdovo elite.

Stop 3. Hillfort of the Gnezdovo settlement and overview of the Dnieper valley

Most of the central settlement occupies the first terrace above the flood plain on both banks of the river Svinets, and part of it lies on the Dnepr flood plain. The earlier buildings are found in the promontory part of the terrace on the right and left banks of the river Svinets. The early settlement was probably not fortified. The Central hillfort occupies a promontory of the first terrace above the flood plain on the left bank of the river Svinets. The open settlement is located on the terrace to the west and to the east and on the adjacent part of the flood plain to the south from it. The ditch which encloses the defended area to the east of the settlement is distinctly marked, as is a group of ramparts along its northern and part of its eastern sides. The hillfort encloses an area of 1 hectare (2.5 acres), and the total area of the central settlement is about 30 hectares (75 acres).

The Central hillfort was constructed not later than at the second third of the 10th century. The first defensive works included enhancing the terrace slope facing the river Dnepr; the earliest rampart (2-2.5 m high) and its ditch sharply separated the area of the hillfort from the settlement site. A timber wall was built at the edge of the hillfort area. The excavations revealed burnt parts of the wooden construction around the hillfort perimeter, suggesting a rebuilding of the defences at the end of the Xth century after the previous construction had been destroyed. Today the rampart is about 5 m high, its base is 17 m wide; the ditch has the depth of 4 m and a width of 18 m.

Selected archaeological finds from the hillfort area are shown on Figure 1.9.

The hillfort is a good view point to observe the *geomorphic structure of the Dnieper valley.*

Dnieper River basin area at Smolensk is 14,100 km^2, the Dnieper River mean annual discharge – 97 m^3/s (3.1 km^3/yr), mean maximum discharge – 1990 m^3/s. Hydrological regime of the Dnieper is characteristic for most rivers of central East-European Plain with dominant snowmelt feeding. During spring flood water levels rise 7-8 m above summer typically; maximum annual amplitude of water levels is around 12 m. Runoff during two months of spring flood (March-May) makes 50-60 % of annual runoff. In summer, especially July, levels are minimal during the ice-free season. In autumn (September-November) low rainfed floods may occur. At Smolensk and adjacent lower reach of the river floodplain is 0.7-1.0 km wide. River channel is 50-70 m wide in low water season, bankfull width is 80-100 m. Bed sediment is medium to coarse sand. Downstream from Smolensk channel pattern is generally straight with irregular meanders.

Ancient settlement occupies the right-bank floodplain segment and low river terrace (Fig. 1.10). The low terrace (“first terrace”, T1) is represented by two sub-levels:

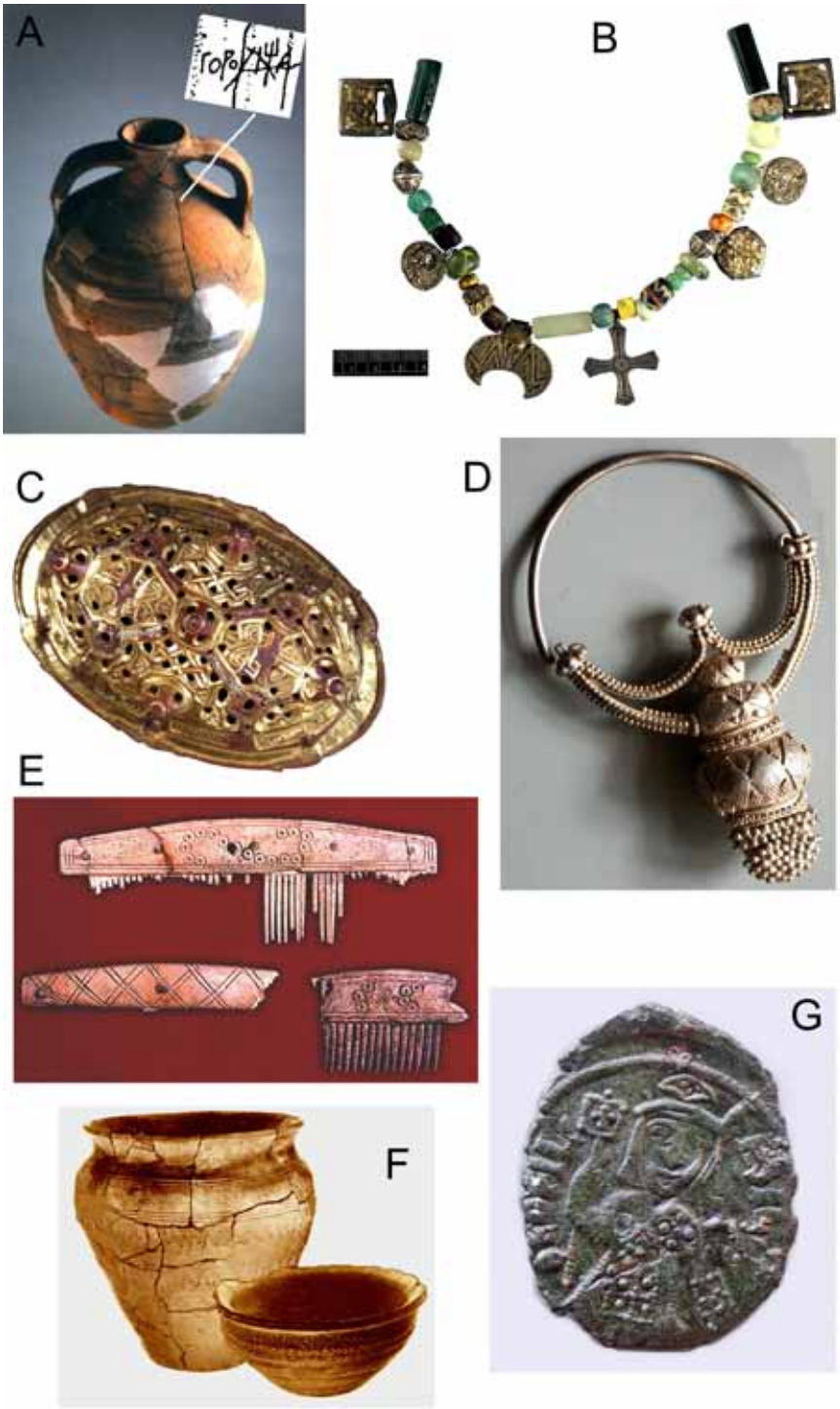

Figure Pu-1 – 1.9. Selected finds from the hillfort area
A – large earthenware pot; B – necklace; C – Scandinavian women fibula;
D –Slavish temporal ring; E – horny combs; F – vessels; G – Byzantine coin.

10-12 m (T1a) and 12-14 m (T1b). The hillfort is located on terrace T1b, other parts of the settlement spread over adjacent areas of T1a and floodplain. There are two floodplain units of different age and morphology (Fp1, Fp2 on Fig. 1.10 B) that are divided by a series of high levees (L on Fig. 1.10 B). The younger floodplain Fp1 has contrasting levee-hollow morphology made during meander shift at its inner bank (Fig. 1.11 a). Area occupied by cultural layer is limited to the older generation of the

floodplain Fp2 (Fig. 1.11 b). Morphology of the older floodplain is unusual. It is characterized by smooth topography but high total relief of >4 m. High levee transverse to the general direction of the river channel divides two depressions occupied by small lakes. Elevation difference between lake levels is 2.5 m, between lake bottoms – 4 m. Such features evidence that the depressions are rather isolated pits than parts of a single abandoned palaeochannel.

Main stages of the floodplain history.

1. Formation of the older floodplain (FP2).

In the Early-Mid Holocene, the river had an irregularly meandering channel with low rates of bank erosion. Overbank fines accumulated on the floodplain and smoothed it. In the interval 6.5-7.5 cal ka BP sedimentation stopped probably due to decrease of flood levels, a soil with signs of zonal process of textural differentiation developed (now found buried within the overbank alluvium).

At the start of the Late Holocene a series of extreme floods concentrated probably within a short time interval led to major channel and floodplain transformation. Narrowing of the floodplain at the Gnezdovo site might have led to additional increase of flow velocities above inundated floodplain. Distinct festoons of terrace edge evidence that during the floodplain formation, the terrace was subject to undercutting by vortex flows with variable horizontal dimensions. Given that, as well as rounded outlines of floodplain depressions and transverse levee existence, the following model of floodplain formation was developed (Fig. 1.12). Deep inundation and stimulated flow macroturbulence and formation of whirlpools of different diameter. Whirlpool action produced holes 20-100 m in diameter; of which the largest is the Bezdonka Lake depression (Fig. 1.12 A). Erosion capacity of flood flows was promoted by low resistance of thin sands that make up the base of the floodplain. The eroded alluvium was partly washed out and partly accumulated at the edge of the vortex zone and formed the transverse levee between the two lake depressions. This is illustrated by scales-like bedding of alluvium visible on GPR profiles across the levee (Fig. 1.12 B). Big portion of floodplain was reworked. Residuals of Early-Mid-Holocene floodplain can be recognized by buried Mid-Holocene forest-type soil formed on fine overbank sediments.

Absolute dating of this extreme event was made by radiocarbon method. We used three dates from sediments associated with the extreme erosion of the floodplain or accumulated shortly after it. Combination of dates gives a wide interval of time with the core at 2.3-2.5 cal ka BP (Fig. 1.13). Given that the sampled sediments dates rather post-date the event, it may be associated with the 2.6-ka climatic event – climate cooling detected by isotopic composition of Greenland ice cores.

2. Break in floodplain sedimentation due to lowering of flood levels.

According to [Bronnikova et al., 2003] inundation of the floodplain had been broken after 2.4 ka BP (uncal); [Alexandrovskiy et al., 2005] refer this event to similar time: 3rd quarter of the 1st millennium BC. This stage had lasted more than 1000 years. Albeluvisols – zonal forest soils had formed on high topographical elements evidencing absence or extreme rareness of inundation. At the end of the stage, between late IXth – early XIth c. AD, the soil was disturbed at places by human impact. Occupation deposits of the Gnezdovo settlement have accumulated. In terms of World Reference Base of Soil Recourses original Albeluvisols were partly displaced by their Technic, Anthric varieties or by a variety of Technosols. Mapping of the occupation deposit (cultural layer) distribution exhibit its occurrence on the highest elements of the floodplain (Fig. 1.14).

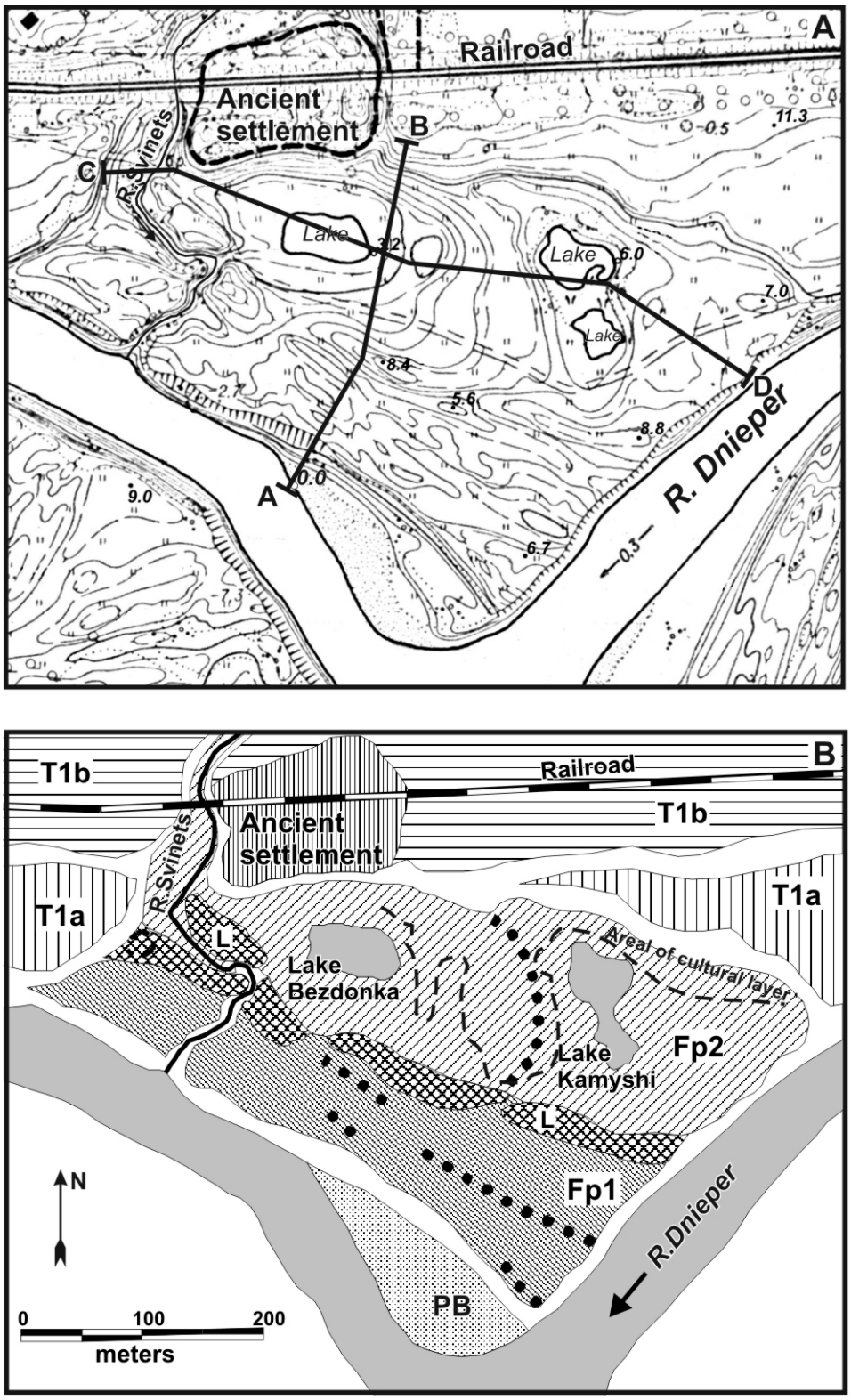

Figure P1 - 1.10. Topographic (A) and geomorphic (B) maps of the key site. Height above the river low water level. Contour interval 1 m.
T1a, T1b – levels of the low ("first) terrace (10-12 m and 12-15 m respectively); FP1, FP2 – floodplain of different age (last millennium and Early-Mid-Holocene respectively); L – large ancient levees; dotted lines are young levees; PB – modern point bars.

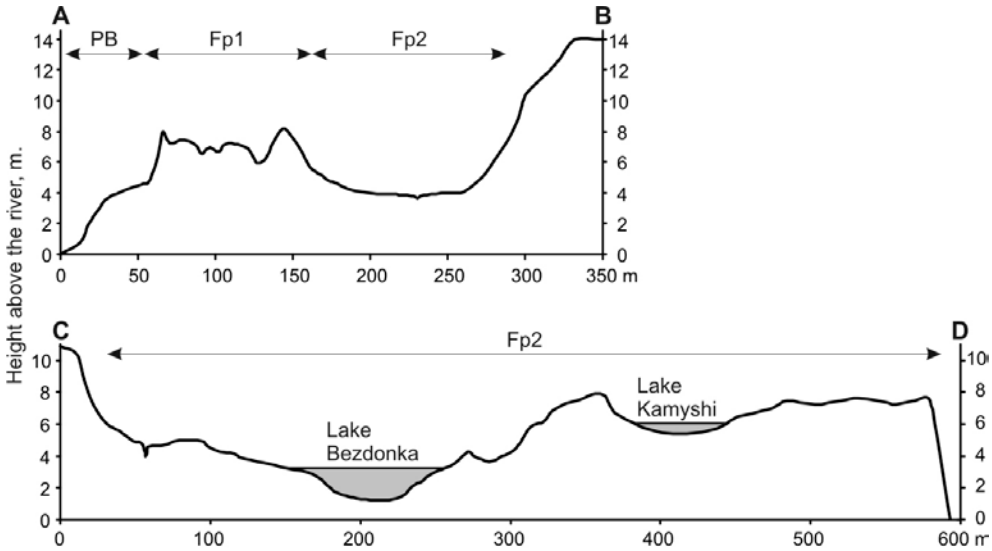

Figure.P2 – 1.11. Topographic section across (AB) and along (CD) the key floodplain area. For location see Fig.1.9B.

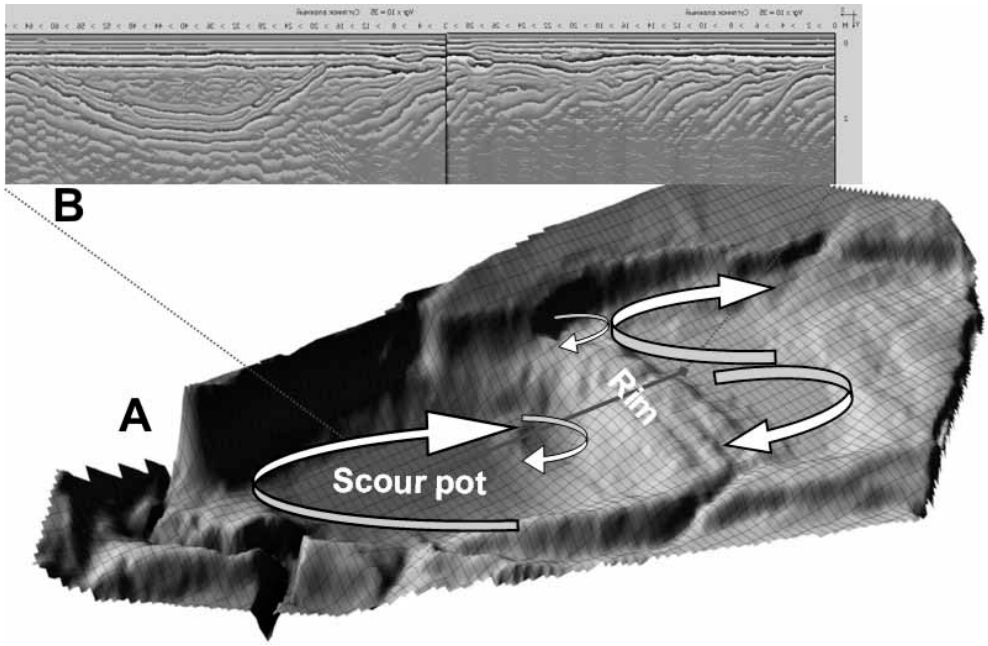

Figure P3 – 1.12. Model of floodplain formation during extreme flood(s).
A – scour pots made by a hierarchy of vortexes; B – GPR profile showing mechanism of the transverse ridge formation due to upstream sediment transport by large vortex.

Reasons for the break of floodplain inundation in Early Medieval times may be found in climatic changes. The Dnieper River hydrological regime is strongly dependant on winter snow storage. During the Medieval Climatic Optimum (MCO) in VIII-XI centuries AD warm and short winters should have resulted in relatively little snow storage and small spring flood discharges and low water levels. The same phenomenon is detected in regional scale: well developed floodplain soils buried around 1000 years ago are found in other river basins – middle Dnieper, Don, middle Volga [Butakov et al., 2000; Alexandrovskiy, 2004; Sycheva, 2003].

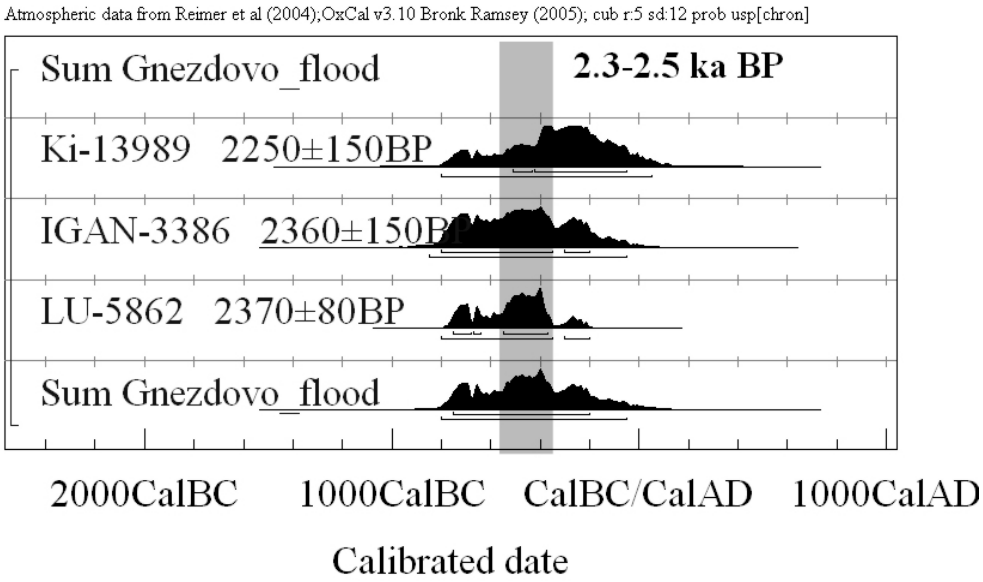

Figure P4 – 1.13. Dating the extreme flood(s).

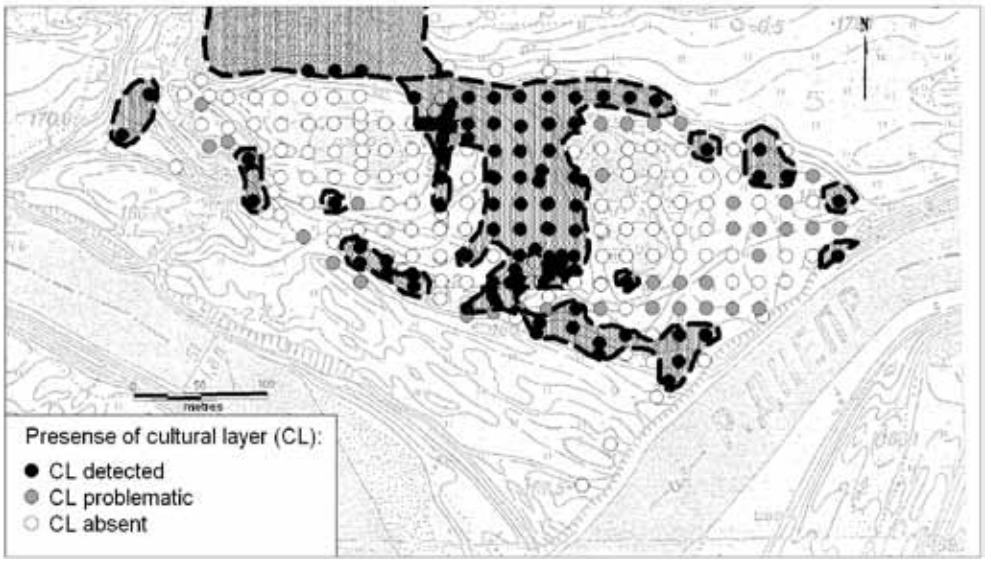

Figure P5 – 1.14. Map of cultural layer distribution over the floodplain.

3. Burial of cultural layer and formation of the younger floodplain generation (FP1).

Good preservation of artifacts on FP2 favors supposition that floodplain inundation had resumed soon after the cultural layer formation. Absolute dating of sediments that bury cultural layer shows that inundation resumed around the XIIIth century AD.

At Gnezdovo time, the right bank of river channel was located at the modern FP2 / FP1 boundary. Initially there was a sand slope from the smooth floodplain surface down to the river (occurrence of cultural layer under the levee deposits). Already during the settlement functioning levees began to form at the edge of FP2 (occurrence of Early Medieval artifacts within the levee deposits in the vicinity of the Svinets River tributary). Rise of floods resulted in activation of both edge levee accretion and channel bank erosion. Southward channel shift began with consequent formation of young floodplain with high-relief levee topography at the right bank. Levees mark crests of point bars that grew at the right channel bank and successively joined the floodplain. Process of

floodplain side accretion and levee formation is illustrated by morphology of the modern point bar. Flood rising seems to have not initiated channel incision: the Holocene alluvial base has about the same level both at older and at younger floodplain segments.

Stop 4. Geology, geomorphology and archaeology of the Dnieper River floodplain.

Point 4.1. Modern point-bar and the last millennium floodplain.

From the modern point bar section of the 10-m terrace at the left bank may be observed (Fig. 1.15). The upper 6.5 m of the section are represented by full alluvial sequence: fine to medium sands interbedded with silts and loams with coarse sand with gravel at the base (lower 0.7 m). At depth 4.0-4.3 m alluvium is radiocarbon dated at 10.120±70 (GIN-14370). This alluvium was deposited by a braided channel that left characteristic morphology of the terrace surface. Channel braiding may be responsible for relatively little thickness of alluvium which is two times as less as that of the Holocene floodplain. Alluvial foot at 4 m above the river indicates deep river incision that must have occurred after to terrace formation. The base of terrace section is composed of firm clays with thin lamination and lenses of fine sand. OSL date at depth 9.4 m is 21.4±2.8 ka (GdTL-1238). These deposits accumulated in the open lake that was probably formed as a result of ice sheet impact over the valley (glacial damming or glacio-isostatic subsidence).

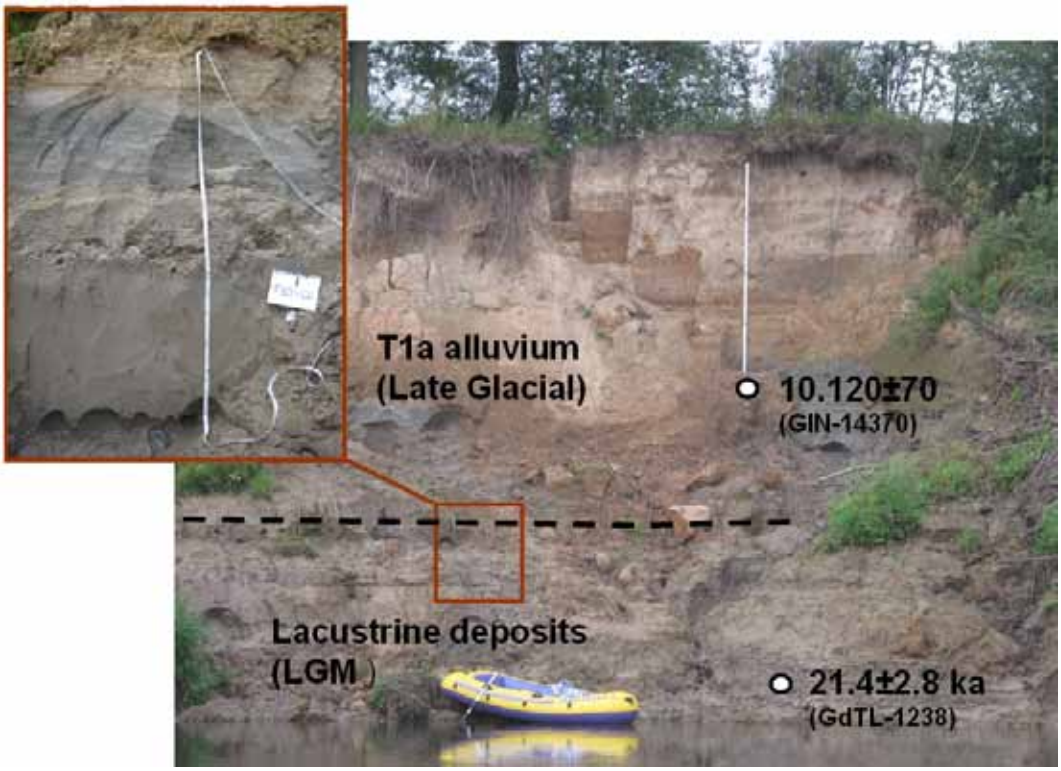

Figure P6 – 1.15. 10-m terrace at the left bank.

On the l0-m terrace the so-called left-bank group of mounds exists. The problem associated with this mound group is absence of any traces of a nearby settlement (it is doubtful that the Gnezdovo dwellers got across the river to bury their dead). Possible explanation is destruction of the left-bank settlement due to undercutting of the left bank in the last millennium that may have reached 100-200 m.

Lateral and downstream growing of the modern point bar evident from GPR profiles (Fig. 1.16) serve a model of the younger floodplain (FP1) development. We cross this floodplain generation on the way to point 3.2. The path follows along the eroded edge of the floodplain (the inner bank in the upstream part of channel bend). Lateral erosion rate in the last 40 years is 0.3-0.5 m/yr on average (10-20 m bank retreat since 1970).

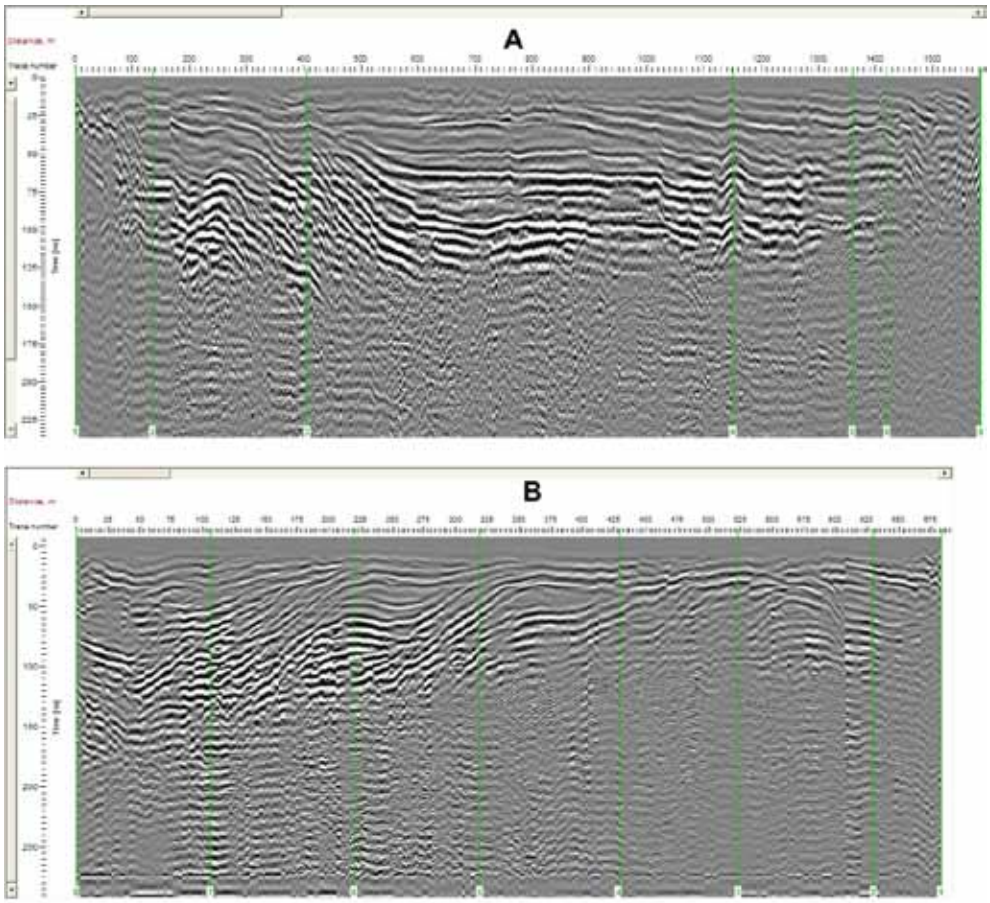

Figure P8 – 1.16. GPR profiles along (A) and across (B) the point bar showing its growing mechanism.

Point 4.2. Remnant of the Early Holocene floodplain.

Section 07-03 is located in the older floodplain generation (Fp2) on the main levee that divides Fp1 and Fp2. It is one of the oldest floodplain generations at the site. The section contains three major lithological units and four soil profiles including the contemporary one. Soil profiles are partly overlapped: pedofeatures of younger soils enter the older profiles. That complicates interpreting of changes in pedogenesis and its environment. Lithostratigraphy of the section is as follow. The lower, oldest unit is silt loam at the depth of 173 – 340 cm. The fraction 0,05-0,01 mm dominates in this unit in spite of a considerable variations in its content (Fig. 1.17 a). In some layers it is competitive with the fraction 0,25-0,05 mm. The next unit 45-173 cm is composed of sandy loams with prevailing fraction 0,25-0,05 mm. The uppermost unit (0-45 cm) is finely stratified loamy sands. The same fraction 0,25-0,05 mm prevails here, fraction 1-0,25 mm appear in the unit. A curve of organic carbon distribution has a saw-like character and do not drop lower than 0,2 % (Fig. 1.17 b) meeting the criteria of WRB for

Fluvic material. The content of organic carbon clearly rises in Ab horizons of three buried soils described in the section.

The upper limits of the buried soils are 253, 173 and 105 cm. Lower buried soil was dates by humus at 6540±70 (IGAN-3835). Other soils haven't been dated but basing on their stratigraphic position and morphology in correlation with dated sections these soils possibly were formed approximately between 2200 and 800 years BP (the second one[1]), and in the time span 600-800 BP (see radiocarbon, OSL and archaeological dates of correlative layers below).

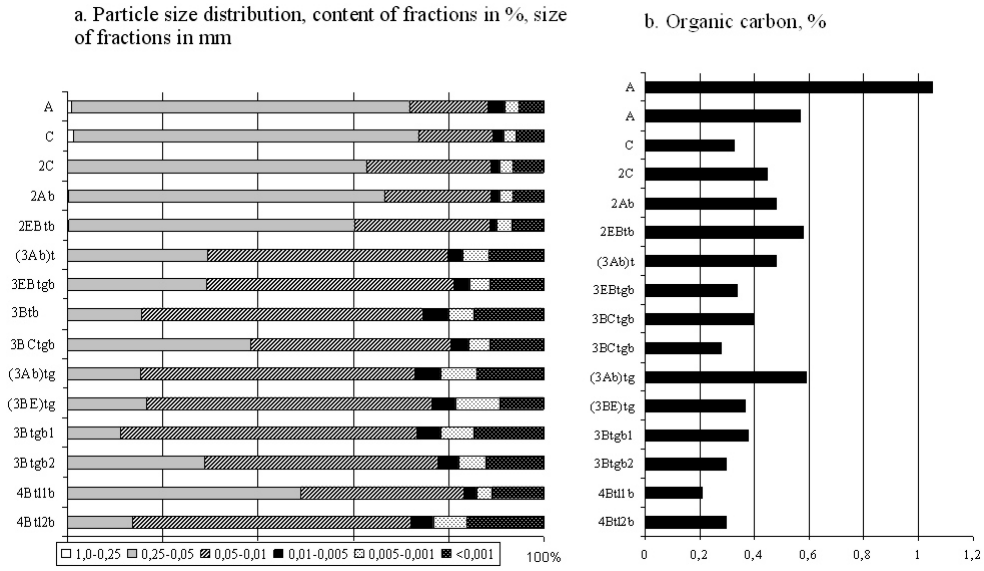

Figure Br10 – 1.17 Section 07-03: analytical features.
a – Particle size distribution; b – content of organic carbon.

Textural pedofeatures (coatings, infillings, intercalations composed of translocated silicate sand, silt, clay, with admixtures of humus and iron oxides, or unsorted silicate material) is related to zonal processes of intrasoil migration of silicate material (lessivage). In soils of floodplains these pedofeatures are diagnostic for more or less long-term interruption of sedimentation related to seasonal inundation. These pedofeatures first appear in the section 07-03 from the depth of 173 cm (in the second Ab horizon) (Table 1). At this depth they are very faint and few and definitely related to the youngest buried soil. That means these pedofeatures are epigenetic for the second buried soil (formed after it was buried, in the next phase of pedogenesis). The phase of illuviation referred to the upper buried soil was obviously incipient and very short, so that related to it illuvial maximum (recorded as a maximum of clay fraction and micromorphologically registered maximum of textural pedofeatures) is combined with the next one of the second buried soil. Double-maxima distribution of textural pedofeatures (Table 1) is in good correspondence both with field morphology of the profiles and distribution of the clay fraction <1 mm (Fig. 1.17 a).

Occurrence of textural pedofeatures starting from the first buried profile evident for more or less prolonged drops of sedimentation rates and even hiatuses in floodplain

[1] We will call it below "Gnezdovo soil", because early medieval habitation activities in the floodplain part of Gnezdovo settlement are related to this soil). This is the most widely spread and well developed buried soil in the floodplain soil-sedimentary sequences of the Upper Dnieper valley.

sedimentation. The last ones gave the way to zonal pedogenic processes in the mid-Holocene time, 2200-800 BP and 800-600 BP spans. Surface, contemporary soil, in the opposite, is typically sin-sedimentary Fluvisol without any signs of zonal pedogenesis.

The longest period of ceased floodplain sedimentation and active textural differentiation of fluvial material within the last 6500 years is referred to the Gnezdovo soil. In this section Gnezdovo soil has no signs of any human impact as far as it is located behind the borders of Gnezdovo settlement. This soil has well developed profile of Albeluvisol – typical soil of boreal ecosystems formed on loamy material. It has all attributes of Albeluvisols. The profile includes Albic horizon which is bleached and zonally impoverished in clay (Fig. 1.18 c). At the same time neighboring zones of it are often enriched in lluvial clay related to the next buried soil. In this horizon certain signs of intra-soil weathering such as transformations of biotite are observed (Fig. 1.18 a). Albic horizon is underlain by a series of Argic ones with numerous and variable textural pedofeatures. Argic and transitional BC horizon contain redoximorophic features: iron impoverished zones and iron-manganese nodules related to seasonal water logging.

All of three buried soils have got more or less developed profiles of textural pedofeatures. In the section 07-03 following morpho-substantial classes were described during microscopying (Table 1): 1. clayey, Fe-oxides and / or humus containing, low anisotropic (Fig. 1.18 d, c, f); 2. sandy-silty, well sorted (Fig. 1.18 d, e); 5. clayey, with bright self and interference colors, sharp strait or wavy extinction (Fig. 1.18 b, e); 6. clayey, pale, impoverished by iron oxides. These classes often are combined in compound coatings (Fig. 1.18 d, e). Together with coatings and infillings textural pedofeatures occur also in numerous intercalations, which are believed to be related to ground waters [Fedoroff, Courty, 2012]. Generally, the most widely spread are classes 1 and 6. Fe-clay or Fe-oxide coatings are combined with Fe-impoverished (often as an alternation of layers within one compound coating). This is characteristic for at least seasonal water stagnation in the eluvial part of the profile [Gerasimova et.al, 1989]. For Gnezdovo soil along with Fe-rich and Fe-impoverished textural pedofeatures clay coatings and infillings with bright yellowish-brown self- and interference colors are typical (class 5). This kind of coatings is formed only in well drained conditions. They are result of so called primary illuviation [Fedoroff, 1972], when iron oxides and clay migrate and accumulate together. It should be stressed that this class of textural pedofeatures is an essential attribute of Gnerzdovo soil in floodplain soil-sedimentary sequences of the Upper Dnieper region. These textural pedofeatures could be used as a sort of stratigraphic marker.

Contradictory co-existence within one profile of classes 1, 6 characteristic for poor drained conditions in eluvial part, morphologically different intercalations belived to be related with ground water influence and the class 5 typical for perfectly drained soils is actually a record of successive processes of soil evolution from a well drained phase to a phase of drainage deterioration resulted both from a rise of ground water and seasonal water logging due to decreased water permeability of Argic horizon. Relations of textural and reoximorphic features are important in connection with time sequence of pedogenic processes. Fragments of brightly colored coatings are often found within Fe-nodules, at the same time Fe-enriched and Fe-impoverished layered coatings are described above nodules (Fig. 1.18 f). That supports the conclusion on deterioration of drainage in the end of Gnezdovo soil development (before it was buried.

The interpreting of Mid-Holocene soil is not very reliable due to its strong overlapping with the Gnezdovo soil. This Mid-Holocene soil is characterized by relatively high biological activity in its top horizon and comparatively abundant

redoximirphic features. Taking in account clear and logical within-the-profile depth distribution of redoximorphic features (Table 1): increasing their number with depth, increasing a contrast between an oxidation and reduction zones and appearance of oxidation zones along ped surfaces in lower B horizon, it is possible to conclude sin-genetic (life-time) short-term reductimorphic conditions in the upper part of the profile and at least seasonal influence of ground waters on the bottom part of the profile.

Table 1. Section 07-03, textural and redoximorphic features

Horizon	Textural pedofeatures							Redoximorpic features: relative abundance
	Classes according the composition and morphology (see below the table)						Relative abundance	
	1	2	3	4	5	6		
A	–	–	–	–	–	–	–	–
C	–	–	–	–	–	–	–	–
2C	–	–	–	–	–	–	–	–
2Ab	–	–	–	–	–	–	–	–
2EBtb	–	–	–	–	–	–	singular	–
(3Ab)t	+	–	–	–	–	–	+	–
3EBtgb	+	+	–	–	–	–	+	–
3Btgb	+	+	–	–	+	+	++	+
3BCtgb	+	+	–	–	+	+	+++	++
(3Ab)tg	+	+	–	–	+	+	+++	+++
(3BE)tg	+	+	–	–	–	+	++	+
3Btgb1	+	+	–	–	+	+	+++	+
3Btgb2	+	+	–	–	–	+	+++	++
4Btl1b	+	+	–	–	+	+	+++	+
4Btl2b	+	+	–	–	+	+	+++	+++

Classes of textural pedofeatures according their composition and morphology (+ occur, – do not occur): 1 – Clay, Fe-oxides and/or humus containing, low anisotropic; 2 – Sandy-silty, well sorted; 3 – Silt and silt clay, unsorted, with admixture of sand, organic (humus impregnation or/and charcoal dust); 4 – Clay with admixture of organic, grayish colour in polarized light, low anisotropic up to isotropic, diffuse or flecked extinction; 5 – Clay, with bright self and interference colors, sharp strait or wavy extinction; 6 – Clay, pale or nearly colorless, impoverished by iron oxides.

Relative abundance is estimated in following classes: – no, + few, ++ common, +++ abundant

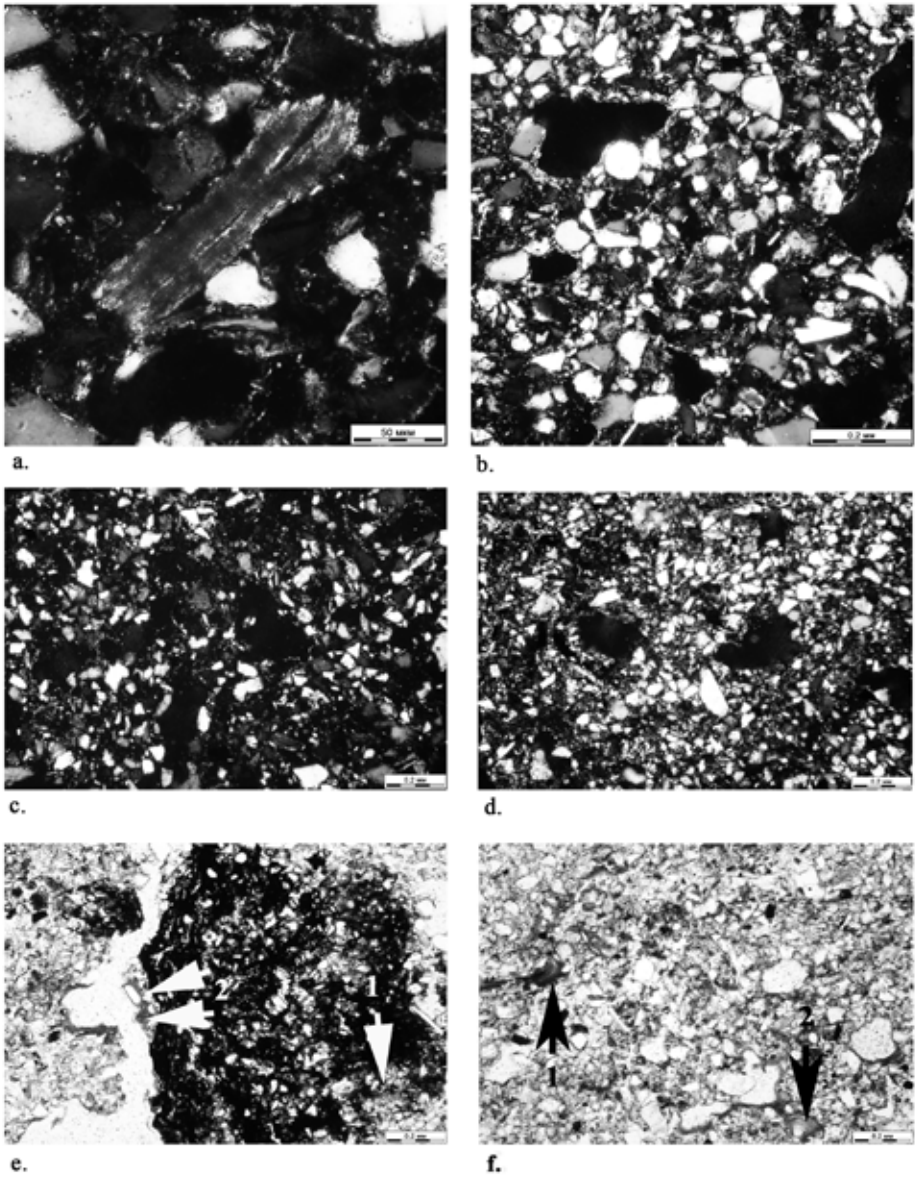

Figure Br11 – 1.18. Section 07-03: micromorphological features. a – altered biotite grain in 3EBtgb horizon (Gnezdovo soil); b – clay coatings in 3EBtgb horizon (Gnezdovo soil); c – clay impoverished zone in 3EBtgb horizon (Gnezdovo soil); d – compound coating in 3Ebtgb horizon (Gnezdovo soil); e – 1 – Fe-nodule incorporated a fragment of clay coating (class 5) partly covered with 2 – compound coating in 3Btgb2 horizon (Athlantic soil); f – Fe-enriched (class 1) and Fe-impoverished (class 6) coatings in the (3BE)tg horizon (Athlantic soil).

Sin-genetic textural differentiation of the profile most probably should be concluded as far as a drop of textural pedofeatures and zones impoverished by plasma are observed in (3Ab)t horizon and particle size distribution of clay fraction (<1 mm) reveals eluvo-illuvial pattern of differentiation (Fig. 1.17 a). Textural pedofeatures in this profile are mostly presented by alternation of bleached clay coatings and not well oriented Fe-clay coatings. Such complex of textural pedofeatures is a clear evidence of seasonally alternating phases of reduction and oxidizing.

Point 4.3. Early Subatlantic floodplain.

Section 07-01 represents the destructive variant of the floodplain created by the 2.6 ka extreme event. Erosion left a depression that began to fill quickly with alluvial fines. At depth under 5.0 m silty sands occur indicating the first, most active phase of filling. Above the level 5.0 m deposits are mainly loams and silts. At their base numerous woody debris concentrate which is typical for standing water pools adjacent to active channel. A 30-cm trunk at 5.0 m was radiocarbon dated at 2370±80 (LU-5862). At depth 1.9-3.8 m lie loams interbedded with peat. In the peat layer at 3.4 m a root part of a trunk in the living position was found (date 1850±40 IGAN-3706). At 3.0-3.1 m were found bone of horse (not dated because of insufficient quantity of collagen) and wood chips dated at 1200±80 (ЛУ-5866) and 1250±60 (ЛУ-6076), i.e. 650-990 AD cal (95.4 %). The latter may belong to human activity at the earliest time of the Gnezdovo settlement. Upper 1.9 m are sands and silty sands indicating rise of floods.

Age-depth model produced from a series of radiocarbon dates (Fig. 1.19 permits estimation of boundaries between the two units with different sedimentation rates that might correlate to the Late Holocene palaeohydrological epochs: low sedimentation rate and low floods epoch - between 2.2 - 0.6 ka BP, high sedimentation rates and high floods epoch – since 0.6 ka BP.

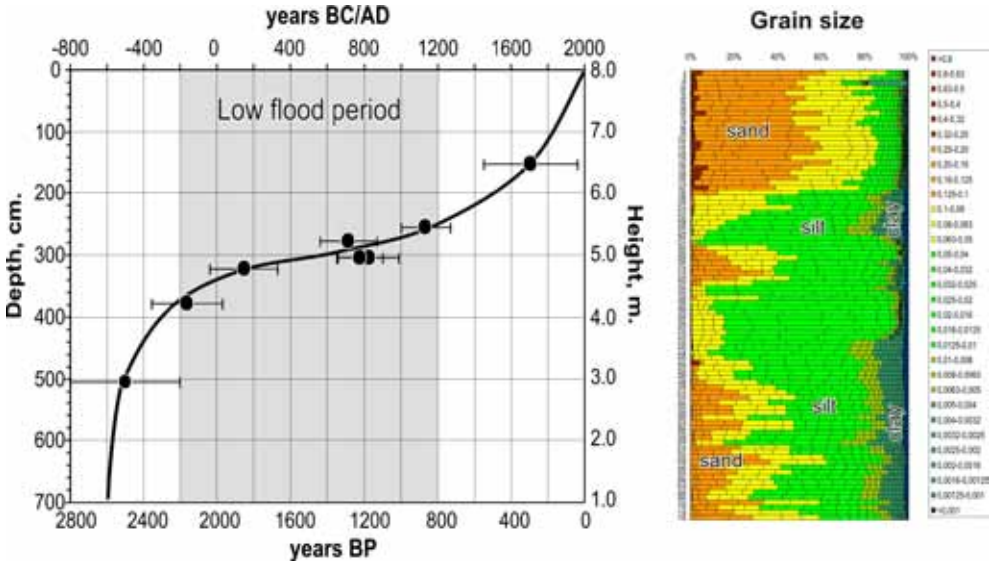

Figure P10 – 1.19. Lithology and sedimentation rates at section 07-01: floodplain created in the beginning of the Late Holocene (FP-2).

Point 4.4. Central area of the floodplain part settlement

Section P-8 represents a constructive type of FP2: it was a zone of prevailing sedimentation during the 2.6-ka extreme floods and got relatively high topographic position, which favored active and diverse activity of Early Medieval people at the site. The arena for this activity which started at the VIII / IX c. boundary was palaeogeomorphic surface fixed by well developed soil. This soil starts from the depth of 110 cm with anthropogenic material of occupation deposit including numerous artefacts. Anthropogenic horizons in terms of World Reference Base for Soil Resources are ascribed to Urbic material. Nearly undisturbed Albic and Argic horizons of Gnezdovo Albeluvisol were described under these horizons. This soil (excluding its Urbic horizons) is generally the same as in above described section 07-03: well differentiated, combining variable textural and redoximorphic features in mid and low horizons. All classes of

textural pedofeatures including class 5 which is specific for Gnezdovo soil, defined for undisturbed Gnezdovo Albeluvisol of the 07-03 section are also registered in P-8 (Table 2, Fig. 1.20 e). There are two additional classes in the assemblage of textural pedofeatures: classes 3 and for. Class 3 includes silty-sandy or unsorted material, often including organic matter (Fig. 1.20 a, d), the class 4 is humus enriched pedofeatures (Fig. 1.20 c). These classes of textural pedofeatures were described only in anthropogenically transformed soils under early medieval occupation deposits. This fact allows us to ascribe 3 and 4 classes of textural pedofeatures to human impact. Besides that there are numerous evidences of biogenic activities such as coprolites (Fig. 1.20 a), and artifacts in layers of habitation deposit, fired stones in particular (Fig. 1.20 b). Processes of accumulation of iron- and humus-enriched illuvial material and formation of Fe-Mh-noduls seem to be more o less synchronous process and most probably related to a final phase of Gnezdovo soil development.

The next phase of pedogenesis with faint signs of lessivage related approximately to 800-600 years BP is recorded in an upper buried soil (starting from the depth of 50 cm).

Table 2. Section P-8, textural pedofeatures.

Horizon	Classes according the composition and morphology (see below the table)						Relative abundance
	1	2	3	4	5	6	
A	–	–	–	–	–	–	–
AC	–	–	–	–	–	–	–
2Ab	–	–	–	–	–	–	–
2EBtb	+	+	–	–	–	–	+
2Bt	+	+	–	–	–	–	+
3(Aub1)t	+	+	+	–	–	–	+
3(Aub2)t	–	+	+	+	+	–	++
4EBtg	–	–	+	+	+	+	++
4Bt1	–	–	+	+	+	+	+++
4BtC	+	–	+	+	+	+	+++

Classes of textural pedofeatures according their composition and morphology (+ occur, – do not occur): 1 – Clay, Fe-oxides and / or humus containing, low anisotropic; 2 – Sandy-silty, well sorted; 3 – Silt and silt clay, unsorted, with admixture of sand, organic (humus impregnation or/and charcoal dust); 4 – Clay with admixture of organic, grayish colour in polarized light, low anisotropic up to isotropic, diffuse or flecked extinction; 5 – Clay, with bright self and interference colors, sharp strait or wavy extinction; 6 – Clay, pale or nearly colorless, impoverished by iron oxides.
Relative abundance is estimated in following classes: – no, + few, ++ common, +++ abundant.

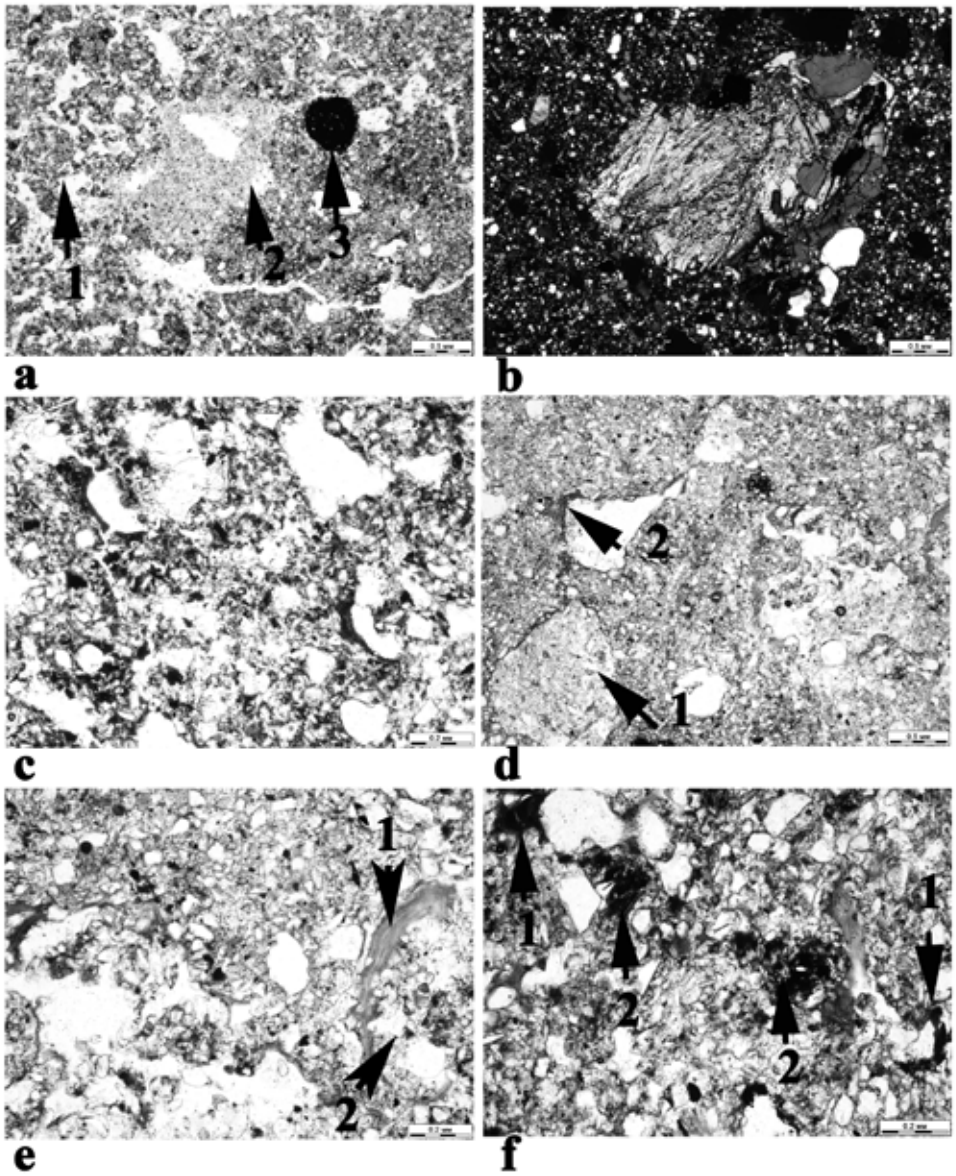

Figure Br12 – 1.20 Section P-8: micromorphological features.
a – 1- welded coprolites; 2 - Silt infilling (class 3); 3- Fe-Mn nodule in 3(Aub1)t horizon (occupation deposit) of Gnezdovo soil; b – Fired stone: cracked and altered along the cracks in 3(Aub1)t horizon (occupation deposit); c – Humus-clay coatings (class 4) in 4EBtg horizon of Gnezdovo soil; d – 1 – Silty infilling and 2 – humus-clay coatings in 4BtC horizon of Gnezdovo soil; e – Clay coating (class 5) and unsorted infilling (class 3) in 4BtC horizon of Gnezdovo soil; f – Fe-enriched coatings (class 1) and Fe nodules in 4BtC horizon of Gnezdovo soil.

Systematic *archaeological investigation* of floodplain sector started in 1999 and during the fieldwork four different function area were identified.

1. “Manufacturing” area is situated near the Kamyshi lake and is characterised as a jewellery and forgery center having also some dwelling houses and household buildings. The alternating record of those is dated back in the range of the second quarter of the 10 century up to the border of the Xth-XIth centuries.

2. “Periphery ” (near-terrace) area is located at the boundary of the flood-plain and the terrace. The remnants of dwelling houses were fixed within the area which were dated back to the beginning of the XIth century representing the final stage of the settlement existence.

3. “Harbour” area at the north-east bank of the Bezdonka lake, which probably was used as the inner harbor. The wooden planking supposedly could have been used as “hards” in the warf of the ancient Gnezdovo. The occupation deposits of this area as a whole could be bated back to the Xth century.

4. “Riverbank” area is located at the southern boundary of cultural layer near the Dnepr ancient river channel bank within the “beach”. The traces of different kind of human riverside activity were revealed. The studied features could be dated back in the range of the second quarter of the 10 century up to the border of the Xth-XIth centuries.

The central and the most elevated part of flood-plain sector of settlement is named “manufacturing” area as at the beginning of archaeological studies there was revealed a system of jewellery and forgery workshops. The finds of forgery furnaces and especially jewellery workshops is considered as a great rarity for the Viking age. The traces of manufacturing shops often are absent even in the case of finds presented with mould and rejected materials. It can be explained by the fact of base metal fusing could be performed in small fire places adapted specially for one crucible. Such primitive constructions could be attributed as a manufacturing workshop only by usage of special methods. The objects of the Gnezdovo flood-plain are of special interest as those can give the information on the different types of the manufacturing workshops. The data allows to trace the dynamics of forgery constructions, so we can speak about four succeeding construction types.

1. The most early object presents the deepened two-camera construction. The numerous slags accumulated in one of the camera indicate the connection of this object with the metal manufacturing. The second camera was adapted for bellows or perhaps was used for the flux storing. The similar scheme is observed at Medieval Trondheim at the 12th century excavations. the complete absence of the crucible fragments may support the assumption of exclusively ferrous metal manufacturing at the ascribed workshop.

2. The furnace of the second period was greatly distinct: it provides the cuplike pit surrounded by the low clay wall protecting the bellow from high temperature heating. A nozzle was found among the fragments of fired clay. Quite the same type of furnace was reconstructed at the Hedebu archaeological materials. It is assumed that such workshops were multifunctional and applied as jewelry and/or iron forgeries, the later being documented by crucible finds as well as numerous ferrous slags. The combination of jewelry and forgery is typical for the early medieval artisans.

3. The deepened furnace with marginal clay wall was succeeded by the construction with the preserved pit-trench. Its form is complicated by the step cut at the northern pit wall. A small stone fire place is sited at the step.

4. Most interesting and well preserved objects are related to the final period of the manufacturing center existence. The central part of the manufacturing area is presented with remains of a large stony fireplace. The fireplace is a joint by a pit of regular oval form with flat bottom and vertical walls. Probably such a near-furnace groove was designed for more comfortable work with bellows mounted at flooring above the pit. The mycological study of the near furnace pit filling demonstrated the presence of spores of keratinophilous fungus developing on wool, leather, hair and skin. Perhaps the later is an evidence of leather bellow usage at this workshop.

The occupation deposit related to the final period is abundant of finds, the majority of those being applied in the manufacturing processes. The crucibles are predominant among the casting implements.

The studying of crucible filling, ingots, metal spitting and manufacturing wastes as well as final products gave the opportunity to attribute the content of row materials of jewelry workshop: silver as well as a high standard gold, pure copper, bronze, brass and pewter were applied.

The ascribed workshop is considered as a center of the studied territory, but there were also several other types of constructions located: deepened household buildings for food storage and presumably living buildings.

Figure M-01 – 1.21. Selected finds from the floodplain area.
A – Dragon-shape mount. Flood-plain area. Central part; B – Reliquary-cross. Flood-plain area. Central part; C – Tongs. Flood-plain area. River-side area; D – Rowlock. Flood-plain area. "Port" area.

One of the most interesting objects ascribed in the study of so called “manufacturing area” was a land use boundary. It served as a western border of the section where a jewelry-forgery workshop was located. Later just at this point the succeeding each other pole fences were constructed. Thus the land use boundary was replaced by the fence. One more boundary was revealed at 13 meters to the west being the argument for the manor character of the lay out and gives materials to compare the planning of Gnezdovo settlement with the former of North European early urban centers, such as Kaupang and Ribe. It could be especially pointed out that the occupation deposit of the manufacturing area comprised numerous fragments of thin-wall glass vessels and amphorae. These objects traditionally are considered as indicating a high social rank of the owners. Such finds could serve as an indirect evidence of a high social rank of the manor owners possessing the jewelry workshop in the manor territory.

Selected archaeological finds from the floodplain are shown on Figure 1.21.

Shortly after decline of the Gnezdovo settlement cultural layer was buried by overbank silts and fine sands due to the rise of floods. Floodplain inundation and alluvial sedimentation on it resumed within the XIIIth century as is exhibited by OSL date 0.777±0.57 ka (GdTL-1237) at the base of overbank alluvial unit (Fig. 1.22). Most active flooding indicated by distinctive unit of laminated sands at depth 15-35 cm occurred in late XIV– early XV c. (OSL date 0.594±0.62 ka, GdTL-1236). After that alluvial sedimentation at the site declined. The last century was probably characterized by lowest floods in the last 800 years as is evident from modern floodplain soil Contemporary soils are developing within sin-sedimentary model of pedogenesis. Soil mantle of the floodplain nowadays is typical for seasonally inundated areas. Contemporary soil mantle includes a variety of Haplic, Gleyic, Stagnic, Histic Fluvisols. Zonal processes of vertical profile re-distribution of silicate material, iron and humus do not proceed nowadays. Only humus (or peat) accumulation, usually combined with short term (related to seasonal floods) or long term processes of reduction and oxidation in Stagnic and Gleyic conditions are ongoing.

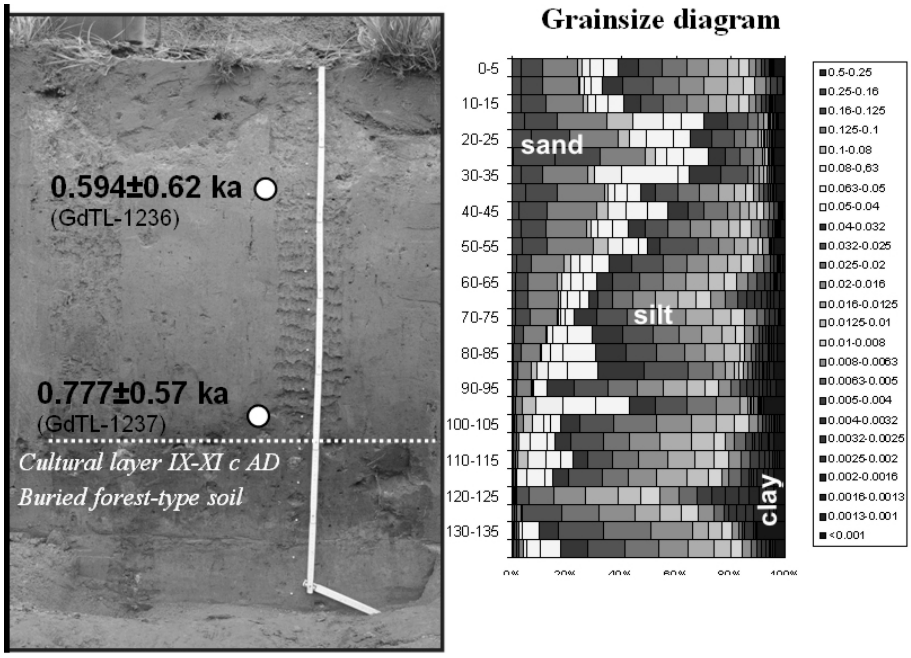

Figure P11 – 1.22. Section P8: another kind of FP-2 floodplain; sedimentation break in the first millennium AD and resume of sedimentation in the second millennium.

Section DP.

In the section that cut the levee at the Fp2 / Fp1 boundary characteristic sloping buried surfaces were found with microfaults indicative of sediment disturbance by gravitation (Fig. 1.23). These structures were most probably associated with steep bank created by lateral erosion by the river. Therefore they relate to the moment when the right river bank stayed at the Fp2 / Fp1 boundary. This river palaeobank was OSL dated by overlaying sediments at depth 1.4 m at 1.14±0.14 ka (GdTL-1235). Similar result was obtained by radiocarbon dating of charcoal at 2.3-2.4 m: 1050±200 (GIN-14377). It means that around the IX-Xth c. the river contacted directly the southern border of the settlement.

Figure P11 – 1.23. Section DP (2010): gravitational deformations of overbank sediments indicative of close location of palaeochannel bank.

This site location made to expect in a frame of archaeological investigations some peculiar objects connected with the shore line. Some traces of manufacturing which could be connected with river boat service, such as tar extraction and black-smith handicraft fire-places were revealed at this territory.

The tar-works pit was round in plane, its walls were sufficiently heated. An additional small pit is located at the bottom and was assumably used to maintain a vessel for tar accumulation. The pit was filled with charcoal.

A system of black-smith handicraft fire-places was excavated at the river-bank area. The fire-places were constructed one after another on the same place, Each fire-place was covered up with earth after the end of utilization and a new one was constructed. As a result a great artificial hill was formed.

The fire-place of final stage of settling was well preserved, the big blacksmith's tongs and the scythe were found nearby. A great number of slags serve as an evidence of activity connected with ferrous material working. The numerous boat rivets (including the whole, half-finished products and broken ones), were found. So we can suppose that this manufacturing area could be connected with river boat service.

The remains of some deepened structures were investigated within the river bank area. The structures had a form of oval pits with a charcoal layer at the bottom being the trace of burned wooden constructions. Its function is unclear. The results of biomorphic analyze showed a high content of moss phytolith. Mosses are not characteristic for a beach area, thus we can suppose, that moss came into the area with the turf, used for roof covering. Or maybe the moss was used for warming the walls. These data serve as indirect evidence of existence of ground-based part of deepened structures.

The Byzantine amphora, which is very remarkable and infrequent find was found in one of the deepened construction. Within other construction a set of beads as much as 50 items was found. Thus all the facts and first of all the location of this site let us to assume that the constructions in question are the riverside seasonal storage remains. It is evident that that this area could be connected with the “port economy” of Gnezdovo.

Point 4.5. Eastern bank of the Bezdonka Lake: sedimentation, traces of human activity, pollen data.

Core S20W60 in the center of the lake opened loams and sandy loams and a layer of peaty loam - loam with high content of plant macrofossils at depth 2.5-3.1 m, or 0.5-1.1 m from the lake bottom (Fig. 1.24). Reconstruction of local environment was made according to analysis of biological microremains (O.N. Uspenskaya, Russian Academy of Agricultural Sciences). Four stages were distinguished (note: depth scale begins at lake surface, lake bottom is at 200 cm): “wet floodplain” (575-445 cm), “dry floodplain” (445-370 cm), permanent lake (370-200 cm). Sediments at depths 370-325 cm and 255-260 cm indicate most shallow conditions, depths 235-250 cm and 200-220 (most recent) – the deepest conditions.

Radiocarbon dating was produced for the PS (peaty silt) layer. Many inversions evidence that the PS layer was disturbed. Majority of dates is contained within the range 800-1800 years BP. Probably this is the interval during which the SP layer was formed. It is confirmed by adjacent cores where the base of PS is dated at 1700-1800 years BP and the roof does at 700-800 years BP. Date 395±45 shows that turbation of sediments occurred or resumed during the XVIth century or later.

Now the Bezdonka Lake has maximum depth of 2.0 m. Its level is now regulated by a spillway cut through the main levee to the Svinets River. In the bottom of the spillway at depth of 2.0 m layer abundant with pine chips was found. Wood was radiocarbon dated to 1260±80 BP (LU-6108), or 840±180 AD cal. (95.4 %). Regardless whether the chips belong to the Gnezdovo cultural layer or to pre-Gnezdovo times, bottom of the spillway and level of the lake were about 2.0 m lower than they are now. Lake surface was at the level of today's lake bottom.

According to the above dating of the SP unit, 1000 years ago the lake bottom located in the upper part of the peaty silt unit, i.e. 60-70 cm below the modern bottom. Consequently, thickness of sediments accumulated in the lake in the last millennium is by

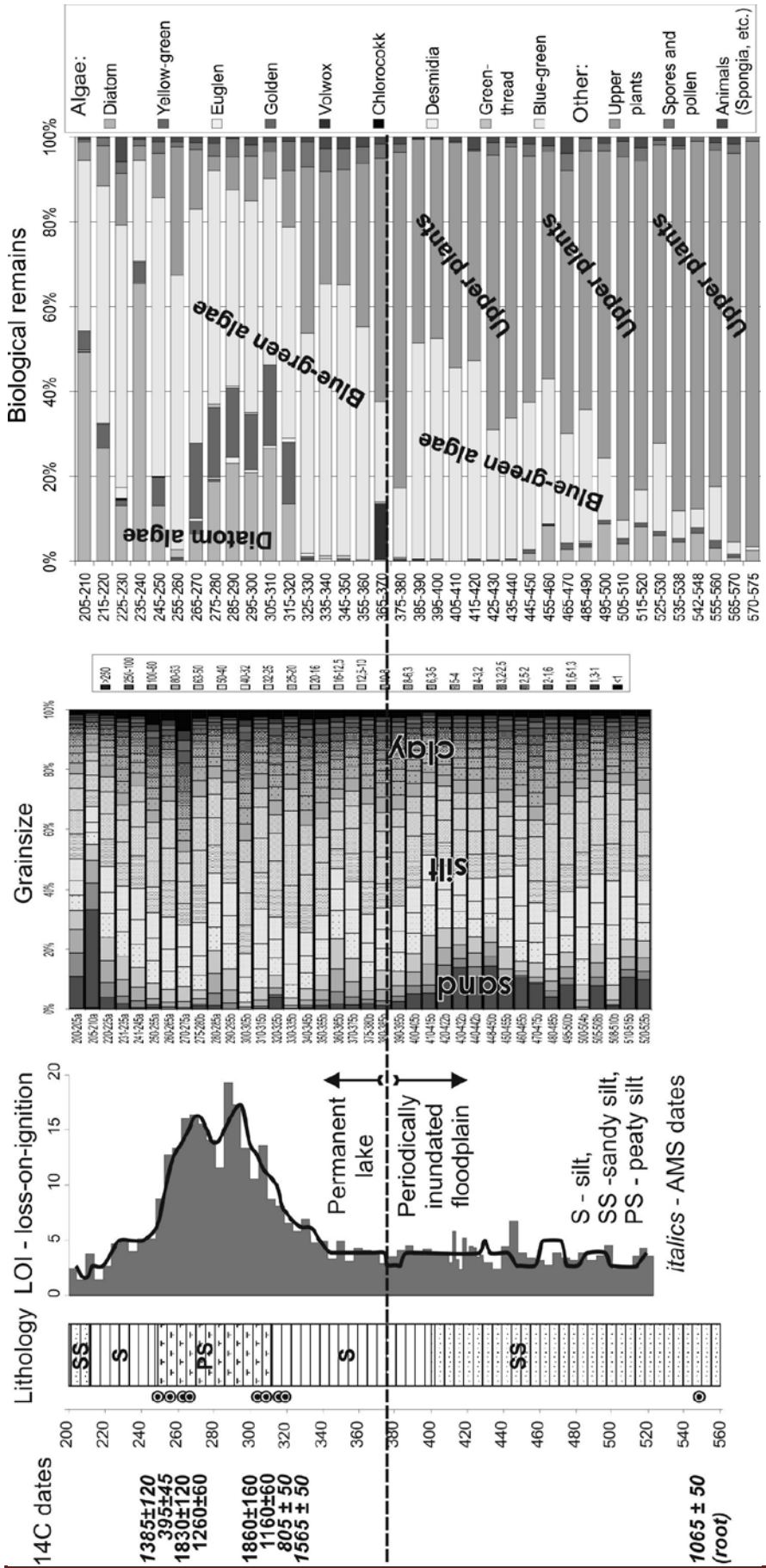

Figure P12 – 1.24. Age and lithology of the Bezdonka Lake bottom sediments (core S20W60). AMS dates are in italics. Depth scale: zero at lake surface (water depth is 2.0 m).

1.3-1.4 m less than that in the spillway. Therefore the lake depth 1000 years ago was by 1.3-1.4 m less than now: maximum depth was 0.6-0.7 m, lake area was two times as less as it is today. The other evidence of reduced dimensions of the lake 1000 years ago is the root of willow found at depth 5.5 m and dated to 1065 ± 50 BP (uncal): lake banks covered by willow woods were much closer to the centre of the lake than they are now.

To summarize, the Bezdonka Lake development indicates major events in local fluvial history. After extreme floods around 2.6 ka BP the depression formed which opened to the river channel and functioned as wet low floodplain. High sedimentation rates were raising the surface and in a while it became more dry. Permanent lake appeared when this depression was isolated by channel levee which formation began when the channel shifted to its edge. It happened about 2-2.2 ka BP. Since this moment the lake area and depth were governed by sedimentation rates in the lake and in the outflow channel (spillway). General tendency was increasing lake depth since it's formation till now.

The lake depression was ever one of the lowest places in the Gnezdovo segment of floodplain. During the time of the Gnezdovo settlement lake level was almost 1.5 m lower than now. Therefore artificial constructions at lake banks (see below) were not so wet as they are now. Nevertheless, unlike the top places of the floodplain, in the lake depression river flooding and alluvial sedimentation never broke. Cultural layer at the lake banks and in some other low parts of the floodplain usually intercalate with overbank alluvium (split CL). It may be used to estimate flood levels at the time of it's formation. Split CL is not found higher than 7 m above the modern river (Fig. 1.25). Most probably, this is the level of the highest floods in the Xth-XIth centuries. It was at least 3 m lower than levels of recent floods.

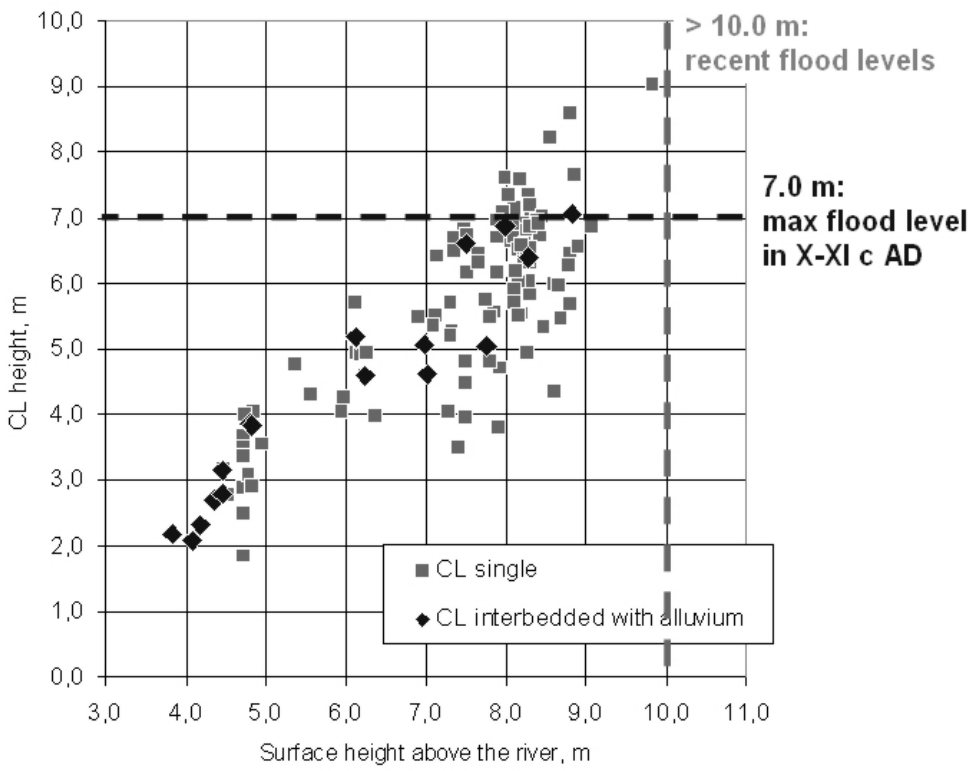

Figure P13 – 1.25. Estimation of flood height in the X-XIth c. AD via elevation of split cultural layer (CL intercalated with alluvium).

Pollen analysis was accomplished for a 335 cm core of Bezdonka sediments. A stratigraphy of the core seems to be intact. The upper part of the core is gyttja with variable amounts of plant remains, and a mineral composition of both sandy and silt particles. At a depth of 94 cm it is silty peaty gyttja and peaty silt. At the 155 cm the character of material changes qualitatively to more or less mineral sediments: clays, silty clays and silts with FeS and plant remains.

The volume of sample was measured and recent *Lycopodium* spores in tablets were added to determine concentration of pollen. Sample preparation followed the standard procedure described in Moore, 1991. The pollen reference collection of the Department of Earth Sciences, Uppsala University, together with keys by Fægri and Iversen (1989) and Moore et al. (1991) were used for pollen identification. To ensure the representativity of pollen counts about 1000 tree pollen grains (for rare samples with extremely low pollen concentration not less than 200) were counted at every level.

Pollen percentages were calculated by the "TILIA" program, based on the sum of tree pollen plus non-arboreal (herbaceous plants) pollen. Black areas on the diagram show the registered pollen in percentages, while white areas show the actual percentages with equal exaggeration. Anthropogenic indicators were defined according to Behre (1988) and Berglund et al. (1986). Grouping of plants was carried out applying a system by Königsson et al. (1995). Pollen assemblage zones were determined visually, on the basis of distinct changes in the vegetation.

The full pollen diagram worked out for oxbow lake sediments is presented in Fig. 1.26. On the evidence of pollen spectra the whole diagram undoubtedly corresponds to Subatlantic. Pine, spruce and alder dominate among tree pollen throughout the diagram only changing their proportion. The lowermost part of the diagram corresponds to the early Subatlantic (SA1), showing a slight predominance of spruce (*Picea*) pollen which is characteristic for the region. Then birch (*Betula*) takes up the first place among tree pollen followed by alder (*Alnus*), pine (*Pinus*) and *Picea*. The last significant phase is marked by the dominance of *Pinus* and general decrease of arboreal pollen exhibiting extensive deforestation.

First the diagram was divided into zones and subzones corresponding to major and minor stages of natural (climatic, successive) and, especially, human induced landscape development. Here the only major zones generally corresponding to big divisions in litho-stratigraphy of the core are discussed. These pollen assemblage zones characterise the basic phases of landscape development.

Zone I: 335–155 cm. This part of the diagram is characterised by high amounts of tree pollen. Originally, the area was densely forested and the presence of broad-leaved trees, mainly oak (*Quercus*) and elm (*Ulmus*) was still considerable. Human impact is not very significant here but nearly constant based on curves of cultivated plants and plants favoured by culture (Hemerophilous). Wheat absolutely predominates in this zone among the cultivated crops, but buckwheat, rye and hemp are also present. There are also some indicators of grazing, namely *Achillea*, *Pteridium*, and *Melampyrum* accompanied by an observable amount of ruderal plants and weeds (*Polygonum aviculare*, *Chenopodeaceae*, *Artemisia*, *Rhinanthus-type*, *Rumex acetosa*). Human impact ceased in the middle of the zone by a short stage of landscape recovery and forest invasion. Here a rise of *Betula*, together with a new increase of alder at the expense of *Pinus* and *Picea*, most probably resulted from human induced successions. Willows (*Salix*) and ferns (*Polypodiaceae*) are components of the alder forests.

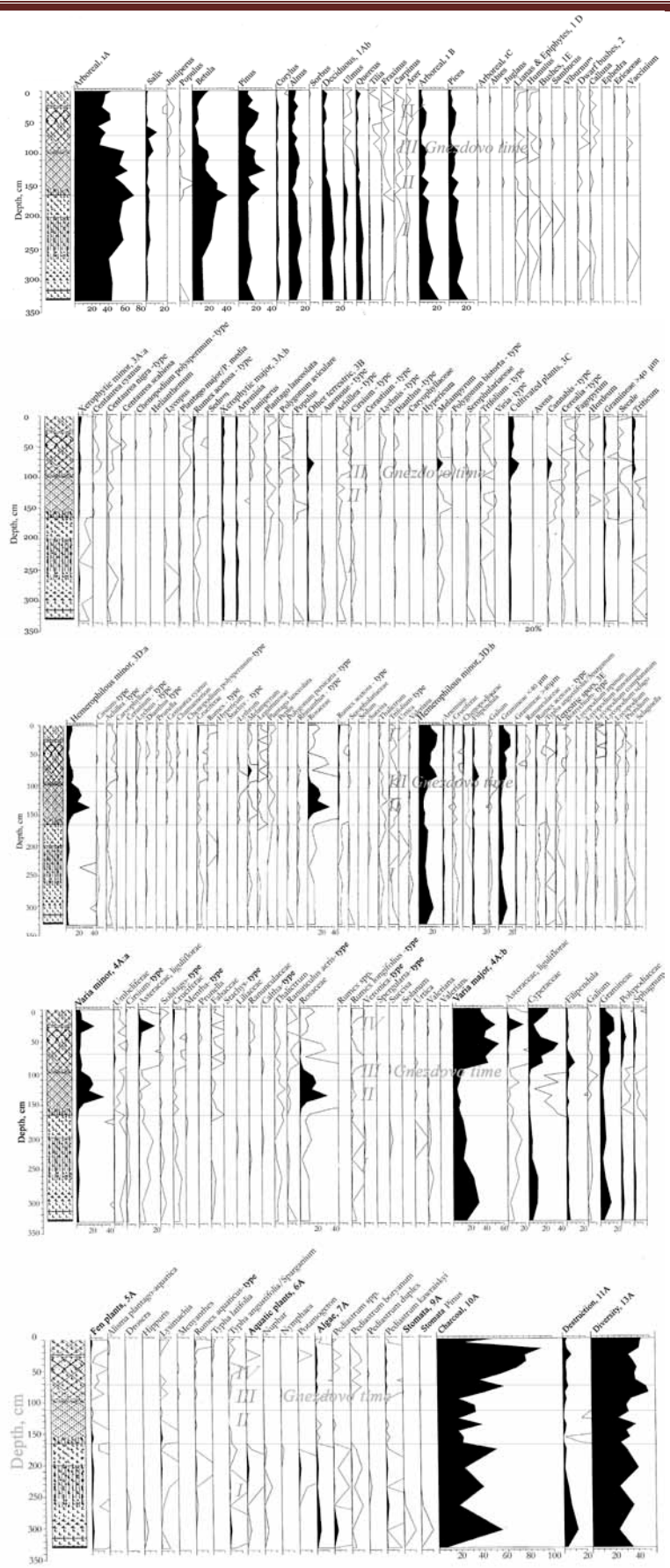

Figure Br14 – 1.26. Pollen diagram from the Bezdonka lacustrine sediments.

Presence of typical aquatic plants such as *Nuphar* and *Nymphaea*, and lots of algae testifies to limnic conditions in the sampling site. Low concentrations of pollen and high values of the Destruction coefficient indicate high sedimentation rates.

Stratigrafically this part of the core is represented by more or less mineral sediments. A number of hiatuses appear in the lowermost sector. That, together with repeated occurrence of sharp-bordered sandy-silty layers, most probably are due to repeated high spring floods of the Dnieper river.

Zone II: 155–110 cm. This pollen assemblage zone generally coincides with the next big stratigrafic division represented by peaty gittjia and peat with a relatively low admixture of mineral phase. The curve of pollen concentration indicates a heavy increase here and reaches its maximum. Such an abrupt change in pollen concentration, together with the rapid decrease of algae and all taxa of aquatic plants followed by their complete disappearance point to a critical change in the character of sedimentation. The oxbow lake dried up and peat formation established. Curves of some xerophytic plants increase steadily. These elements point to a climatically dryer phase of landscape development, characterised by low sedimentation rates, and low and irregular spring floods that did not affect the sampling site.

Agricultural activities diminished at this time but still took place according to the curves of cultivated plants and other culturally induced plants.

Zone III: 110–70 cm. The zone corresponds to the most extensive human impact reflected in the diagram. A particular feature of this zone is the extraordinary amount of *Cannabis* in the pollen spectra (more than 5 % of pollen sum). High quantities of *Cannabis* are regarded to be a specific characteristic of the Viking Age in the Baltic region (Andersen, 1984). Well ^{14}C dated diagrams were worked out recently for Novgorod and Ryurikovo Gorodische, where layers dated between the 9 and 12 centuries AD also revealed an extreme peak of *Cannabis* (Königgson et al., 1997). All this allows us to consider the zone III as corresponding to the time of Early Slavonic/Viking Age settlement at Gnezdovo.

The zone starts from an abrupt and drastic deforestation coinciding with a heavy rise in the charcoal curve. All curves of trees go down steeply. The curve of deciduous trees reaches its minimum. The sum of tree pollen is less than 35 %. Thus the originally forested area was turned into a more or less open landscape. Outstanding maximums of wheat and hemp with a considerable share of buckwheat pollen show their remarkable place in the economy of the settlement. Evident peaks in the curves of ruderal taxa, weeds, and grazing indicators emphasise variable and extensive land use. Consequently, this period is particularly remarkable for all types of human impact: deforestation related to everyday needs (fuel wood, timber etc.), fire clearance for husbandry, extensive and variable crop production, pastoral economy, as well as other habitation-related activities.

An important point is that the zone of the most intensive human impact falls at the very end of the climatically dryer period when the Dnieper's floods ceased, ant the floodplain surface was relatively dry and stable. This is obvious both from stratigraphy and pollen spectra. At a depth of 94 cm peaty sediments are replaced by clay gyttja and then silty clay gyttja. Algae, and aquatic plants appeared again which points to a re-establishment of limnic conditions in the oxbow-lake after the previous stage of overgrowth.

Zone III: 70–0 cm. This part of the diagram exhibit signs of a slight landscape recovery after the diminishing of early medieval settlement (decrease of cultivated plants accompanied by a rise of the tree pollen curve) followed again by enhanced human impact. After extensive deforestation in early medieval time the curve of tree pollen never

reaches its initial values. All anthropogenic indicators show a considerable drop in the beginning but nevertheless persist in the upper part of the diagram.

Total pollen concentration decreases heavily in the beginning of zone III indicating a rise in sedimentation rates. Sediments contain more and more silty and even sandy particles. The subsequent rise of pollen concentration in the uppermost horizon is most probably due not only to a new increase of sedimentation rates but also high activity of soil biota feeding on pollen. Considerable amounts of algae and aquatic plants are registered in this zone. Thus this last phase of landscape development is characterised by limnic conditions in the sampling site (or its closest vicinity), re-established intensive floodplain sedimentation and persisting human impact.

Pollen analysis of the Bezdonka lacustrine sediments allowed to draw following conclusions on Subatlantic development of vegetation and landscapes. Landscape development of the Gnezdovo micro-region, as reflected in the pollen diagram, was strongly affected by land use activities of population throughout the investigated period. Originally the area was densely forested. These were mixed forests with a considerable proportion of broad-leaved trees (10-15 % of pollen sum), especially oak. Phases of slight deforestation and increased human impact (increase of cultivated plants, grazing indicators, plants favoured by culture in the pollen spectrum) correspond to periods of population influx. These periods alternate with phases of landscape recovery after the decline of land use activities.

Signs of natural climatic change are evident in the middle part of the section. This was a period of slight aridization and reduced sedimentation on the floodplain. It is reflected by a change of sedimentation regime, the character of sediments and overgrowth of the oxbow lake, slight natural deforestation and the rise of dry-meadow plants.

The zone of the most significant and variable human impact is referred as the Slavonic / Viking Age Gnyezdovo settlement (1100-1000 BP) and falls at the end of a climatically dryer period when Dnieper's floods ceased; the floodplain surface was relatively dry and stable. Deforestation reached a dramatic extent at this time. Forests were most probably superseded by that time, particularly due to land use activities of the population. A heavy rise of cultivated plants in the pollen curve testifies to the importance of local crop production in the economy of the settlement. Wheat, hemp and buckwheat predominated among cultivated crops. Grazing activities also took place.

The decline of the settlement is denoted by the drop in cultivated plants, plants favoured by culture and slight forest invasion. This phase of landscape recovery is followed by the next stage of deforestation and expanded agricultural pressure, which corresponds to the contemporary state of the landscape.

The interpretation of Gnezdovo site like a key-point on the road from the Varangians to the Greeks allowed to assume the existence of structures servicing the fluvial route, but until recently no complexes or areas related to port activity here was discovered. A special task within the framework of the reconstruction of the topography of the settlement was to identify the areas which could be used for reception, fix, loading/unloading of ships and boats.

Participation of Gnezdovo inhabitants in navigation was documented by indirect data, predominantly by the finds of a large quantity of boat rivets both within the occupation deposits and in the graves and prominent rise of hemp in pollen spectra of the Gnezdovo time. Prominent maximum of hemp in pollen curves is very characteristic for the Viking Age in Scandinavia and is believed to be related to ship building (rope production). In addition to archaeological data we have the written sources evidence. Byzantine Emperor Constantine Porphyrogenitus in the mid of Xth century wrote that

Krivichy (local Slavonic tribe) constructed their monoxila (it means “dig-out”) in the hill-fort of Smolensk and navigated to Kiev, capital of Ancient Russia with Rhos (it means Scandinavian incomers).

“The monoxila which come down from outer Rhosia to Constantinople are from Nemogardas (Novgorod) and other from the city of Miliniska (Smolensk). Their Slave tributaries, the so-called Krivetaienoi (Krivichy) cut the monoxila on their mountains and come down to Kioba (Kiev).”

Constantine Porphyrogenitus “De administrando imperio”.

The main problem in search of fluvial harbor structures is the inexpressiveness of early medieval river wharf constructions. At the initial stage landing places could not have had no special constructions: the boats and people were simply pulled out on the bank. Naturally the archaeological criteria are not valid here, excluding perhaps the unical finds of boats or their fragments. The most primitive constructions were stones or posts used for mooring. At best the berth zone as at the sea coast as well as at the river bank could have been framed by the wooden planking (hards in order to approach to the water line).

The structures which could be interpreted as port ones were firstly ascribed near Bezdonka lake. This inner lake is located at the foot of the Central Hill-fort. It is connected by a channel to a tributary of Dnieper.

Two levels of planking were discovered here. The latest one represented a rather complicated construction – it was a system of wooden planks, under which the mats of birchen bark were lain. May be these mats were used like a dampproof course. Two levels of planking were discovered here. The earlier planking was more primitive: it was made of large planks, superimposed straightly on the ground. It is impossible to find out how those plankings were used. Such planking could be applied for pulling out the boats or inversely for launching and. perhaps for repair. At the same time these simple construction could be used for everyday purposes like fishing and laundering. It is impossible to find any archaeological criteria to divide these two functions.

At the lake bank two more objects were discovered which presumably also could be associated with navigation. First of those is the trench directed to the terrace from the Bezdonka lake, dated as the most ancient construction. The traces of wooden panelling of thin logs and perches are observed at the southern side of this trench. It could be assumed that the trench was used for pulling out the boats from the lake. Thus this construction could be interpreted as small inner portage.

The filling of trench contained one of our most impressive finds. It was a boat rowlock – a symbol of Gnezdovo harbor. The rowlock was decorated with ornamental pattern of Scandinavian origin.

The second object presumably connected with the navigation is a finely preserved picket rooted in the ground at one of the most ancient uncovered surfaces. This picket has some traces of a bast rope. It could be assumed that it was one of “mooring picket”, one of most ancient harbor construction.

At the territory of the “harbor area” the traces of peculiar handicraft activity were ascribed in a form of tar-works. The pit for tar extraction had a depth of one meter, its lower part was filled with dense fatted charcoal interpreted as relics of tar sublimation. The analyses of remnants showed the presence of coniferous bark.

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PART II.
GEOARCHAEOLOGY OF THE SERTEYA MICROREGION, THE UPPER DVINA BASIN.

CHAPTER 2.1.
GEOMORPHIC AND SEDIMENTATION HISTORY OF THE UPPER DVINA BASIN

Geological structure of Dvina-Lovat' basin

The area of Dvina-Lovat' basin is located at the boundary of Pskov and Smolensk regions of the North-Western Russia (Figs. 2.1, 2.10). The feature of this territory is the glacial and fluvioglacial topography, a lot of lakes and the recent drainage network. According to K.K. Markov [Markov, 1961], the formation of quaternary relief during Wűrm glacial stage depended on the geological features of region: the ledges of Southern part of Baltic shield, the Cambrian and Devonian lowlands, the Ordovician and Carbonic plateaus. The areas of moraine plains, moraine hills, kames, which are the regional formations of Last Wűrm glacial expansion, are located among the undulating plains composed of fluvial-glacial and lake-glacial deposits. Such type of landscape is typical for Dvina-Lovat' area. The local formations in this area are the separate moraine ridges and lake-glacial hills eroded by glacial snowmelt runoffs. The chains of lakes in this area were formed during Holocene period within the fluvioglacial and moraine depressions after recession of Late Wűrm stage Ice-sheet. At present time these lakes have turned into swamps. The Serteya River cuts the lacustrine sediments and flows into Western Dvina River.

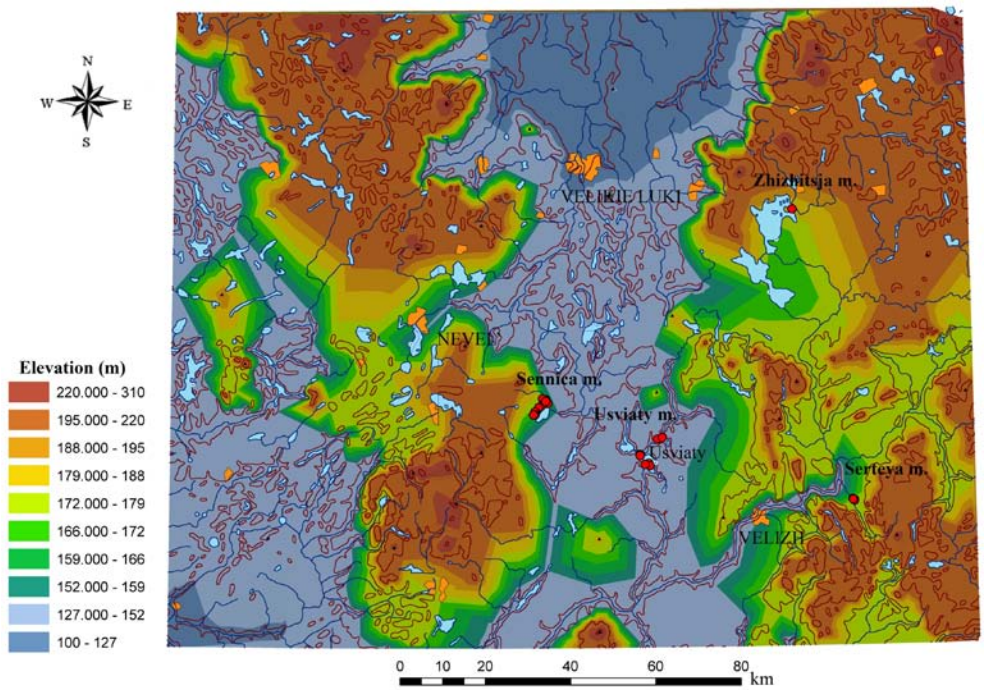


Figure 2.1. Archaeological microregions of Dnepr-Dvina basin.

The most active processes of lake formation on this territory had a place in the end of Pleistocene – the beginning of Holocene and their activity has increased during humid stage of Holocene, as is supposed by N. Davidova [History…, 1992]. The age of the lakes

was determined by the time of region deglaciation, the melting of buried ice. It was the time of beginning of the most lake formations. The climatic conditions of territory located in the humid zone of high precipitation were favored for lakes developments. The lake sediments were excavated in the bottom of numerous of peatbogs located in the North-Western Russia. These data reveals that small lakes turned into swamps during Holocene because of high deposit sedimentation.

The tectonic processes of the Fennoscandian shield had more influence on the development of drainage network on North-Western Russian plateau and the water fluctuations in the lake basins during Holocene than climatic changes. It was argued by many authors [Miettinen, 2002; Lak, 1975]. The isostatic elevations of the earth's crust in the study region were the most intensive right away after the degradation of icesheet. This process influenced the global fluctuations of Sea level because of the entry of great water volume. The eustatic variations of ancient Baltic Sea and drainage network of North-Western were connected with these events too. Therefore the changes of water level in the lakes of North-Western Russian plateau coincide with the transgressive-regressive stages of Baltic Sea. Depending on the rate of the land elevation the maximum of transgression stages in the lakes of different zones occurred at different time and had asynchronous character. So, the transgression in the basins has begun earlier in the zones of slow elevation of the land in comparison with the zones of fast elevation.

The important changes in the life of prehistoric people occurred in the Dvina–Lovat' region during Holocene. Climatic fluctuations influenced the development of prehistoric societies. The Holocene period was one of the most favorable time in the history of humanity. Recent investigations, however, have showed that this period was characterized by global climatic fluctuations connected with solar activity (see Dergachev and van Geel, 2004; Dergachev et al., 2003; van Geel et al., 1998, 1999). They are characterized as very cold short phases. Many of these changes were sufficiently fast from the point of view of human civilization (i.e. a few hundred years and less) that they may be considered "rapid" [Mayewski et al., 2004]. According to numerous researches, the global episodes of fall temperature synchronous with a period of low solar activity after the Younger Dryas (12700-11500 cal BP) were recorded at 8200 cal BP (6200 cal BC) (Kofler et al., 2005; Magny et al., 2003; Heiri et al., 2004), at 5800 cal BP (3850 cal BC) and 5300 cal BP (3350 cal BC) ((Magny and Haas, 2004); around 4100 cal BP (2150 cal BC) (An et al., 2006; Chen et al., 2006); at 2800 cal BP (850 cal BC) (van Geel et al., 2004; van Geel and Beer, 2007); and around 300 cal BP (17-19 cc. AD).

Chotinskiy N.A. [Chotinskiy, 1978] and Pazdur A. [Pazdur et al., 2004] distinguish the following climatic periods for the humid zone in the North-Western Russia and Poland area during Holocene:

Preboreal period, dated about 10470-9900 cal BC is characterized by cool and dry conditions. In Poland area the interval of Preboreal stage was determined at 9550-8350 cal BC.

Boreal period (8800-8250 cal BC) is characterized by rising of temperature in comparison with previous period. According to Pazdur, the Boreal period was warm and dry and it proceeded from 8350 to 7500 cal BC.

The transition to Atlantic period, beginning about 7500 cal BC is characterized by more warm and humid climate. The forests became more multifarious. The deciduous forests with oak, elm, linden and hazel are prevailed. On the Pazdur data, Atlantic period can be divided into four stages: AT1 (7500-6480 cal BC) – cool and dry stage; AT2 (6480-5550 BC) – warm and humid stage, AT3 (5550-4900 cal BC) – warm and humid

stage, AT4 (4900-3800 BC) – cool and humid stage. Aleshinskaya A.S. and Spiridonova E.A. [2000] note that the interval of 4900-2750 cal BC in the steppe zone of Russia was the time of late Atlantic climatic optimum, including the first half of Subboreal period. In this time the forests penetrated deep into Western regions of Eastern Europe and they were spread in the river valleys. The transitional Atlantic-Subboreal stage was about 3650-3350 cal BC. The transition to Early Subboreal cool stage has begun about 3350-2600 cal BC. The climate became drier. After 2750 cal BC the arid climate and decreasing of precipitation was recorded by Aleshinskaya A.S. The steppes extended on the Western part of Russia. The water level in the rivers and lakes has fallen in this period. The Middle Subboreal warming and decreasing of precipitation has begun at 2200 cal BC and its maximum is registered at 1700 cal BC. The Late Subboreal fall of temperature and increasing of humidity was registered about 1450-600 cal BC. Such conditions proceeded during second half Subboreal period and first half of Subatlantic period. According to D.Van Geel et al. [1996] the sharp increasing of humidity and fall of temperature was registered at 850 cal BC in the Netherlands area. They found the data about such climatic change at 800 cal BC in another regions of the Earth too. This global climatic change could be due to the fact of solar activity variations in this period. On the territory of modern Poland the Subboreal 1 stage was noted at 3800-2850 cal BC. It was warm and dry stage. The Subboreal 2 stage was at 2850-950 cal BC and it is characterized by warm and humid climate.

The Subatlantic period has begun at about 800 cal BC. Its beginning can be characterized as cool and humid stage. According to A. Pazdur the beginning of the Subatlantic period was at 950 cal BC. Subatlantic 1 stage was at 950 cal BC-150 cal AD – warm and humid stage. Subatlantic 2 stage was at 150 cal AD – 500 cal AD, warm and dry stage. Subatlantic 3 stage was at 500-1430 cal AD, the climate was cold and dry.

The present-day climate of Dnepr-Dvina basin is moderately continental, with mean temperatures of -8°C in January and 17–18° C in July, and the annual precipitation of 500–700 mm, mostly in summer. This area belongs to the East European mixed broadleaved-coniferous forests. Temperate deciduous formations consist of mixed oak forests, which are found mostly on the clayey soil of the morainic hills. Boreal evergreen conifer (mostly pine) forests cover the sandy outwash plain. Spruce forests are usually restricted to the lower levels of the morainic hills. An intensive felling of forests started in the XIII–XIVth centuries and much increased after the 1860^{s}. The woodland currently occupies less than 20 % of the originally forested area. The secondary forests consist of birch, and alder with shrubs. Bottomland floodplain meadows, bogs and mires occupy about 40 % of the total area. Agricultural plots take up the remaining 40 %. Main staple crops are rye, wheat and flax.

Detailed reconstruction of climate is necessary for understanding the influence of landscape and paleoclimate conditions on ancient inhabitants. Use of different and independent natural scientific methods allow making detailed picture of regional and local climatic changes and their influence on ancient inhabitants. Such complex researches were conducted in Dvina-Lovat basin especially in Serteysky microregion [Mazurkevich, 2003, 2004; Mazurkevich et al., 2009; Dolukhanov et al., 2004; Kulkova and Savelieva, 2003; Zaitseva et al., 2003; Kulkova, 2005; Kulkova, 2006; Kulkova et al., 2001]. The two main lake valleys on the sides of which the ancient settlements were found can be distinguished in the modern landscape of Serteysky microregion. It is the Serteyskaya big lake valley and Nivnikovskaya small lake valley. The ancient lakes situated in chain were connected with each other by narrow neck of land which has been eroded during transgressive stages. Archaeological sites are situated on their shores and

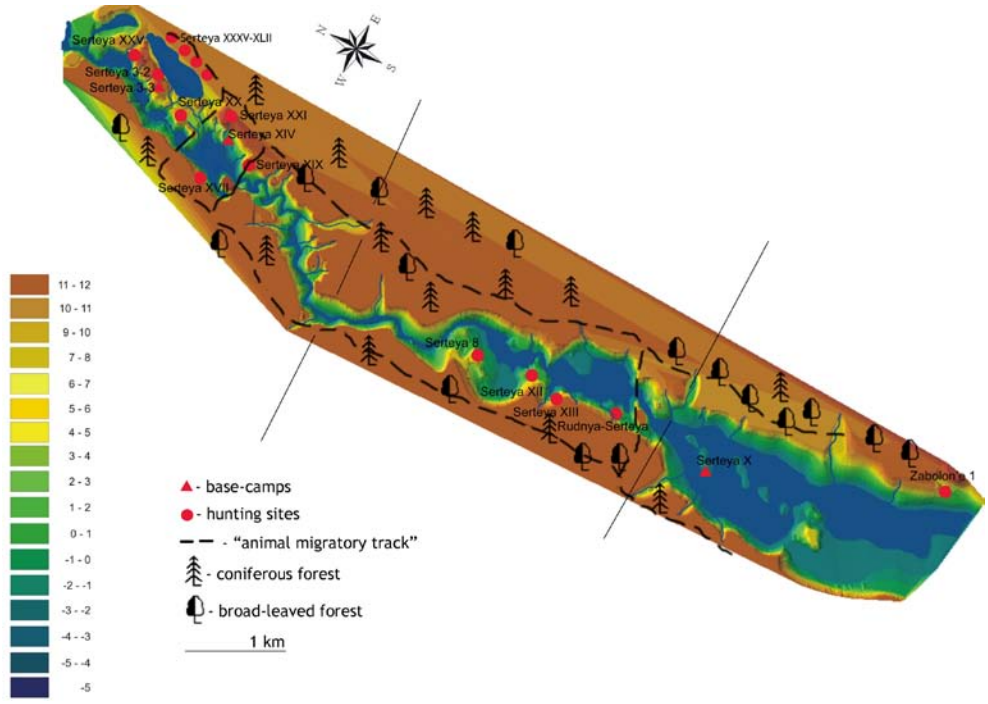
inside of lake basins (Fig. 2.2). The variations of water level of these lakes mainly depended on the changes of Baltic Sea level. The influence of climatic changes on the transgression-regression stages was low. This factor could have the vital importance for prehistoric people which migrated during periods of climatic deteriorations when the most of water reservoirs of the forest-steppe zone became shallow.

Figure 2.2. Valley of Serteyka River.

Gyttja lake sediments from two lake depressions – Serteyskaya big lake depression and small Nivnikovskaya lake depression – were studied in order to reconstruct landscape-climatic conditions using methods of geochemical indications. The Serteyskaya lake depression consists of rust-red moraine loam. The Nivnikovskaya lake depression consists of fluvioglacial medium-grained laminated sands and siltstones of yellow and pink-yellow colors. The boarder of moraine deposits and fluvioglacial deposits is located in the Northern part of Serteyskaya valley. The mineralogical composition of deposits was determined by optical microscope and XR-diffraction analysis. The deposits consist of quartz, feldspars, amphibole, mica, from accessories minerals as carbonates, ilmenite, magnetite, rutile, tourmaline, zircon, garnet. The Holocene lake deposits can be differed into two types. The deepwater deposits consist of eight meter thickness of peat and gyttja. The shallow deposits of one meter thickness consist of laminated sands, siltstones and loams with organic components of light grey, yellow-grey colors.

Holocene organogenic sediments – gyttja and peat – were studied in cores № 62, 72 (a), 63 (Figs. 2.3, 2.16) situated in deep-water parts of Serteyskaya and Nivnikovskaya lake depressions using hand “Russian” drill. The core № 63 is situated near archaeological site Serteya X, the core № 72 (a) – near the site Serteya XIV, the core № 62 – near the site Serteya II. Samples were taken from every layer, the age of sediments was determined using ^{14}C dating. The radiocarbon measurements have been obtained for 96 samples of wood and charcoal from archaeological structures, as well as for organic samples from lacustrine deposits. These measurements were carried out

mainly at the Labs of the St.Petersburg Institute of History of Material Culture (LE) [Zaitseva, 2003] and the Institute of Geography (LU) [Arslanov, 2003]. The combining of stratigraphical and archaeological information and radiocarbon dates by means of MCMC simulation allowed us to obtain more accurate calendar ages for environmental and historical events (Kulkova in print). The Markov Chain Monte Carlo (MCMC) simulations base on the Gibbs algorithms [Gilks et al., 1996; Litton, Buck, 1996] and Metropolis-Hastings algorithms. Both of them are applied in OxCal program by Bronk Ramsey [2001]. The reconstruction of paleoenvironmental events and chronology of archeological cultures of Dvina-Lovat' basin is shown on Figure 2.8. The main



archaeological sites are situated in the Serteya river basin.

Figure 2.3. Distribturion of early Neolithic sites in Serteysky microregion.

Lacustrine sediments from the cores № 62 and 63 were studied using pollen analysis by Savelieva L.V. [Kulkova and Savelieva, 2003], diatomic analysis was made by Djinoridze E.N. [Arslanov et al., 2003]. The mineral composition of gyttja is: quartz 20-30 %, feldspar 40-50 %, mica 5-10 %, carbonate to 10 %, clay to 15 %, anhydrite 2-3 %. The iron oxides and hydroxides are in mineral forms of hematite, goethite, hydrogoethite and hydrotroillit. Loss on ignitions were determined at 550^0 C and it estimates loss of organic and carbonate part in the samples.

The chemical composition was obtained by XRF and spectral emission methods. The investigation of mineral and chemical compositions of peat- gyttja deposits from two cores and data processing by mathematic statistic methods (correlation and principal component analysis) allows us to established the antagonism between chemical element complexes: TiO_2, Al_2O_3, K_2O, Na_2O / CaO, C_{org}, MnO and Ni, Co, Cu, Cr, Zn, Pb / Ca, Sr. The complexes TiO_2, Al_2O_3, K_2O, Na_2O in concerned sediments mainly belong to feldspar, mica and clay minerals. These terrigenic minerals enter in the lake from shores. According to hydromechanical differentiation these minerals accumulate in the clay-aleuric sediments. The more deepwater pelitic sediments contain a lot of organic material and authigenic minerals, which were sedimented by means of biogenic and chemogenic

processes in the water column and near-bottom layers. These minerals contain MnO, CaO, Sr. Calcium and strontium were determined in the carbonate and sulphate composition. Manganese forms oxides and hydroxides. These data were compared with diatom analysis data. The increasing of concentration of TiO_2, Al_2O_3, K_2O, Na_2O compounds and Ni, Co, Cu, Cr, Zn, Pb elements in the sediments correspond with the stages of lake level decreasing, but the increasing of CaO, C_{org}, MnO, Sr concentrations correspond with the stages of lake level increasing. The ratios of complexes terrigenic to authigenic elements were used as the lake level marker.

The lake productivity depends on diatom development. The improving of climatic conditions, for example, high temperature and high humidity, intensive soil erosion favours the increasing of population of diatoms. As a result of hydromechanical differentiation the clay – aleuric sediments, containing clay, feldspar and biogenic silica deposited at the deepwater lake part, but quartz sedimented in the sand lacustrine deposits. Gavshin M., Chlistov O.M. [2000], Shimarev M.N. and Mizandronzev I.B. [2004] proposed to use for estimation of lake productivity the SiO_2 / Al_2O_3 ratio, which mean the biogenic silica part in the deepwater organic deposits. This ratio was used for Serteya lake productivity estimation and it has good correlation with the quantitative estimation of planktonic diatoms.

According to Gerald A.G. [1984], Kalik S.A. and Mazilov V.N. [1998] for weathering intensity evaluation, which depends on the temperature variations, the following markers are used: $(K_2O+Na_2O) / Al_2O_3$; K_2O / Na_2O; $CIA = Al_2O_3 / (Al_2O_3+CaO+Na_2O+K_2O)$. These markers were calculated for organic deposits of Serteya lake. The comparison with pollen analysis data allows establishing the most sensitive temperature geochemical marker. It is the Na_2O / K_2O ratio, which shows the grade of plagioclase weathering to the potassium feldspar. In conformity with Chen Yun et al. [2001] the plagioclase is more sensitive to weathering then the potassium feldspar.

In the humid climatic zone the precipitation prevails under evaporation and the oxidation and aquation processes are more intensive. Iron is the element, which sediments in these conditions. According to Makedonov A.V [1985], the high concentration of iron in the deposits is indicator of humid climatic conditions. The carbonate calcium is another indicator mineral, which characterizes the variation of humidity, as Bor-ming Jahn et al. [2001] notes. The increasing of humidity and therefore the increasing of CO_2 concentration in the water solution is the cause of carbonate dilution. In Serteya lake deposits iron mainly compose the oxide and hydroxide. Calcium mainly compose the carbonate calcium. The Fe_2O_3 / CaO ratio variations in the organic lake deposits, marked the humidity changes, have a good agreement with the pollen data and the Fe_2O_3 / CaO ratio was used for estimation of humidity.

The sediments in the Serteya basin deposited in the zone of intensive ancient settlement development during Holocene. The geological surrounding was the sphere of human influence. Therefore man's impact on the sediment formation must not be ruled out. Finkl Ch. [1985] and Milton G. Nunez [1977] noted that calcium and phosphorous are the main components of teeth and bones and the carbonate-apatite is the initial source of soil phosphorous considerable proportion. According to these authors, in case of phosphorous accumulation in the deposits during human activity, the most part of phosphorous bounds with iron and aluminium and these compositions are stable to weathering during thousand years and they can not be take up by plants. The ancient settlements were found not only in the littoral lake parts but in the central lake parts. At this points the pile dwelling constructions were located. As a result of investigations of

gyttja deposits from deepwater lake parts the antagonism of P_2O_5 to another elements was established. The sediments rich with P_2O_5 were deposited in the periods of ancient site appearance and development. Thus the increasing of P_2O_5 proportion to other chemical components in the lake deposits of this region can reflect the anthropogenic impact on the lake.

Pollen and diatom analysis

Lacustrine sediments from cores № 62, 63 were studied with the use of pollen analysis by L.B. Savelieva [Kul'kova and Savel'eva, 2003] and diatom analysis by Djinoridze E.N. [Arslanov et al., 2003].

Core № 63. The core № 63 (Figs. 2.4; 2.5) is located in the deepwater lake part near the settlement Serteya X. The core depth is 8 meters.

Pollen analysis (Fig.2.4):

1. Zone I (AL, 750-850 cm, aleuric sediments). The pollen of plantations of trees prevails in the spectrums (*Betula sect. Albae* 15-50 %, *Pinus* 15-30 %, *Picea* 10-20 %) with significant content of weed pollen (17-39 %), mainly *Artemisia* (10-20 %). The concentration of alder pollen varies from 2 % to 10 %. Among spore plants the *Bryales* dominant in the deposit. The *Selaginella selaginoides* moss is rare. The Drias deposits are absent according to the pollen data.

2. Zone II (PB-1, 750-700 cm, gyttja). The concentration of pine pollen increases (*Pinus* 25-55 %), but the spruce pollen decreases (2 %). The birch pollen concentration is 20-55 %. The herb pollen concentration is not more than 10 %, mainly it is *Poaceae* and *Cyperaceae*. The concentration of spores are low. The climate was cold.

3. Zone III (PB-2, 710-650 cm, gyttja). The deposits contain the pollen of *Betula sect. Albae* (65-80 %), *Pinus* (15 %). The concentration of spruce and deciduous tree pollen is small. The herb pollen concentration is 5 %. The spores of *Polypodiaceae* prevail.

4. Zone IY (PB-3, 650-610 cm, gyttja). The *Betula sect. Albae* pollen concentration is decreased to 55-60 %. The *Pinus* pollen concentration increases to 20-25 %. The appearance of deciduous forest is the typical feature of this stage.

In the Boreal period the forest predominates because of the climate improvement. The climate was cool and dry.

5. Zone Y (BO-1, 550-610 cm, gyttja). The curve of *Pinus* pollen increases sharply (30-60 %). The *Betula sect. Albae* pollen concentration decrease (to 25-35 %). Sum of deciduous tree pollen makes up 20-23 %, *Corylus* – 2-3 %. The herb pollen concentration is not more than 8 %. The spores of *Polypodiaceae* prevail.

6. Zone YI (BO-2, 550-490 cm, gyttja). The *Pinus* and *Betula sect. Albae* pollen concentrations are in the spectrum in equal amounts (25-35 %). The *Ulmus* pollen concentration reaches to 20 %. Sum of deciduous tree pollen *(Ulmus, Tilia, Quercus)* makes up 30 %. The *Corylus* pollen concentration is 5-10 %, *Alnus* – 3-12 %, *Picea* – 4 %. The herb and spore pollens are single.

The beginning of Atlantic period is characterized by maximum of deciduous trees and increasing of hazel pollen concentration (to 36 %) and decreasing of pine and birch pollen concentration. The climate became warmer and more humid.

7. Zone YII (AT-1, 490-440 cm, gyttja). In the spectrums the deciduous tree pollen (30-36 %), *Alnus* – 15-20 % and *Corylus* – 10-15 % predominate. The *Pinus* and *Betula sect. Albae* pollen concentration falls. The *Picea* pollen concentration is 5 %. The herb and spore pollens are single.

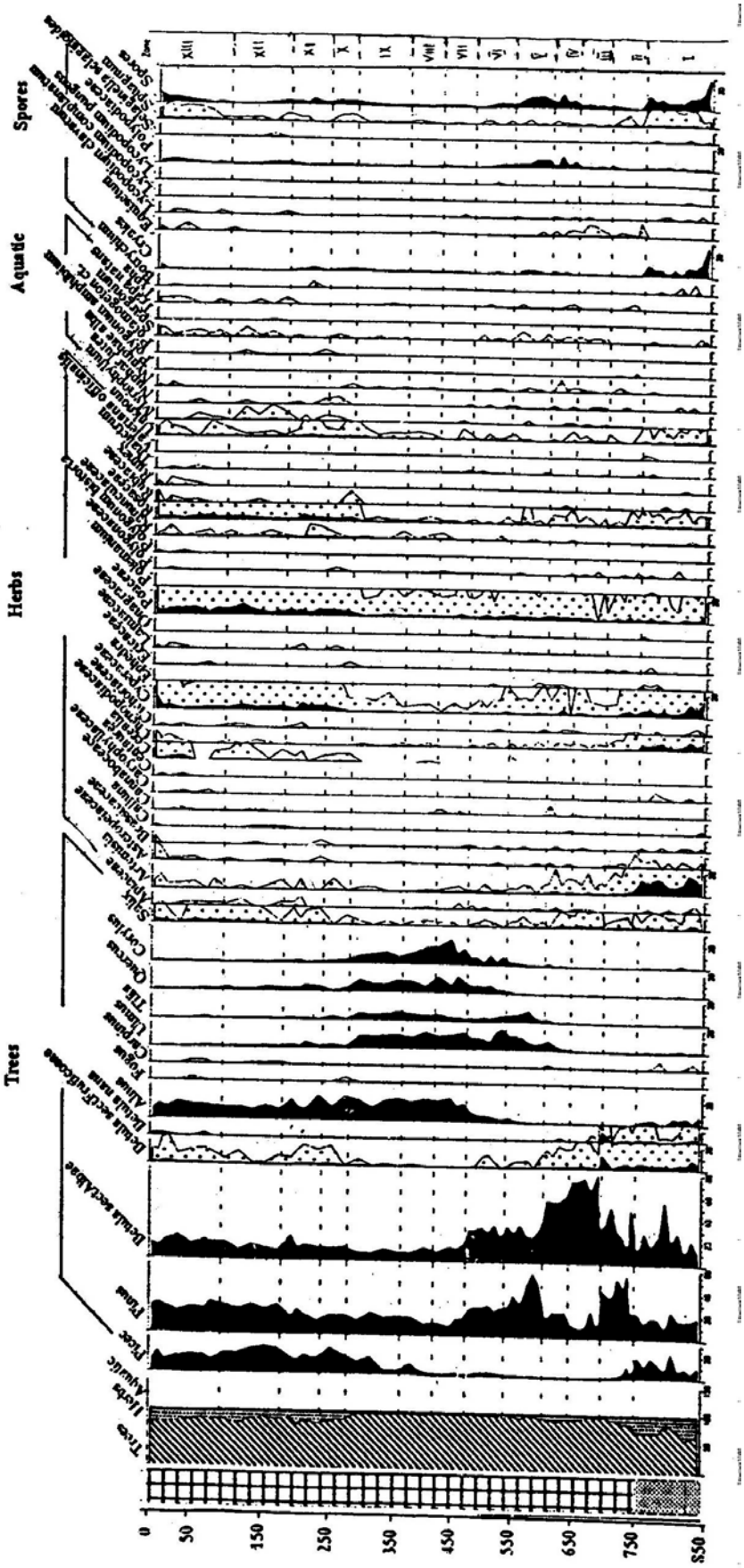


Figure 2.4. Pollen diagram of the core № 63.

8. Zone YIII (AT-2, 440-390 cm, gyttja). The base components of spectrum *(Picea, Pinus, Alnus)* are the same as in Zone YII. The decreasing of the deciduous trees and *Coryius* pollen concentration is registered. The herb and spore pollens are single.

In the middle Atlantic period the decreasing of deciduous forest was registered. The climate became more cool.

9. Zone IX (AT-3, 390-310 cm, gyttja). The distinctive feature of this zone is the peak of *Picea* pollen curves (12 %). The deciduous tree pollen concentration slightly increased.

In the end of Atlantic period the deciduous tree pollen concentration increased and the spruce pollen appeared. The climate became warmer.

In the Subboreal period the spruce became the base forest type. The pine-spruce and birch-spruce forest with alder-trees, deciduous trees and hazels were developed. In the spectrums the beech pollen appeared, the herb pollen concentration increased.

10. Zone X (SB, 310-270 cm, gyttja). The maximum of *Picea* pollen (23 %) is registered. Amount of *Pinus*, *Betula sect. Albae* and *Alnus* pollen varies between 12-20 %. The deciduous tree pollen concentration decreases sharply: *Ulmus* – to 3 %, *Tilia* – to 4 %, *Quercus* – to 2 %. The single grains of *Fagus* appear. The herb pollen concentration increases to 18 %.

The transition to cold and humid climate takes place in the beginning of Subatlantic period.

11. Zone XI (SA-1, 270-210 cm, gyttja). In the spectrums the *Picea* pollen concentration decreases to 15 %. Amount of *Pinus* pollen varies from 15 % to 20 %, *Betula sect. Albae* from 10 % to 15 %, *Alnus* from 10 % to 20 %. Sum of deciduous tree pollen *(Ulmus, Tilia, Quercus)* makes up 10 % due to increasing of oak pollen concentration.

12. Zone XII (SA-2, 210-120 cm, gyttja). In the spectrums the *Picea* and *Pinus* pollen predominate (20-25 %). The *Betula sect. Albae* and *Alnus* pollen concentration is not more than 10 %. Sum of deciduous tree pollen decreases to 2 %. The single grains *Carpinus* appear. In the herb group the culture cereals of *Cerealia* (3-5 %) were found.

13. Zone XII (SA-3, 120-0 cm, peat). The base components of spectrum are *Picea, Pinus, Betula sect. Albae, Alnus* pollen (10-25 %). Sum of deciduous tree pollen decreases to 1 %, it is mainly the oak pollen. The herb pollen is presented by *Poaceae, Cyperaceae, Rosaceae, Chenopodiaceae, Polygonaceae, Cannabaceae, Caryophyllaceae, Artemisia, Thalictrum, Rumex.*

Diatom analysis.

Depth 850-685 cm – the deposits do not contain the diatoms.

Depth 665-610 cm – the poor complex of freshwater planktonic diatoms *(Aulacoseira granulata, A. italica, Cyclostephanos dubius, Synedra ulna)* appear in the deposits.

On the depth of 530-490 cm and 490-460 cm the single freshwater diatoms were found.

Depth 460-330 cm – the deposits do not contain the diatoms.

Depth 300-240 cm – *Epithemia zebra, E. turgida, Cocconeis placentula, Fragilaria construens, Synedra ulna, Meridion circulare* diatoms compose almost 80 % of diatoms. Among the planktonic species consisted not more 20 %, *Aulacoseira granulate* diatom predominates. The appearance of *Melosira varians* diatom (3-9 %) is the indicator of weakly saline water. These data allow suggesting that the lake basin was shallow and returning into marsh.

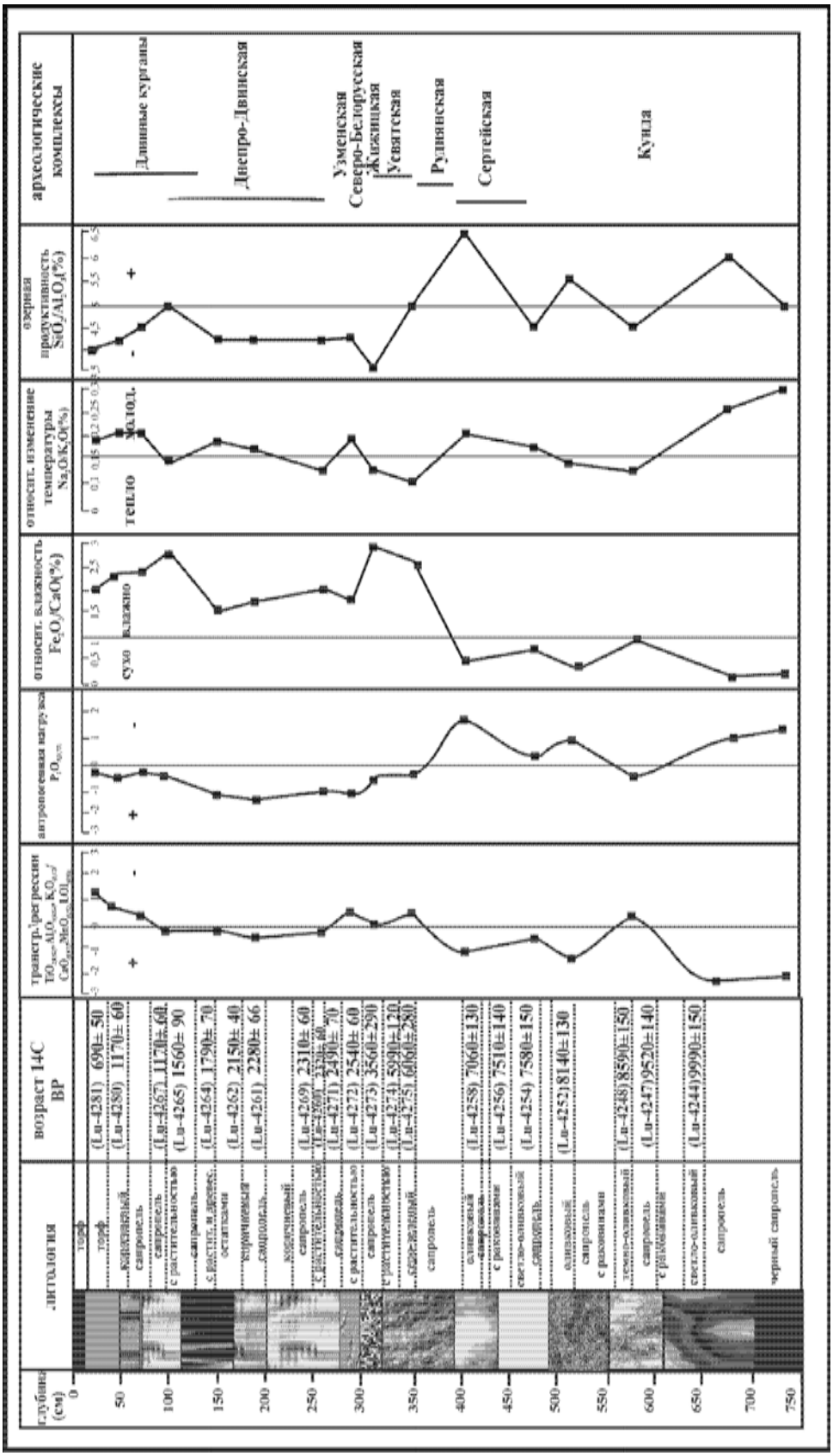


Figure 2.5. Scheme of sediments and data of geochemical analysis of the core № 63.

Depth 230-200 cm – amount of diatoms decreases sharply. The *Meridion circulare* type (to 30 %) became the dominant. It is the inhabitants of fresh and weakly saline waters. The amount of *Melosira varians* species decreases. Among planktonic species the *Aulacoseira subarctica, A. granulata* diatoms were registered. The lake level changes slightly. The prevalence of *Meridon circulare, Aulacoseria crenulata* species is typical for clear spring waters.

Depth 170-200 cm – lake level increases, the planktonic species consist more than 50 %. Maximum planktonic species is registered at the depth of 190 cm. The *Epithemia zebra, Eturgida, Fragilaria construens* species preserve. The appearance *M. varians, Rhopalodia gibba* and *Rhoicosphaenia curvata* species is the indicator of weakly saline waters.

Depth 160-110 cm – the amount of planktonic species decreases sharply (5-10 %). It is evidence of decreasing of lake level. The *Epithemia zebra, E. turgida* species prevail. The *Eunotia praerupta et var*. (17-37 %) species are the indicator of swamp. The species living in the wet soils were registered: *Hantzschia amphyoxis, Navicula mutica*. Abundance of *Meridion circulare* leafs (7-18 %) is the marker of running fresh waters.

Depth 110-70 cm – the character of lake basin was the same as at the depth of 160-110 cm.

Depth 70-60 cm – the planktonic *Aulacoseira italica, A. granulata, A. valida* species (to 50 %) are the indicators of lake level increasing.

Depth 40-50 cm – the decreasing of planktonic diatoms to 10-17 % is the marker of lake level decreasing and the lake was transformed into swamp.

Core № 62. The core (Figs. 2.6, 2.7) is located 350 m from core № 63, near the site Serteya II.

Pollen analysis.

Depth 460-405 cm. Compact clayey lake silt. The dominance of *Betula* (40-55 %) followed by *Pinus* (15-20 %). *Ulmus* (10-13 %) dominates among broad-leaves species, with *Tilia* at 4-5 %. *Quercus* appears only at the end of this unit, likewise *Alnus* and *Corilus*. The herb taxa vary between 5-15 %, most common are Poaceae and Cyperaceae. Spores are represented by Polypodiaceae in insignificant quantity.

Depth 460-265 cm. Gyttja with shells. A stable state of the woodland with low amounts of herbs (<3 %). High content of *Alnus* (20-35 %) and low presence of *Pinus, Picea* and *Betula* (<15 % in total). Comparatively high content broad-leaved species, *Ulmus* (12-18 %), *Quercus* (7-12 %), *Tilia* (2-7 %) and also *Corylus* (10-20 %).

Depth 265-240 cm. Gyttja with fragmented lake shells. A rapid rise in *Picea* and *Pinus* with the decrease of *Betula, Alnus,* and broad-leaved species, *Ulmus, Quercus, Tilia* and also *Corylus.* An increased amount of herbs, *Poaceae* and *Cyperaceae*. One notes the appearance of water chestnut, *Trapa natans*.

Depth 240-200 cm. Gyttja with fragmented lake shells. A decrease in *Picea* and *Pinus,* concomitant with the rise of *Betula* and *Alnus,* and an increase of broad-leaved species, *Ulmus, Quercus Tilia* and also *Corylus.* A general increase of herbs, *Poaceae* and *Cyperaceae*, including the appearance of heliophytic herbs, *Artemisia* and *Chenopodiaceae*, and isolated occurrence of grains of *Cerealia*.

Depth 200-0 cm This part of the sequence includes the deposits of Late Neolithic – Early Bronze Age. A significant instability of the woodland, allegedly caused by a strong human impact: selective felling in considerable parts of forests for procurement of piles and the burning in the course of swidden-type agriculture. Several cycles may be distinguished.

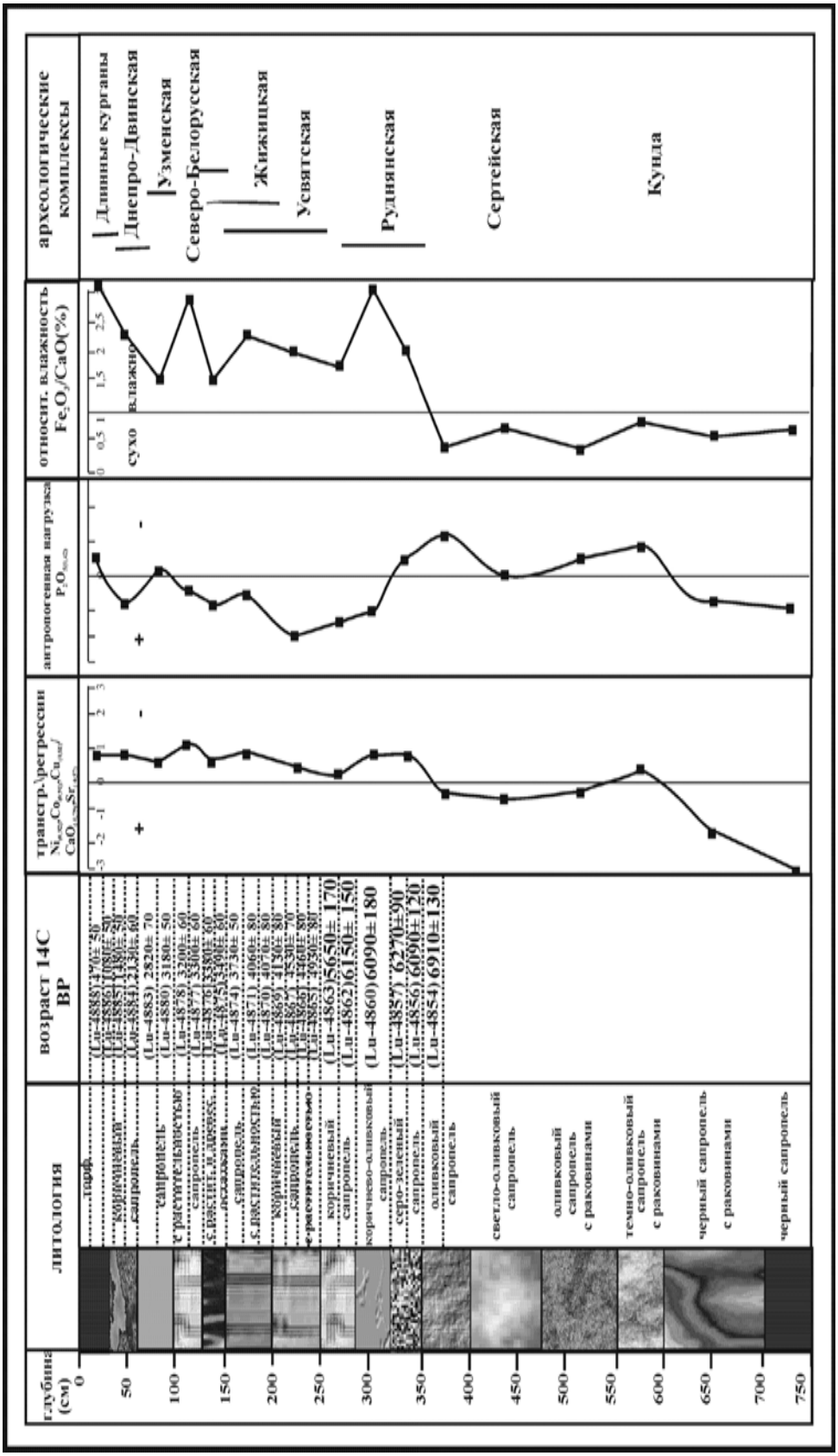


Figure 2.6. Correlated table with the results of geochemical analysis of sediments.

Depth 200-180 cm. Gyttja with fragmented lake shells. A increase in the amount of *Picea* and *Pinus*, and *Betula*. Decrease in *Alnus*,and an *Ulmus*, *Quercus*, *Tilia* and also *Corylus*. Increase in the content of herbs, *Poaceae* and *Cyperaceae*, heliophytic harbs, *Artemisia* and *Chenopodiaceae*. Isolated grains of *Cerealia*.

Depth 180-150 cm. Gyttja and archaeological deposits. Decreased content of *Picea* and *Pinus*, with the rise of *Betula* and *Alnus* (up to 40 %). Further fall in the rate of broad-leaved species, *Ulmus*, *Quercus* and also *Corylus*. Further increase of the content of herbs, *Poaceae* and *Cyperaceae*, *Artemisia*, *Chenopodiaceae*, *Gramineae*. One notes the appearance of *Filipendula*, *Lythrum* and *Lamiaceae*. Increased frequency of *Cerealia*.

Depth 150-90 cm. Gyttja and archaeological deposits. Rapid decrease of the content of *Picea* and slight increase of *Pinus*. A slight increase followed by a sharp increase of the content of *Alnus* (up to 40 %). Further reduction and quasi total disappearance of *Ulmus*, *Quercus* and also *Corylus*. General decline of the content of herbs, notably, *Poaceae*, *Cyperaceae* and *Artemisia* and *Chenopodiaceae*. The maximum frequency of *Cerealia*, and the appearance of weeds (notably, *Plantago lanceolata*) and apophytes or plants indicative of strong or modern human impact: *Apiaceae*, *Rubiaceae* and *Rosaceae*.

Depth 90-0 cm. Gyttja with plant detritus. Rapid reduction of forest which became dominated by *Picea* and *Pinus*. Vast expansion of open treeless species and wet meadows as indicated by a rapid increase of *Cyperaceae* and various herbs including *Filipendula*, *Apiaceae* and *Carophyllaceae*.

Diatom analysis.

Depth 460-430 cm. The deposits contain rare finds of valves.

Depth 430-390 cm. Concentration of valves varies from 15 to 50 thousand per 1 g of dry sediment. Among the identified 49 taxa, epiphytic species form 65-80 %. The dominant species is *Fragilaria construens*, *F. infanta* and the planktonic species, *Aulacoseria italica*, and *A. ambigua*. The total amount of planktonic species is 7-16 %. Alkaliphilous taxa typical of moderately alkaline lakes make up 90-97 % of the total assemblage. Biogeographically indifferent species are in majority. The species adapted to boreal moderately warm conditions constitute 17-26 %. Cold water species are represented by those typical of Late Glacial and early Holocene lakes in Central Russia: *Navicula scutelloides*, *Frgilaria inflata*. Hence one may suggest the occurrence of a mesotrophic-modetately eutrophic lake, which included a body of free water and macrophyte coverage. The fall in productivity of planktonic species recorded at 410-390 cm, was supposedly due to the lowering of the lake level.

Depth 390-320 cm. Concentration of valves varies from 0.1 to 0.5 million per 1 g of dry sediment. The total number of taxa rises to 65, mostly due to boreal species (20-30 %). *Fragilaria* are the dominant species, with the subdominant remaining the same as in the lower unit. Fluctuation in the content of planktonic species (15-24 %) shows an instability of the lake level. The appearance of planktonic species such as *Cyclostephanos dubius* and *Stephanodiscus hantzshii*, is indicative of the lake's increased trophic state. The abundance of alkaliphilous taxa (97-99 %) shows its eutrophic character.

Depth 320-300 cm. Planktonic species form 7-11 %. Productivity of benthic diatoms reaches 1-2.3 million per 1 g of dry sediment. The lake-level supposedly lowered.

Depth 300-240 cm. Productivity of diatoms reaches the highest value of 1.5-4.5 million per 1 g of dry sediment. The total number of taxa rises to 78. An increased rate

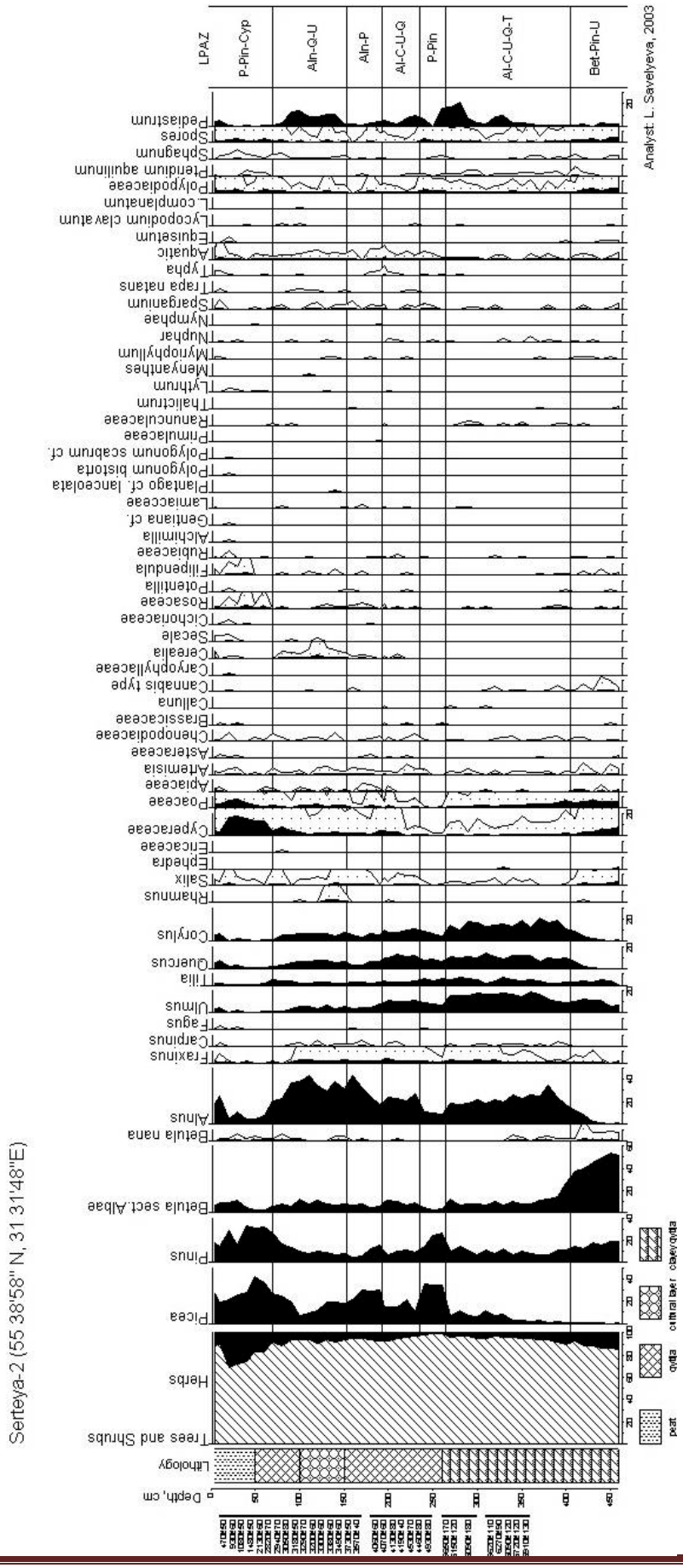


Figure 2.7. Pollen diagram of the core № 62.

of planktonic species (25-35 %) indicates a stable rise of lake-level. The dominant species include the peryphytic *Fragilaria ssp*, combined with the planktonic, *Aulacoseria ambigua, A. italica, and A.granulata.* The subdominants consist of the benthic and epiphyte species, *Amphora ovalis, Gyrosigma attenuatum, Cocconeis placentula, Achnanthes ssp, Navicula* benthic genius is represented by 10 taxa. The proportion of epiphytes diminishes to 60-72 %. The rise of lake-level led to the restriction of the macrophyte coverage. This combined with the improved light condition of the water column, was favourable for the development of planktonic and benthic species. Alkaliphilous taxa remain dominant (96-99 %). *Cyclostephanos* dubious being subdominant. One note also planktonic species of *Steohanodiscus hantzschii* (<1 %). At that time, the lake reached the maximum depth, while retaining its eutrophic character.

Depth 240-150 cm. Rapid decline in the rate of planktonic species (4-11 %). Productivity of diatoms varies in the range of 0.7-2.0 million per 1 g of dry sediment. The total number of taxa reaches 114, due to the appearance of benthic species: *Pinnularia* (11 taxa), *Navicula* (15 taxa), *Gomphomena* (9 taxa). In addition to *Fragilaria*, the dominant – subdominant group includes *Cocconeis placentula, Amphora ovalis, Achnanthes ssp*. The dominance of alkaliphilous taxa shows a moderately alkaline and eutrophic character of the lake. The lake-level was lower as in the preceding unit.

Depth 150-90 cm. High productivity of diatoms reach the values of 0,9-1,5 million per 1 g of dry sediment. High rate of planktonic species (39-42 %), markedly dropping at 90 cm. The dominant group consists of *Aulacoseria ambigua* and epiphyte *Fragilaria* ssp. The subdominants include the benthic species, *Amphora ovalis, and Synedra ulna*. Alkaliphilous taxa are dominant (88-90 %). The total proportion of epiphytes diminishes (41-67 %). Considerable rise of the lake-level reduced the macrophyte cover.

Depth 90-50 cm. Diatom productivity varies in the range of 0.2-1 million per 1 g of dry sediment. At the depth of 80-85 cm one notes the cells of the planktonic species, *Aulacoseria ambigua*, and a considerable amount of the spores of *Aulacoseria* ssp. The latter make up >50 % of the total amount of valves at the depth of 55-85 cm. The dominant-subdominant group includes the epiphytes and rheophilous species, adapted to small streams and spring rich in free oxygen: *Gomphonema angustatum, Meridion circulare, Eunotia preaerupta*. The rate of alkaliphilous taxa diminishes to 45-75 %. The increased rate of acidophilous taxa is indicative of the moderately acidic reaction. At the end of the unit the lake-level finally drops and the lake transform into low fen mire.

Depth 50-0 cm. Diatom productivity varies in the range of 0.06-0.2 million per 1 g of dry sediment. Benthic species are dominant, *Eunotia preaerupta, Synedra ulna, Meridion circulare. Fragilaria* ssp appears at 40-0 cm. One notes the occurrence of edaphic species adapted to soils and moist habitats: *Pinnularis borealis, Navicula mutica*. The diatoms of mire habitat show a wide diversity: *Pinnularia* (8 taxa), *Eunotia* (7 taxa); they are notmally found in organic-rich slighty acid (pH <7) water bodies. Acidophilous taxa form 13-26 % at then depth 30-50 cm. Their rate diminishes to 6 % at 20-0 cm. At the same depth, alkaliphilous taxa sharply increase, reaching 80-85 %. The rate of planktonic species increases in the same interval from 6 to 12 %. One notes the occurrence of species indicative of anthropogenous-related eutrophication: *Cyclostephanos dubius, Stephanodiscus hantzschii*.

Reconstruction of sedimentation conditions in the lakes during Holocene on the base of complex analysis.

The investigations allow us to reconstruct the follow sedimentation cycles in the Serteya lakes (Figs. 2.8, 2.9).

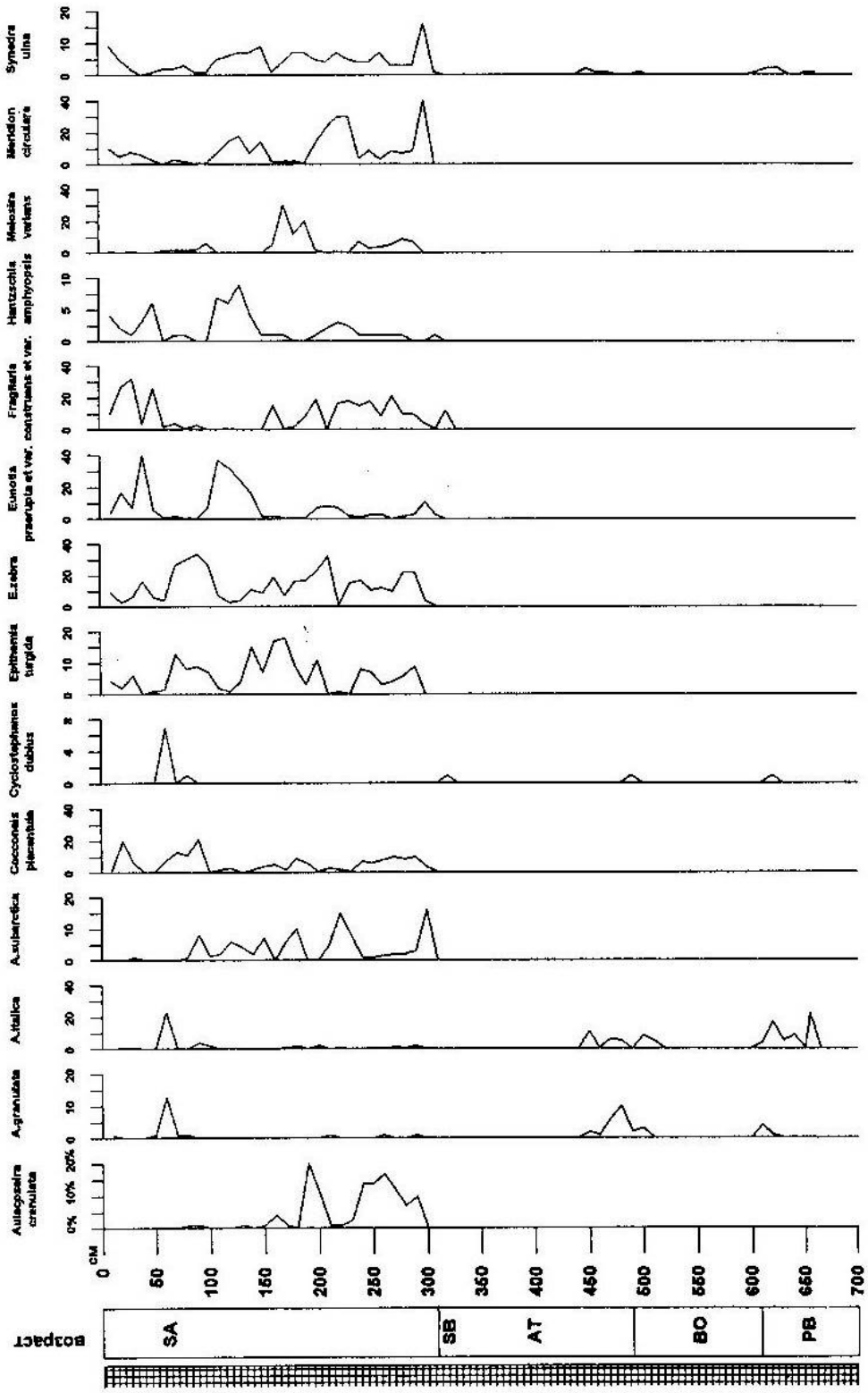


Figure 2.8. Results oa diatom analysis of lake sediments of the core № 62.

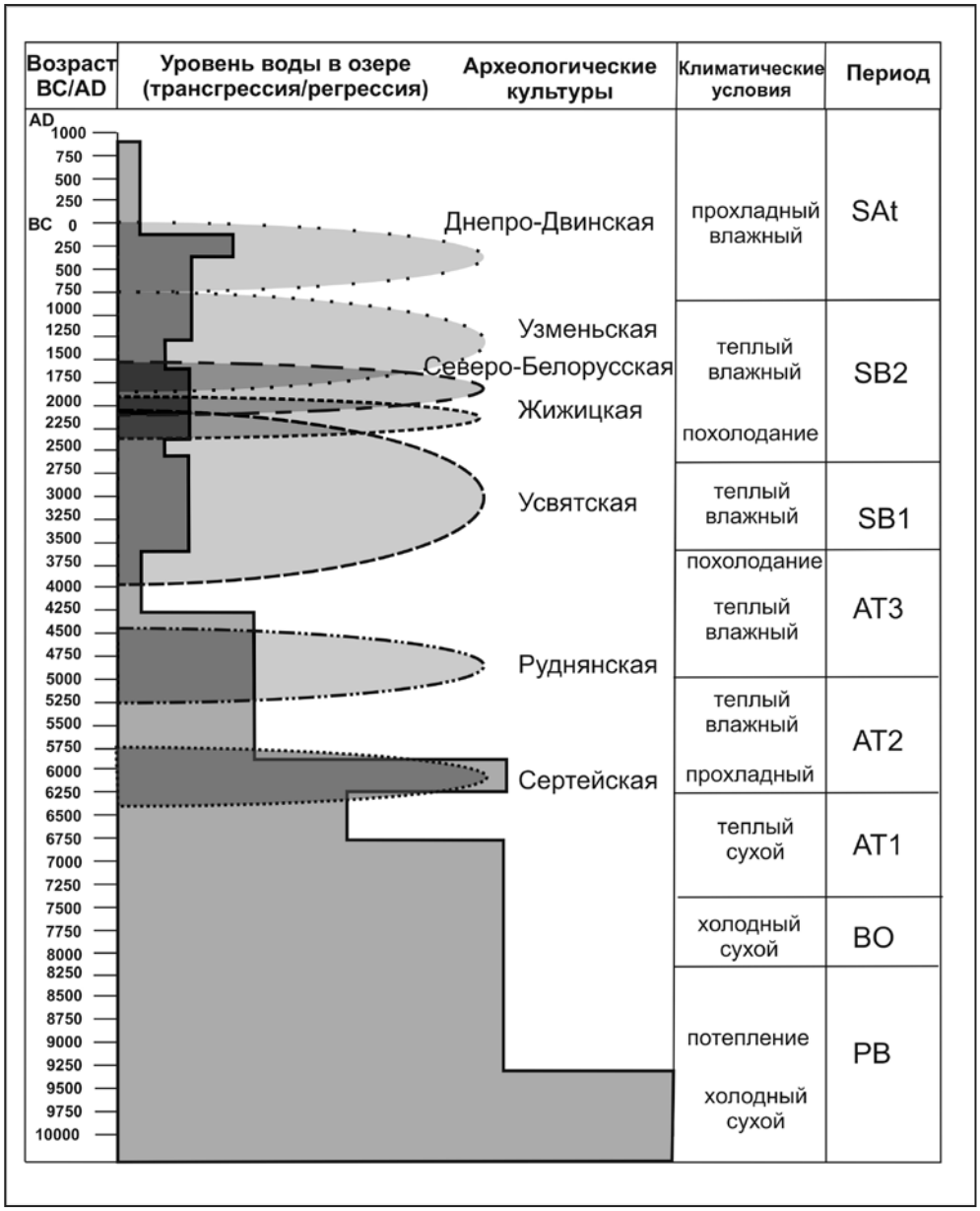


Figure 2.9. Synchronization table of climatic changes and archaeological cultures.

Cycle I. Sedimentation on the depth 850-750 cm (core № 63) was in the cold climate of post-glacial period (alleröd). In this period the fine-grained blue aleurite deposited.

Cycle II. Preboreal period (depth 750-610 cm – core № 63, depth 750-600 cm – core № 62).

1. Depth 750-700 cm – core № 63, black gyttja with small particles of shells.

2. Depth 700-610 cm (Age ^{14}C – 633-650 cm, 9990±150 BP, (Lu-4244)) – core № 63, light-olivcoloured gyttja.

These deposits are characterised by small terrigenic element contents Al_2O_3 (6.2 %), TiO_2 (0.30 %), MgO (1.7 %), higher content of chemogenic and biogenic elements – CaO (28 %), MnO (0.37 %), organic material – LOI (18 %). The concentration of SiO_2 tot. is 38 %.

The deposit sedimentation was in deepwater lake basin because the deposits content the small concentration of terrigenic elements and they enrichment by authigenic components. On the depth of 700-610 cm the increasing of productivity is registered (SiO_2 biog. – 6.5 %). The climate was cold and dry, the lake conditions can be characterized as oxidizing and alkaline. The higher concentration of calcium carbonate, manganese oxide, high ratio of Na_2O / K_2O are the indicators of such environments. The deposits contain a rare finds of valves.

Cycle III. Boreal period (depth 610-490 cm – core № 63, depth 600-470 cm – core № 62).

3. Depths 610-550 cm (583-600 cm, 9520±140 BP (Lu-4247)); (560-583 cm, 8590±150 BP (Lu-4248)) – core № 63, 600-550 cm – core № 62, dark- olivacoloured gyttja with shells.

The concentration of terrigenic elements – Al_2O_3 12.1 %, TiO_2 0.63 %, MgO 1.9 % increase. The concentration of biogenic and chemogenic elements – CaO 11.8 %, MnO 0.069 % and organic material – LOI 5.8 % decrease. The content of SiO_2 tot. increases to 54.4 %.

The sharp increasing of terrigenic elements and minerals such as feldspar, clay is the indicator of lake level decreasing. The small content of biogenic silica (SiO_2 biog.– 4.5 %) is characteristic of low productivity. The concentration of phosphorus (P_2O_5) increases from 0.22 to 0.27 %. That reflects anthropogenic impact on the lake. The regressive stage is fixed in the basin. Diatoms are absent in the deposits. The climate became more humid and warm, but the dry climate conditions still remain. The pollen data confirms this. The hydrochemical conditions are neutral and weakly reductive.

4. Depths 550-490 cm (500-516 cm, 8140±130 BP (Lu-4252)) – core № 63, 550-470 cm – core № 62, olivacoloured gyttja with shells.

The decreasing of terrigenic element content – Al_2O_3 7.9 %, TiO_2 0.40 %, MgO 1,6 % and increasing of chemogenic and biogenic element concentrations – CaO 21.0 %, MnO 0.13 %, organic material – LOI 14.2 % are fixed. The SiO_2 tot. decreases to 45.1 %. The increasing of biogeneic and chemogenic element contents are marker of the lake transgressision. The high content of SiO_2 biog. (5.7 %) indicates the growth of productivity. The deposits contain the rare finds of valves. The anthropogenic impact on the lake basin decreases. The P_2O_5 concentration decreases to 0.23 %. The climate became more dry.

Cycle IV. Atlantic period (depth 490-310 cm – core № 63, depth 470-250 cm-core № 62).

5. Depths 490-440 cm (466-483 cm, 7580±150 BP (Lu-4254)) – core № 63, 470-400 cm, light- olivacoloured gyttja with shells.

The increasing of terrigenic elements– Al_2O_3 9.4 %, TiO_2 0.45 %, MgO 2 % and small decreasing of chemogenic and biogenic element concentrations – CaO 0.2 %, MnO 0.087 %, organic material – LOI 12.8 % are registered. The concentration of SiO_2 tot. is 42.0 %.

The small increasing of terrigenic element content indicates the low lake level. The concentration of SiO_2 biog. – 4.5 % characterizes the law lake productivity. The anthropogenic element content increases, so the P_2O_5 increases to 0.30 %. The climate in this period at whole was dry and warm. The hydrochemical regime in the lake changes to decreasing of pH and reducing conditions. The concentration of iron hydroxides and sulphur increases in the deposits. In the layer the few in number of diatoms were found.

6. Depths 440-390 cm (433-450 cm, 7510±140 BP (Lu-4256)), (400-416 cm, 7060±130 BP (Lu-4258)) – core № 63; 400-350 cm (6910±130 BP, (Lu-4854)) – core № 62, olivacoloured gyttja with shells.

The concentration of terregenic elements is low – Al_2O_3 7 %, TiO_2 0.33 %, MgO 1.6 %. The content of chemogenic and biogenic elements increases – CaO 20.5 %, MnO 0.22 %, and organic material – LOI 11.2 %. The concentration of SiO_2 tot. is 49.0 %.

The increasing of biogenic and chemogenic element content but the decreasing of terrigenic element concentration indicates the transgression in the lake. The growth of biogenic silica to 7 % reflects the lake productivity growth. The concentration of anthropogenic elements decreases. The climate changes to more cool and dry. The pollen analysis shows the low concentration of pollen in the deposits, degradation of broadleaf trees and cool climate. Hydrochemical conditions became alkaline and oxidizing.

7. Depths 390-310 cm (333-350 cm, 6060±280 BP (Lu-4275)), (316-333 см, 5990±120 BP (Lu-4274)) – core № 63; 350-320 cm (350-340 cm, 6760±130 BP (Lu-4855), (340-330 cm, 6090±120 BP (Lu-4856), (330-320 cm, 6270±90 BP (Lu-4857)) (300-280 cm, 6090±180 BP (Lu-4860)) (280-270 cm, 6150±120 BP (ЛУ-4862)), (270-260 cm, 5650±170 BP (ЛУ-4863)) – core № 62, grey-green and brawn gyttja with plant remains.

The sharp increasing of terrigenic element concentration – Al_2O_3 11.2 %, TiO_2 0.57 %, MgO 1.7 % but the decreasing of chemogenic and biogenic element concentration – CaO 3.7 %, MnO 0.046 %, organic material – LOI 6.3 % is registered. The concentration of SiO_2 tot. is 63.8 %.

The regressive stage in the lake is indicated by increasing of terrigenic component content and decreasing of chemogenic and biogenic component content. The concentration of biogenic silica decreases to 5,5 %. The concentration of anthropogenic component – P_2O_5 increases. The climate was warm and humid. That is confirmed by pollen analysis, which shows the increasing of pollen concentration and high content of broadleaf tree pollen and appearance of spruce pollen. The hydrochemical lake conditions became more oxidizing and weakly acid. In spite of the algae blooming and photosynthesis processes the carbonate concentration in the deposits is low. It can be connected with the high humidity, which influences on the dissolving of carbonates.

Cycle V. Subboreal period (depth 310-280 cm – core № 63, depth 250-150 cm – core № 62).

8. Depths 310-300 cm (300-316 cm, 3560±290 BP (Lu-4273)) – core № 63, 250-200 cm (250-240 cm, 4930±80 BP (Lu-4865)), (240-230 cm, 4460±80 BP (Lu-4866)), (230-220 cm, 4530±70 BP (Lu-4867)), (220-210 cm, 4190±40 BP (Lu-4868)), (210-200 cm, 4130±80 BP (Lu-4869)) – core № 62, brawn gyttja with plant remains.

The concentration of terrigenic components is Al_2O_3 12.6 %, TiO_2 0.59 %, MgO 1.7 %. The content of chemogenic and biogenic components increases – CaO 3.7 %, MnO 0.078 %, organic material – LOI 7.3 %. The concentration of biogenic silica is 60.6 %. The increasing of P_2O_5 from 0.24 to 0.42 % reflects the increasing of anthropogenic impact on the lake. The transgessive stage in the lake is registered by the increasing of authigenic component concentration. The content of biogenic silica decreases to 5 % and lake productivity became low. The climate was humid and warm. The hydrochemical lake conditions were oxidizing and weakly acid. The high concentration of oxide and hydroxide of iron and clay minerals indicates on that.

9. Depths 200-150 cm (200-190 cm, 4070±80 BP (Lu-4870)), (190-180 cm, 4060±80 BP (Lu-4871)), (160-150 cm, 3730±50 BP (Lu-4874)) – core № 62, brawn

gyttja with plant remains. In the lake the regressive stage is registered. The precipitation decreased. The anthropogenic impact was high.

10. Depths 150-130 cm (150-140 cm, 3490±60 BP (Lu-4875)), (140-130 cm, 3380±60 BP (Lu-4876)) – core № 62, the brawn gyttja with plant and wood remains. The lake level increasing is registered. The climate was humid.

11. Depths 130-100 cm (130-120 cm, 3300±60 BP (Lu -4877)), (120-110 cm, 3200±60 BP (Lu -4878)), (110-100 cm, 3290±70 BP (Lu -4879)) – core № 62, the brawn gyttja with plant remains. The regressive stage is registered in the lake. The climate was dry.

12. Depths 100-60 cm (100-90 cm, 3180±50 BP (Lu У-4880)), (90-80 cm, 3050±80 BP (Lu -4881)), (80-70 cm, 2940±70 BP (Lu -4882)), (70-60 cm, 2820±70 BP (Lu -4883)) – core № 62, the brawn gyttja with plant remains. The lake level increasing is registered. The climate was humid.

Cycle VI. Subatlantic period (depth 300-0 cm – core № 63, depth 250-200 cm – core № 62).

13. Depths 300-270 cm (283-300 cm, 2540±60 BP (Lu-4272)) – core № 63, the brawn gyttja with plant and wood remains.

The increase of terrigenic component – Al_2O_3 14.7 %, TiO_2 0.66 %, MgO 2.1 % reflects the low lake level and returning of lake into swamp. According to the diatom analysis the appearance of benthos species to 80 % indicates the shallow, obliterating basin. The concentrations of chemogenic and biogenic components increase – CaO 5.7 %, MnO 0.11 %, organic material – LOI (5.8 %). The content of SiO_2 tot. is 56.6 %. The content of P_2O_5 is 0.61 %. The content of biogenic silica decreases to 3.7 %. The anthropogenic impact increases. The climate became more cool.

14. Depths 270-200 cm (266-283 cm, 2490±70 BP (Lu-4271)), (250-266 cm, 2320±60 BP (Lu-4270)), (233-250 cm, 2310±60 BP (Lu-4269)), (216-233 cm, 2370±50 BP (Lu-4260)), (200-216 cm, 2250±50 BP (Lu-4259)) – core № 63, the brawn gyttja with plant remains.

The concentration of terrigenic components decreases – Al_2O_3 13.4 %, TiO_2 0.61 %, MgO 1.8 %. The content of chemogenic and biogenic components is CaO 6.1 %, MnO 0.19 %, organic material – LOI 6.0 %. The concentration of SiO_2 tot. is 57.3 %. The concentration of P_2O_5 is 0.72 %. The anthropogenic impact on the basin falls. The increasing of authigenic component proportion to terrigenic components reflects the small growth of lake level. That was confirmed by diatom analysis. The biogenic silica concentration increases to 4.5 %. The precipitation in that period increased. The climate became some warmer. According to pollen analysis the sum of broadleaf tree pollen rise to 10 %, owing to oak pollen increase.

15. Depths 200-170 cm (183-200 cm, 2280±66 BP (Lu-4261)) – core № 63, dark-brawn gyttja with plant remains.

The lake level some increased. That is confirmed by diatom analysis, the planktonic species in the deposit consist more than 50 %. The anthropogenic impact increased. The appearance of poorly decayed macrofossils in the cool and humid condition results in the reducing and acidic indexes of aquatic environment. According to pollen analysis the amount of broadleaf tree pollen falls to 2 %.

16. Depths 170-120 cm (166-183 cm, 2150±40 BP (Lu-4262)), (133-150 cm, 1790±70 BP (Lu-4264)), (116-133 cm, 1560±90 BP (Lu-4265)) – core № 63; 60-40 cm (60-50 cm, 2130±60 BP (Lu-4884)), (50-40 cm, 1480±50 BP (Lu-4885)) – core № 62, the brawn gyttja with plant and wood remains.

The lake level decreases. According to diatom analysis on the depth of 160-110 cm amount of planktonic species sharply decrease to 5-10 %. That can be the marker of lake level drop. The climate was cold and the humidity decreases.

17. Depths 120-70 cm (116-100 cm, 1560±70 BP (Lu-4266)), (100-83 cm, 1170±50 BP (Lu-4267)) – core № 62, dark-brawn gyttja with plant remains.

18. Depths 70-50 cm (50-35 cm, 1170±60 BP (Lu-4280)) – core № 63; 40-10 cm (40-30 cm, 1080±50 BP (Lu-4886)), (30-20 cm, 930±60 BP (Lu-4887)) – core № 62, dark-brawn gyttja with plant remains.

The concentration of terrigenic elements remains constant – Al_2O_3 13 %, TiO_2 0.58 %, MgO 1.75 %. The concentration of chemogenic and biogenic elements is CaO 5.5 %, MnO 0.19 %, organic material– LOI 6 %. The content of SiO_2 tot. is 60 %. The content of P_2O_5 is 0.80 %. The high concentration of terrigenic components is the characteristic of swamp condition. It confirms the diatom analysis data.

19. Depths 50-15 cm (20-35 см, 690±50 BP (ЛУ-4281)) – core № 63; 20-10 cm, (470±50 BP (Lu-4888)) – core № 62, poorly decomposed peat.

20. Depth 15-0 cm – core № 63, peat.

The concentration of terrigenic components some increases Al_2O_3 14.3 %, TiO_2 0.75 %, MgO 1.8 %. The concentration of chemogenic and biogenic elements decreases – CaO 4.9 %, MnO 0.12 %, organic material – LOI 3 %. The content of SiO_2 tot. is 59.7 %. The content of P_2O_5 is 1 %.

CHAPTER 2.2.
HUMAN OCCUPATION HISTORY OF THE UPPER DVINA BASIN

Part of the territory of lake areas from Eastern Poland to Valday elevation was inhabited about 10 mil BP. Rich natural resources of lake areas attracted all the time new groups of Neolithic hunters, fishers, gatherers, first forest farmers and cattle-breaders. It was a place of intersection of European cultures and people. Densely inhabited lake basins were divided by huge uninhabited areas which were slowly populated during early Iron age and early Middle ages. Most part of the lakes was overgrown and became peat-bogs and swamps till XIII-XIV c. due to different natural reasons. Peat-bogs covered remains of ancient settlements and cult places of stone age.

Natural complexes were not homogeneous here and their values for people were being changed through the time and consequently the system of settlement was being also changed [Dolukhanov et al., 1983; Miklyaev, 1995]. Ancient inhabitants chose different types of landscape at different periods in the past reasoning from the characteristics of their economical strategy, climatic conditions, hydrology and other natural and social factors.

Neolithic sites were situated along small-residual ice-dam lakes, occupying zones of fluvioglacial sediments, situated sometimes at the border of different types of landscape. Whereas the sites of early Iron age were disposed on the hills of morainic zone edges, the sites of middle-late Iron age and early Middle age occupied the eminences of lake-glacial plains. And place around lakes and mires, free of water due to very strong regression, was used for ploughed fields and meadows. With the appearance of plough inhabitants started to settle on the territory of Lovat aspirail with very fertile soils [Miklyaev, 1995].

The investigation of sites of this region from the beginning (the 1970^{s}) was made in the course of scientific approach developed in Saint-Petersburg by A. Miklyaev that was named “archaeological geography”. The aim of “archaeological geography” was to study archaeological sites using all the appropriate methods of archaeology and the natural sciences, regarding the archaeological site and environment as one socio-biocenose. According to A. Miklyaev, “only the analysis of material culture and geographical data will allow us to understand the mechanism of interaction between man and environment in the past” [Miklyaev, 1984, P 127-130].

This approach appeared under the influence of one soviet scientific school existed at the end of the XIXth – beginning of the XXth century which investigated ancient people of Stone Age from a natural – scientific point of view. At the beginning of the XXth century this approach was developed into palaeoethnological school under the direction of F.K. Volkov– the disciple of G. de Mortillet, the founder of french palaeoethnological school. But the soviet-russian palaeoethnological school did not follow entirely the traditions of french palaeoethnological school. In contrast to the latter the main aim here was to compare archaeological data with geographical data and to understand relationships between human culture and environment [Platonova, 2008, P. 67-68]. But in 1929-1930 the soviet palaeoethnological school was almost destroyed as a result of repressions and ideological pressure of historical method in its Marxist-Leninist variant. However its conceptions and ideas were saved and were passed on from generation to generation of Leningrad archaeologists during the 1930-1980^{s}. As a result main conceptions, developed by the soviet palaeoethnological school were reformulated in the 1970^{s} in the approach named “archaeological geography”.

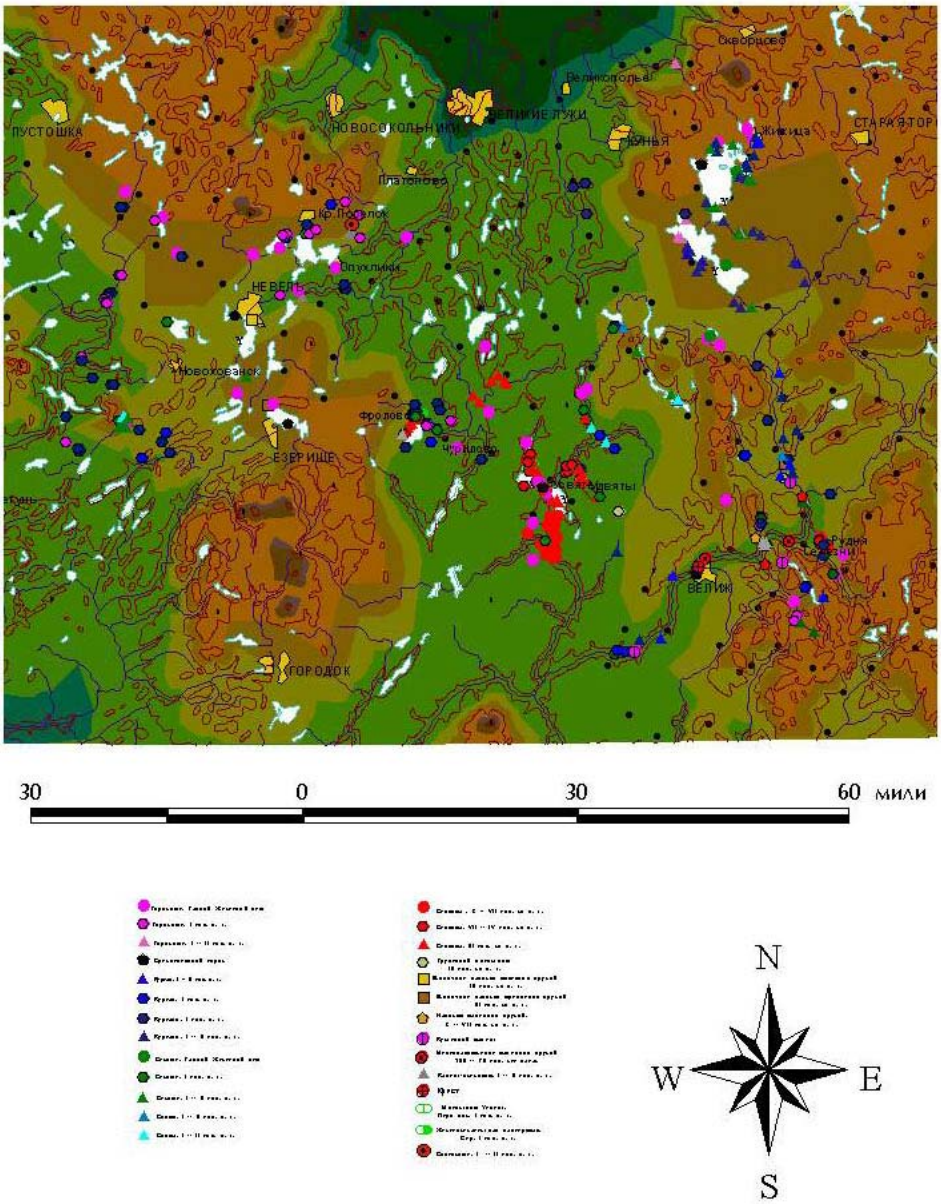


Figure 2.10. Distribution of archaeological sites of stone-iron age in upper Western Dvina River.

According to A. Miklyaev, the only method of “archaeological geography” is the method of complex analysis of archaeological data and palaeogeographical data [Miklyaev, 1984, P. 129]. This is per se the multi-disciplinary investigations in the stream of landscape archaeology, more precisely, the archaeological investigation of spatial expression of interrelations between the man and his physical and social environment [Afanas'ev et al., 2004, P. 55].

The investigated region was divided into four archaeological microregions (lake basins including archaeological sites): the Serteya, Usvyaty, Sennica Udviaty, and Zhizhitsa microregions (Figs. 2.2, 2.3). Sites of early and middle Neolithic occupy different topographical positions situated in different types of landscapes.

The most part of stone age sites in Upper Dvina basin is situated in the areas of Usviaty lake, Sennitsa lake, Zhizhitsa lake (Pskov region) and in the valley of Serteya

River – left confluent of Western Dvina River – which flows from the south to the north on the territory of Velizhsky district of Smolensk region. Sites from the epoch of early Paleolithic (140-70 mil BP) and final Paleolithic (12 mil BP) till the time of Old Russian state development were found here.

First information about archaeological sites was systematized by A.P. Sapunov at the end of XIX c. (1893) and E.R. Romanov In the second half of XX c. first information about stone age sites in river Serteyka valley were gained by E.A. Shcmidt. A.M. Mykljaev started his works here in the 1960s.

Early Paleolithic (№1).

In 1989 I.Y. Ivanova, the head of Velizhsky museum, showed me finds of mamooth tusks and teeth which were found with very archaic flint tools (Fig. 2.11). We surveyed the place on the shore of Western Dvina River with schoolchildren who found these objects. We found other ancient tools dated to the epoch of early Paleolithic (140-70 mil BP) on the river gravel beach higher than Yastreb rapids [Miklyaev et al., 1995; Drevnosti …, 1995, P. 16-17].

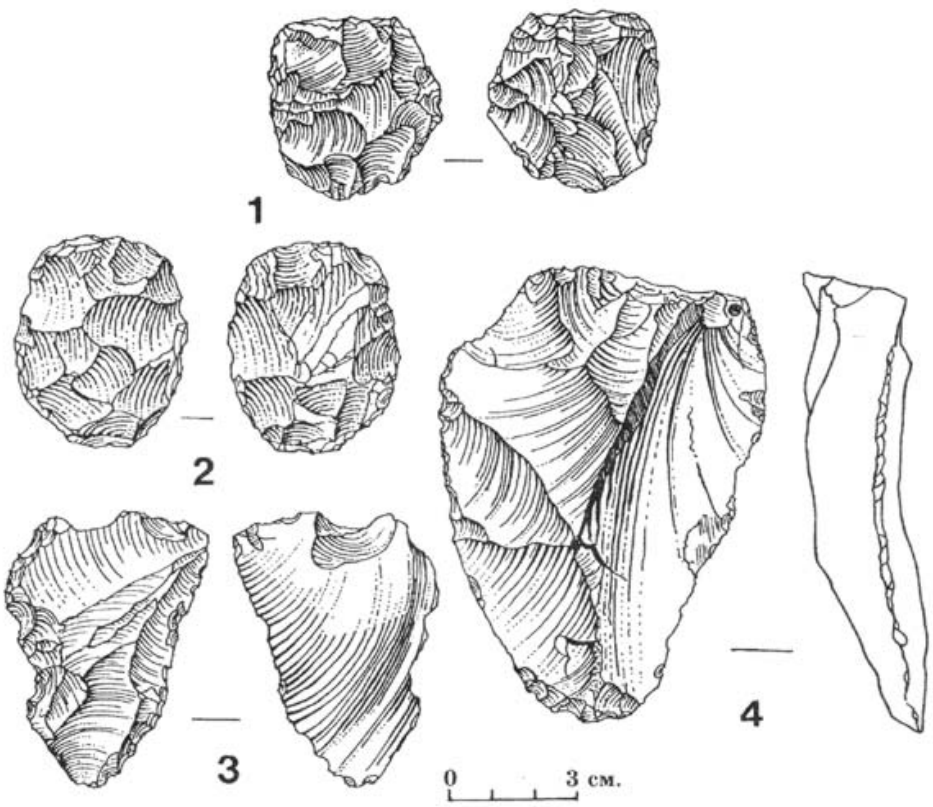


Figure 2.11. Stone tools of Acheul-mustie from Yastreb and Klimovo sites.

In late Pleistocene warming and fall of temperature replaced each other repeatedly. At the end of middle Pleistocene – Mikuline interglacial – the territory of North-western Russia was full of lakes and covered by birch and pine forests and at the end of the period – by fir forests [San'ko, 1987]. It was at that time when ancient man appeared on the shores of lakes of modern Smolensk and may be in the south of Pskov regions. Finds of stone tools and performs of Achel-Mustie testify it. They are made in places where Western Dvina River cut through quaternary sediments and abut rock massif which

served in the Past shores of lakes of Mikuline time and they have become now Yastreb and Klim rapids in the riverbed of Western Dvina River. Fall of temperature occurred 70 mil BP led to glaciation of the area of North-Western Russia.

Epipaleolithic.

Favorable conditions of inhabitation on the territory of North-Western part of Russian plain appeared again only after final recession of glacier (16-15 mil BP) accompanied by recovery of vegetation and opening of depressions of future Holocene lakes. Thinned pine and birch forests and predominance of vegetation was typical for this time. Remains of ancient settlements are situated on sandy dunes near shores of late glacial lakes. All flint tools are simply lying on sandy and tilled fields and occupy large squares. Finds of stone tools extended on the distance of about 4 km near village Lukashenki along river Usviacha and near village Serteya– on 2.5 km (№ 2).

Mesolithic.

The beginning of Holocene is the time of new epoch – mesolithic (X-VIII mil BP). Large changes of all elements of natural environment occurred in this epoch. Common warming led to disappearance of glacier caused changes of vegetation: forest appeared on the place of glacial steppes. Vegetation changes reflected animal world. Not less than ten representatives of mammoth fauna disappeared at the time of Pleistocene-Holocene border (about 12 mil BP). Areas of horse, bison, aurochs and red deer widespread in pleistocene decreased. At the same time population of elk, ducks, black grouse, fishes and sea animals increased. At this time man opened up all natural zones of Europe. Economy of this time was characterized by prevalence of hunter-gatherer economy and was based mostly on the use of natural resources of river valleys and lake depressions. Tribes with material culture coming from epipaleolithic cultures traditions (sviderian tradition) lived on these territories.

Underwater excavations of the site Dubokray VI situated on the bottom of the lake Sennica (Pskovskaya oblast') revealed bone and flint tools that allowed us to suppose appearance of new inhabitants from Eastern Baltic region – bearers of kunda culture traditions - in middle Mesolithic. Some of the types of tools typical for this culture were found also on the site Serteya 1, Serteya X, Serteya XIV (№ 3). Non-numerous sites with flint materials of kunda culture are situated on the edges of depressions on dunes, at the end of the period – on lakes shores and islands. This culture appeared in Preboreal period (10200–9600 BP). This period is characterized by common warming and changes in natural environment which led to disappearance of glacial flora and development of woodland landscapes. Pine and birch forests dominated, fir, rarely – alder could have occupied river valleys. Climate was relatively cool and dry. Geochemical analysis allowed us to suppose that lake productivity was relatively low, at the end of the period regression took place as well as warming, humidity increased. Appearance of elements-indicators of human influence on the ecosystem of ancient lakes can also be traced [Kulkova, Mazurkevich, Dolukhanov, 2001].

The beginning of Boreal period (9600—8000 BP) is characterized by further warming and humidity increase. Mixed pine-birch forests with inclusions of broad-leaved species (elm and lime predominately) and hazel existed. Previous regression continued, productivity decreased and human influence on ecosystem of ancient lakes cannot be traced. At the middle-end of Boreal period moderate cooling and decrease of humidity as well as transgression and increase of lake productivity can be traced due to pollen and

geochemical analysis. At the second half of Boreal period different types of forest appeared, thermophilic elements of flora started to penetrate actively onto this territory. Favorable climatic conditions stimulated increase of elm, lime, oak and hazel among birch-pine forests.

Settlements of this period are situated in the same topographical conditions as epipaleolithic sites. New types of sites appeared with roundish dwellings of pile construction with deepened floor and oval deepened hearth near the walls. This type of constructions changed into ground oval dwellings of pile construction with deepened hearths in the center (Figs. 2.12, 2.13).

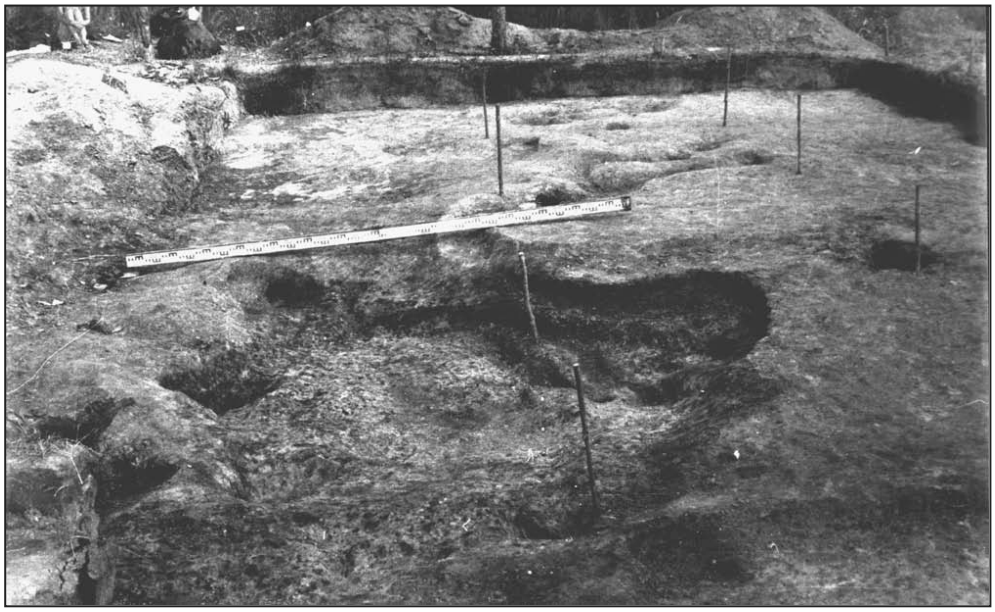


Figure 2.12. Remains of Mesolithic dwelling on the site Serteya X.

Figure 2.13. Remains of Mesolithic dwelling on the site Serteya XIV.

Early neolithic of Dnepr-Dvina basin and specificity of neolithisation of Eastern Europe (Figs. 2.3 2.14).

The beginning of the Neolithic era is connected with a complicated process of information accumulation, which led to discoveries that changed human history. It concerns gradual accumulation of knowledge, skills of animal and plant domestication that led to formation of complex economy. Concurrently changes in the ideological sphere took place that archaeologically fixed in appearance of the cult of the skull, figurines, first temple complexes that stimulated further development of productive economy. This process was long because productive economy served only for ideological sphere at this stage. These people were pioneers and could not estimate the advantages of a productive economy; they did not have to consider whether to appropriate this economy.

Gradual accumulation of positive experience that allowed people to estimate the attraction of a productive economy and connected with it processes of changes in social structure, culture and ideology in the Near East can be named *neolithisation*. Further process of diffusion of accumulated knowledge that is usually named "Neolithic packet" (productive economy, pottery, clay figurines, adobe architecture, stone vessels, idea of private property) differs not only by its models but more importantly – the meaning of this process.

All this packet or part of it was established on new territories, which was transported by new inhabitants that came once or repeatedly into territories inhabited by local Mesolithic societies (see Perlès 2004). Mesolithic inhabitants of Europe had a unique opportunity to observe life of newly-arrived people with productive economy living near them. Their way of life competed with the ideology of new inhabitants based on different principles of society organisation. What is important is that social structure of mesolithic inhabitants was in the process of formation and it was not stable and could have been destroyed or became degraded relatively simply under the influence of different cultural and ecological factors.

The competitive character of different economic strategies can be seen at this stage and "readiness" of local inhabitants to admit definite innovations would be important. It determined appropriating of innovations that were very often a prestigious part of "Neolithic packet" that led to the uneven distribution of this packet. That is why not all components of "neolithisation packet" appeared on the territory of forest and steppe-forest zone with new groups of people or indirectly, took roots in local milieu. The advantages of components of "neolithisation packet" were not evident for tribes of hunter-gatherers who could estimate value of these components and chose the components suitable for them, which appeared to be a pottery, seemed to be not the most important part of "neolithisation packet". The appearance of pottery making tradition should not be regarded just as a formal feature. The fact of similar (from technological, typological view and design analysis) ceramic traditions distribution on a great territory in a very short chronological period, probably, had definite reasons. Some techniques, artefacts, materials, designs appear to be transcultural and displace in other regions, whereas the zone of other things distribution is limited to the place of their origin (see Martineau, 2000, P. 226). The exactness of copying of pottery making technology, choice of raw materials, design, forms of pottery suggest the conservation of initial traditions in the milieu of local inhabitants during a long period of time that testifies that pottery became a transcultural phenomenon. One of the reasons of it could be an idea of prestige and/or sacral significance of this first pottery.

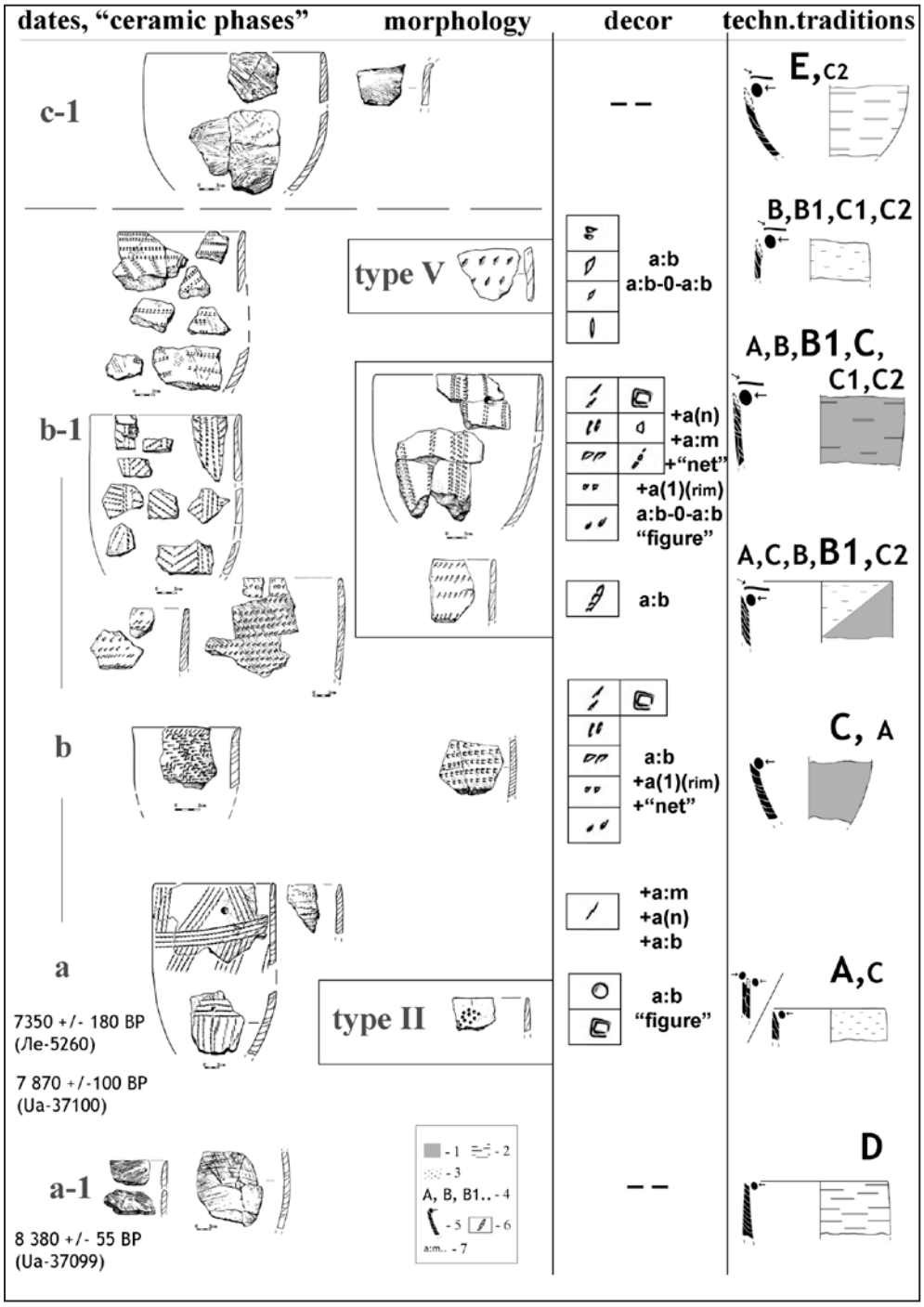


Figure 2.14. Scheme of early neolithic pottery development in Upper Western Dvina River.

Neolithic epoch began at different time on different territories of Eastern Europe. One of the main features of Neolithic time of forest zone of the modern Russian plain is widespread distribution of pottery not known in the former period. Aridization that took place about 8 mil BP in modern steppe zones of Eastern Europe led to migrations to the north of small groups of ancient inhabitants from these territories. Distribution of traditions of pottery making in the local milieu can be connected with appearance of these people here. This process of Neolithic innovations distribution on the territory of Eastern

Europe and part of the Western Europe due to its specificity was proposed to name "revolution of pottery making" [Mazurkevich et al., 2000, P. 20].

Detailed analysis of early-Neolithic pottery of Dnepr-Dvina basin allowed us to distinguish several ceramic traditions and to make hypothesis about material culture development and also reconstruct some historical processes. In 1987, the idea was suggested that Serteyskaya culture was included in the vast early-Neolithic community located from south of Russian valley to Valdai [Mikljaev et al., 1987, P. 170]. Analogies to another phase were found among materials of sites of Eastern Belorussia, Valdai Hills, Upper Volga and left-shore Ukraine [Mikljaev, 1994]. This idea suggested that existing ceramic impulses found its confirmation in materials of south-western territories, more precisely – in Bug-dnestr and Dnepr-donetsk cultures that influenced certain territories of Dnestr basin and Upper Dvina river.

Multiplicity of analogies that can be pointed for pottery of Upper Dvina and varieties of pottery-making traditions is the reflection of specificity of "Neolithic packet" distribution on the territory of Eastern Europe. Several independent centers in the steppe zone of Eastern Europe where "Neolithic packet" was distributed and where pottery making first appeared can be divided. Cultural impulses began to diffuse from these centers that are archaeologically fixed through pottery – "ceramic waves" – on the whole territory of the Eastern-European plain. One of these centers was formed in the Azov-Caspian region. Appearance of the most archaic pottery in this region on the site Rakushechny Yar can be linked, probably, with Near-Eastern influence. It is testified by special features in morphology and pottery making technology, fragments of vessels covered by ochre on the inner and outer surface, stone vessels, adobe architecture and appearance of productive economy. The most ancient pottery found on this sity has flat bottoms with straight or slightly turned-out rims, with thick or thin walls, with traces of polishing by pebble, traces of "comb", non-decorated or decorated by lines organized in net, triangular signs, roundish impressions. This tradition of pottery making can be observed among materials of sites situated in forest and steppe-forest zone of eastern Europe: the basin of Desna river, Volga-Oka, Low Volga, Southern Onega, in the basin of Sukhona river (sites like Tudozero V) [Ivanisheva, 2006; Cetlin, 2008; Smirnov, 1991; Vybornov, 2008] and on the territory of Dnepr-Dvina basin.

The tradition of pottery decorated by pin action formed triangular marks and by individual marks linked through one continuous stepped back drawn movement was formed in the same region (basin of Low Volga and Northern Caspy) [Vybornov, 2008]. Cultural impulse from this place is fixed on a great territory of forest-steppe and forest zone of Eastern Europe.

Probably, another "ceramic centre" was formed on south-western territories of Eastern Europe – in area of Bug-Dnestr culture [Danilenko, 1969; Kotova, 2002; Markevich, 1974]. Pottery of this culture is decorated by drawn-curvilinear design as well as with impressions of the tool in the form of shell or shell and "I" [Markevich, 1974] (pottery decorated in the latter manner was also found in the lowest layers of the site Rakushechny Yar). It can be presumed that the following territories were influenced by this culture– basin of Dnepr river, Desna river, Upper Dvina river. It is important to underline that traces of productive economy were found in these "initial centres" [Kotova, 2002; Krizhevskaya, 1992; Pashkevich et al., 2009; Motuzaite-Matuzeviciute et al., 2009]: people with several components of "neolithisation packet" moved here. The role of elshanian sites as a probable other "initial centre" is under discussion.

Distribution of "ceramic traditions" from these three centres, due to dates ^{14}C [Timofeev et al., 2004], was realised during short period of time along main water-routes

of Eastern Europe flowing in meridional direction. While rivers going in latitudinal directions became a natural barrier in this process of distribution of "ceramic traditions" at the first stage. Small groups of people moved and settled on different territories which traces are difficult to be seen archaeologically and they brought into the Mesolithic milieu innovations such as traditions of pottery making.

Due to ethnographic data, widespread uniformity of pottery styles must exist in communities of hunters-gatherers in the course of individuals displacement from one camp to another [Hodder, 1982]. This process can be named "migration of ideas" [Mazurkevich, 1994. P. 82] in the case when migration of people is almost elusive. Established on a new place these "centres" of innovations began to be *secondary centres* from which ceramic traditions began to diffuse and develop gradually among ancient inhabitants of surrounding territories. Thus, in Dnepr-Dvina region this process reflected in appearance here of Rakushechny Yar traditions at the first stage that did not find their further continuation and were not admitted by local inhabitants. Then triangular pin-holes decorative traditions and techniques of coil-modelling with the use of polishing and the comb-like-tool of Low Volga – North Caspian center appeared here. At this stage geographical proximity played more important role in diffusion of ceramic traditions than linguistic/historical [Gosselain, 2002].

Calibrated dates [Timofeev et al., 2004; Davison et al., 2009] prove that the beginning of Neolithic in steppe zone of Eastern Europe can be dated to the end of VIII – beginning of VII mil BC that is equable to dates of early Neolithic (ceramic) sites of Near East. At this time most ancient pottery making centers appeared on the territory of Eastern Europe, the origins of which were explained by Belanovskaya T.D. as the result of influence of Neolithic cultures of the Caucasus [Belanovskaya, 1995, P. 181–182]. In its turn the territory of Southern Caucasus was included in the zone of influence of Anatolian early-Neolithic cultures yet in the period PPNB [Kiguradze et al., 2004, P. 353]. More of it, based on the proximity of a range of features of material culture (similar forms of stone vessels [Belanovskaya 1995, Fig. XXVII-3; Kozlowski et al., 2005, Fig. 3.1.1], similar forms of pottery and similar technique of pottery making with the help of coils or short stretched coils/slabs, simplicity of pottery, rarity of design [Vandiver, 1987, P. 9-23; M. le Mière et al., 1999, P. 5-16; Nishiaki et al., 2005, P. 59-63; Voigt, 1983] and close ^{14}C dates, direct infiltrations from territories of Near East and Anatolia to the territory of Low Don might be supposed. Influence of cultures of Balcanic peninsula on the territory of Bug-Dnestr can be suggested [Kotova, 2002]. The latter transmitted indirectly the tradition of pottery decoration using shell or tools that left very similar impressions.

Evidently, different models of neolithisation were realised in the territory of Eastern Europe. First one – "standard" –spread of "packet of innovations" that mark the beginning of Neolithic epoch: pottery making, productive economy, architecture, stone vessels and new social organization. Another model is "septentrional" (appearance of pottery making only). Appearance of skills of pottery making, their dispersed distribution and further expansion on the territory of Eastern Europe, their development are *two different processes*. We suggest that it is necessary to divide a process of "Neolithic packet" diffusion and further distribution of ceramic traditions in the Mesolithic milieu from other, *secondary*, centers situated in forest and steppe-forest zone. The end of development of the first early-Neolithic traditions might be regarded as the end of early Neolithic that happened in different territories at different times.

Early Neolithic began on the territory of Dnepr-Dvina basin on the border of Boreal and Atlantic periods – at the beginning of the VII mil calBC. Early Neolithic sites

are situated in different microregions. In the Serteya microregion – sites Rudnya Serteya (№ 4), Serteya 3–3, Serteya XXVII, Serteya XX, Serteya XIV, Serteya XXI, Serteya XXII, Serteya XXXVI, Serteya XXXVII, Serteya XLIX, Serteya L, Serteya 3–1, Serteya 3–2, Serteya XIX, Serteya XXIV, Serteya XXIII, Serteya 3–4, Serteya 3–5, Serteya 3–6, Serteya XXXV, Serteya XXXIX, field near Rudnya Serteya N3, Serteya XII, Serteya X; in Usviatsky microregion – site Uzmen', Usviaty II, Romanovskoe, Lukashenki II, Udviaty I, Cyganovy Nivy, Poloneika, in Sennitsky microregion – Dubokray I, Dubokray V, Dubokray VIII, Froly I.

The Serteya microregion consists of a chain of small residual ice-dam lakes (dating from the late Valdai / Würm glacial) connected by rivers. All sites are located on the shores of confluences and lakes remote from the main waterway, the Western Dvina. The relatively modest occupation of the banks of the big rivers could be explained by insecurity of the main waterways in the past [Kalechic, 2003, P. 162]. Early Neolithic sites are situated in the northern and southern parts of the Serteya microregion, and are separated by an uninhabited area.

The prevalence of vessels in the middle phase of the Early Neolithic could be an indirect sign of an increase in population in the Middle Atlantic period (7.345-6200 BP). This supposition is also supported by a greater anthropogenic influence on the ecosystem and palaeo-lakes in comparison with the preceding Early Atlantic period (7.860-7.345 BP). The water level rose and amount of available food increased as well. It corresponds with a slight fall in temperature in the Middle Atlantic period that is shown by a decrease of pollen of deciduous trees by 1-3 %.

The sites situated on the shores of the southern palaeo-lake (Rudnya Serteya, the field above Rudnya Serteya No. 3, and Serteya XII) occupy a territory of fluvioglacial sediments, hence the zone of broadleaved-coniferous forests with birches. The site Serteya X is situated on the border of fluvioglacial and morainic sediments, i.e. the territory of spruce, birch and oak forests. The majority of the sites is situated on the shores at the confluence of the palaeolake and ancient streams, or – like Serteya X – on the island. These locations were suitable for fishing and hunting in broadleaved forests, i.e. in the summer habitats of animals. Thus, these sites might be places of summer settling, with a base camp at Serteya X, where traces of permanent constructions were found.

The sites situated in the northern part of the Serteya microregion (the district of the Nivniky lake basin) are found in a zone of sandy loam and yellow sand sediments. They have the same topographical position and are deep inside the zone of coniferous-birch forests. The 3D ancient relief reconstruction, taking into account geomagnetic survey and slope analysis, showed that sites located on the plateau along the boards of the lake basins were situated in small depressions, protected on the north side by ridges.

GIS modelling of the passage by water from the Western Dvina along the river Serteya showed that some of the sites that were occupying advantageous positions on the second terrace could control this water passage. The poor illumination, particularly in winter and the openness to strong northern winds made these places inconvenient for permanent habitation, but they could serve as places for fishing or as observation posts.

In the northern part of the Serteya region a group of sites situated on the capes of the boards of lake basins was discovered. All of them are found in a line on the periphery of the lake basins crossing an animal migratory track existing even now, occupying advantageous high-altitude positions. It is known that the migratory tracks of animals have not changed very much through time. Only debitage, scrapers, points and tiny calcined bones were found on these small sites, Some of the sites seem to be synchronous with sites with traces of substantial dwellings (found at Serteya 3–3 and Serteya XIV)

and, consequently, they could all be part of the same settlement system, reflecting seasonal activities of the ancient inhabitants settling in this microregion. Probably, they could move into this territory from the end of autumn until the middle of spring, when animals migrate to coniferous-birch forests of the northern basin. Furthermore, on the Serteya 3–3 site, a three-room dwelling with different types of Early Neolithic pottery was found (Fig. 2.15). It was situated in the northern lake basin and could indicate that different societies (probably, from different lake basins) were living here together in winter. The analysis of clay and pottery serves as a supporting argument for this supposition. A few pots in the northern lake basin were made from clay from the southern lake basin, so they were probably brought here from the latter [Mazurkevich et al., 2008].

Figure 2.15. Remains of Neolithic three-chambered dwelling on the site Serteya–3.

The human impact on the Serteya (southern) lake basin in the middle phase of the Early Neolithic was lower than the impact on the Nivniky (northern) lake-basin [Mazurkevich, 2003]. This difference can be deduced from a different density of sites located in these lake basins and, consequently, of population in these two parts. Probably one of the reasons for intensive settlement was the favorable landscape conditions of the northern part that allowed people to maintain an efficient economy, hunting for elk, boar, bear, birds and fish. With the help of cost weighted distance calculations, the zones of easy accessibility that were attractive to economic activity were distinguished. From this, we can calculate the size of these zones taking into account that areas within a radius of 500 m were the most-used, whereas areas within a radius of 2.5 km covered all economically favorable zones. The relief should be also taken into account because it determines the extension of the economic zones for different territories in many aspects. Furthermore, the existence of two base camps (Serteya 3–3 and Serteya XIV) in the territory of one economic zone can be an indication of their non-simultaneity. We can also distinguish two different groups in the northern (Serteya XIV) and southern

(Serteya X) parts of the microregion as is shown by the modelling of their economic activity zones.

This seasonal orientation of two parts of the Serteya microregion and the different economic orientation of various sites can also be illustrated by the analysis of aspect and illumination. It was not comfortable to live on the north-eastern and north-western slopes in winter. That is why the ancient inhabitants chose western or south-western slopes, whereas in summer they could also settle on the eastern slopes. Moreover, the illumination in winter was better in the northern part of the Serteya microregion. In contrast, all sites with traces of substantial dwellings (Serteya X, Serteya XIV and Serteya 3–3) are exposed to the south / south-west and are protected from the north by the border of lake depressions, terraces or higher elevations [Mazurkevich et al., 2003, P. 260-265].

In this way we have distinguished several specialised sites situated in specific parts of landscape – winter and summer camps, hunting sites situated along an animal migratory track, fishing spots, and possible observation posts which together formed the settlement system of the Early Neolithic from the 6th to the beginning of the 4th millennium BC. This varied settlement system took into account the seasonal convenience of different places in order to use all the rich resources of the Holocene to their optimum, and took maximum control of the area that was used for the observation of the natural resources, or for guarding the territory.

In the middle of V mil calBC bearers of traditions of LBK culture, ancient farmers of Middle Europe, appeared in the basin of Western Dvina River. The remains of this culture were found on the bottom of lake Sennica on the site Dubokray V in the course of underwater excavations. Fragments of pottery decorated in linear-ribbon manner using drawn lines, drawn lines and impressions, incisions, clay attachment and its imitation made with pinching, bone and antler points, daggers, arrowheads and two flutes were found there. The latter are made from cortical bone of big waders and have four lateral holes (Fig. 2.39). One of them is decorated by round incisions, another – by complicated geometrical decoration. These flutes can be attributed to straight and oblique types but made basing on one musical standard that testifies accumulation of large theoretical and methodological experience. These flutes have scale that combines very narrow melodic interval with a wide one which can be correlated with ancient Greece enharmonic tonality. Also cylindrical amber pendant was found here – one of the earliest ornaments from Baltic amber in Eastern Europe. On the territory of Serteysky microregion (site Serteya XIV) stone axe, remains of long house and fragments of pottery attributed to this culture were found.

Middle-late Neolithic.

Unique culture of pile-dwellings appeared at the second half of IV mil calBC in Western Dvina River region. The first pile dwellings, which belong to the Usvyatian Culture, existed between 3500 and 2550 cal BC. Their appearance marks a cultural discontinuity, and coincides with a major change in the environment. The pile dwellings reached their maximum size during the next stage, which included the Zhizhitsian (2550-2250 cal BC) and North Belorussian (2250–1950 cal BC) cultures. In middle Neolithic northern laake basin of Serteysky microregion (Figs. 2.5, 2.6, 2.16, 2.17) was not populated. Pile-dwellings were situated only in southern lake basin (sites Serteya I, II, X, XI – № 5).

Pile dwellings appeared at the Atlantic / Subboreal boundary (3700–3200 cal BC) when there was a regression stage of lakes. As shown by pollen analysis, the end of

Atlantic period coincided with the maximum extent of broad-leaved species, mainly restricted to the endmorainic uplands. However, the fall of temperature that began in the Subboreal period caused a decrease of broad-leaved species and an increase of spruce (*Picea*). At that time pile dwellings also appeared in southern Germany and Switzerland in a similar landscape; they were situated on lakeshores located in front of the morainic formations of the Würm Glaciation [Petrequin, 1988; Dolukhanov, Mazurkevich, 2000].

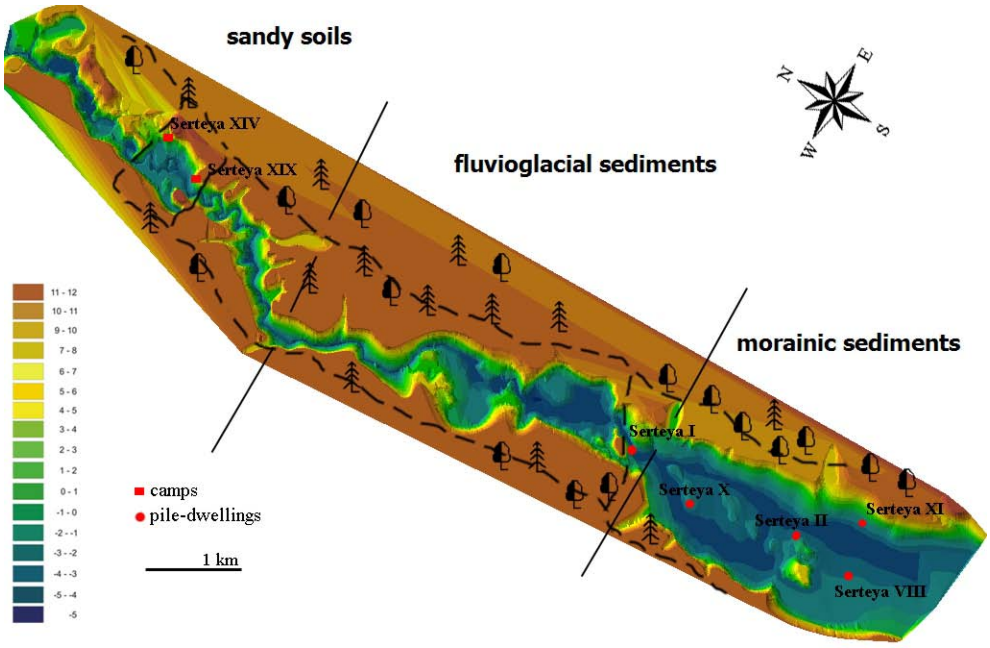


Figure 2.16. Distribution of pile-dwellings of middle Neolithic in Serteysky microregion.

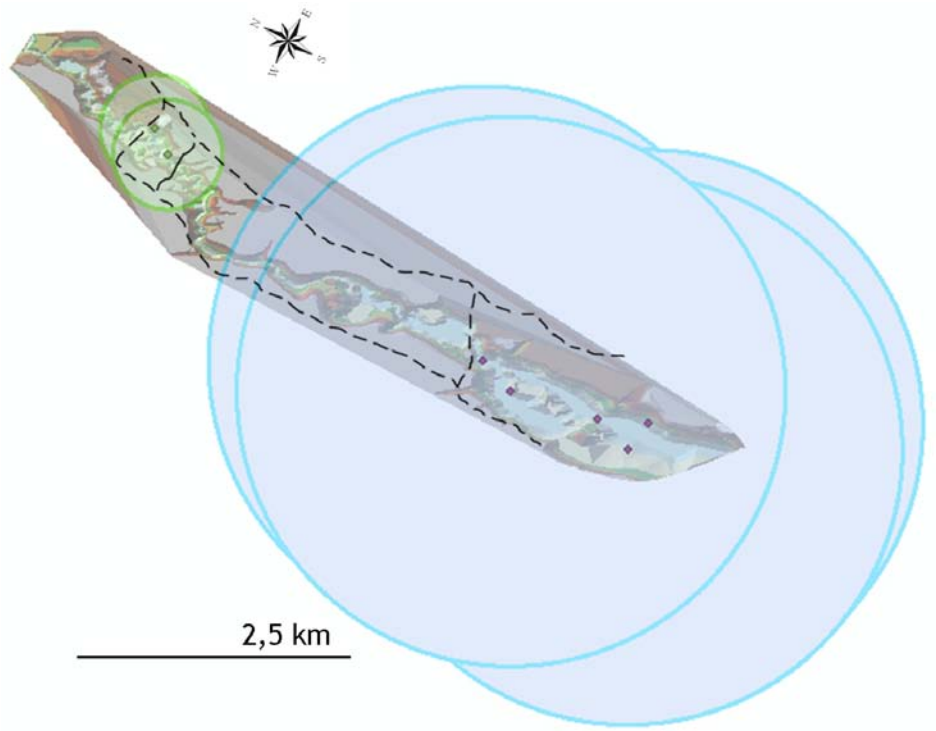


Figure 2.17. Zones of economical activity of pile-settlements inhabitants in Serteysky microregion.

Spatial analysis of lacustrine pile dwellings in the study area reveals a clear subsistence pattern based on catchment area, which limits foraging to a two-hour walking distance (*c*. 10 km) from the central hunting lodge [Zvelebil, 1996]. The settlement and the zone of economic activity are regarded as one natural-economic complex. It determines the boundaries of the economically favourable landscape surrounding the settlement, which allows us to estimate the extent and types of natural resources used by ancient people. It allows the reconstruction of the peculiarities of the economy and an estimation of the demographic situation of this area. The catchment area of the pile dwellings includes three distinct landscape types: (i) lake plus low-lying terraces and offshore mires; (ii) endmorainic formations with predominantly clayey soils covered by broad-leaved trees; and (iii) glaciofluvial outwash plains with sandy, podzolic soils covered with pine forests [Dolukhanov, Miklyaev, 1986]. The combination of these types of landscape made possible a productive hunter-gatherer economy and strongly contributed to the settlement system at this time [Dolukhanov, Miklyaev, 1986]. Only specific types of landscape were chosen for settlement, whereas the rest of the region was uninhabited. It also explains the long duration of pile dwellings in one place.

Interesting results have also been acquired from GIS-modelling of Lake Sennica (Pskov region) where sites are only situated on the western and northern side of the lake basin. Poor natural light on the eastern and southern shores, particularly in winter, as well as exposure to strong northerly winds and maximum remoteness from broad-leaved forests, all contributed to making these locations inconvenient for inhabitation. Furthermore, several former lake basins were made visible by remote sensing and analysis of sediments from boreholes made in the middle of these palaeolacustrine features. There are several ancient small lake basins joined by channels near the western and northern shores, which are separated from the central lakes by islands where the sites are situated [Mazurkevich et al., 2005].

The economy of the pile dwellers had a complex character; hunting prevailed over fishing and food gathering. Some boar (*Sus scrofa fer.*) caught in the course of hunting were not killed immediately but were being kept for some time on several sites and these animals were fed with fish. This is evident from the analysis of pig faeces containing small fish bones and scales, which were found in the base of cultural layers. Thus, we observe the apparent initial stage of pig domestication. This happened under the influence of the Globular Amphora and Funnel Beaker cultures, which can be clearly traced through the pottery typology of this time. Furthermore, bones of already domesticated pig (*Sus scrofa dom.*) and bones of a cow (*Bos taurus*) and a dog (*Canis familiaris*) have been found on the site of Usviaty IV dating to the end of 4th millennium cal BC [Sablin, Siromyatnikova, 2009, P. 155]. Teeth of a horse were found on the site of Serteya XI dating to the beginning of 3rd millennium cal BC. Their small size and thin, weak enamel indicate that these teeth belonged to an old domesticated horse (*Equus caballus*) [Kuz'mina, 2003, P. 305] (Fig. 2.18).

Traces of agriculture are observed in the early Subboreal (Sb-1) period. However, judging from the palynological data, this was not the first evidence of agriculture (Fig. 2.18). However, all previous "attempts" at farming had no continuity; agriculture was not adopted or was not continuously employed in the local environment. Thus, the first stable appearance of Cerealia in the pollen record is dated to the beginning of the Subboreal. A high content of grassy vegetation is shown in the pollen diagram for the same period, which marks the expansion of open spaces that could have been used by prehistoric people for agriculture and cattle herding. Ethnographic evidence shows that in northern Russia, Finland and Karelia "burn clearings" were cultivated on sloping and

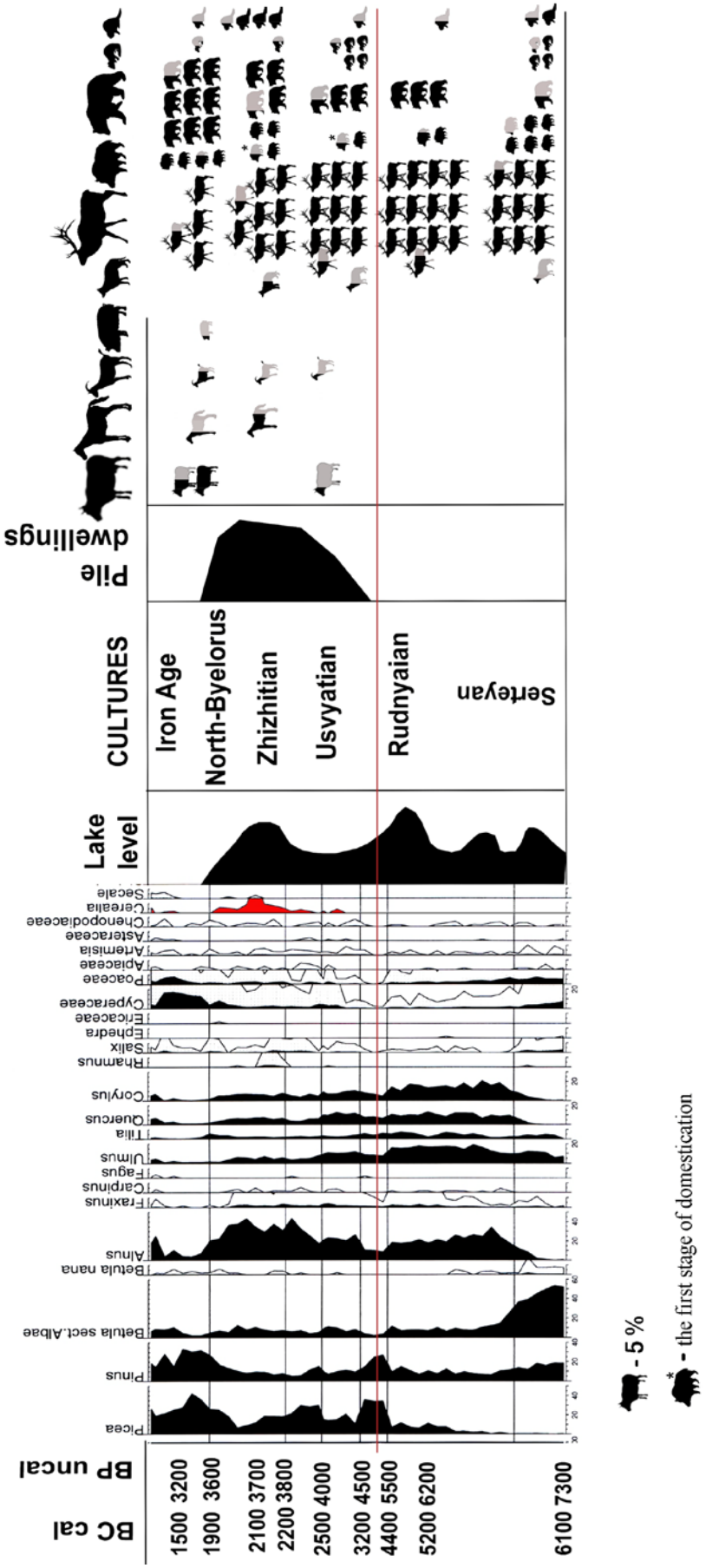


Figure 2.18. Synchronization of pollen diagram with radiocarbon dates, lake level data, faunal evidence, and archaeological.

hilly terrain [Petrov, 1968]. In the case of the Serteya River the corresponding terrain could be found along the steep slopes of the valley at a distance of less than 2 km from the site. “Swidden” farming was well suited to the natural renewal of forests. After the plots were abandoned, the area was populated by young birch, and later, by mixed forests dominated by deciduous trees. Analysis of the palaeolandscape suggests that at the beginning of the Subboreal fertile soils along the margins of the lakes were used as fields for crops and cattle herding Finds of agricultural implements (hoes and ploughs) also provide evidence for the existence of agriculture.

Figure 2.19. Fragment of plough from the site Dubokray I.

Pottery from the Usviatian Culture is represented by vessels with flared rims, forms that include characteristics of a cylinder plus a cone, low-volume vessels with turned-in rims and biconical forms, and vessels of simple conical form with rounded or flat bottoms. Wall thickness varies from 6 to 10 mm. Organic material or shell was used as temper; the latter was predominantly used during the early Usviatian Culture. During the last phase sand appeared as ceramic temper. The pots were made by coils that were joined together using the “S” technique. There are also traces of paddle and anvil, as well as polishing and comb-tool techniques. Decorations consisted of motifs made by impressions with straight-edged or denticulated tools; incisions and rounded-incisions are predominant, whereas comb-ornamentation is the third most frequently observed form of ornamentation. Also, there are decorative elements consisting of oval pits, lines, and cord impressions. Designs are arranged in zones and do not cover the entire vessel surface. Motifs consist of geometric figures, rows of impressions, and impressions placed at angles to one another. Additionally, there are triangle, rhombus and hexagon motifs, the last mentioned in the form of honeycombs with incisions, zigzags and nets of lines, and cord impressions. The decorative system was formed under the influence of the Funnel Beaker Culture, whereas the appearance of ‘honeycombs’ and impressions placed at angles to one another is the result of influence from the Globular Amphora Culture. Cord and line ornamentation reflects the successive influences of these two cultures. Comb ornamentation belongs to the local tradition, but the motifs used reflect foreign influences.

Tools were made of high-quality black and grey flint of non-local origin. Flint implements are represented by “daggers”, small knives, tanged darts and arrowheads, quadrangular scrapers, end-scrapers on blades, knives on flakes, and massive scrapers. Most tools were found outside the perimeter of the living platforms. This suggests that activities such as flint knapping and butchering were done on the spot [Poplevko, 2007, P. 179, 186, Figs. 95–98]. Flint daggers made from long blades and daggers with short tangs appear at the beginning and middle of the 3rd millennium cal BC, respectively. The period of their occurrence coincides with the chronology of similar types of artefacts from Central Europe [Schlichtherle, 2005, Fig. 30].

Influences from the south, from the basins of the High Dnepr (Dnepr–Donets Culture) and Oka (Rhomb–Pit Culture), led to transformation of the local culture and formation of the Zhizhitsian Culture. Pottery from Zhizhitsian Culture is represented by vessels made in the “S” technique and also by slabs or coils. There are traces of polishing, smoothing, and use of a comb-tool. Sand, organic materials (including grass) and, more rarely, shell were used as temper. Pottery was fully decorated and the ornamental pattern was not determined by geography. Pottery was decorated with lines forming a net pattern, denticulate impressions, by cord made of bark, impressions of small knots, and elongated impressions of tools with flat edged or denticulated tools; it was organized in rows or staggered rows. There are also complex compositions made with different symbols and motifs. Vessels are of different forms compared to the Usviatian and Corded Ware cultures, and include small biconical, globular and cylindrical vessel forms with flat or pointed bottoms. Cord impressions and cylindrical and globular vessel forms typical of the middle Dnepr Culture reflect influences from the Corded Ware Culture. There are also vessels with flat bottoms, trays as well as their imitations, and a ladle with a clay hand (see Mazurkevich 2006, Fig. 92), but the most remarkable thing is the pintadera [Mazurkevich, 2006]. The pintadera which has a handle and a round surface, is 3.2 cm in diameter with three similar impressions along the edge of the surface. Analogues for this object can only be found in the archaeological cultures of the northern Balkans (see Makkay, 1984, Figs. III-7, XIII-6 and XVIII-XXI). The appearance of a copper awl found on the site of Usviaty IV likely is also connected to the influence of these foreign sources [Mazurkevich, 2007, P. 236-240].

During the time of the Zhizhitsian Culture inhabitants of the pile dwellings used local boulder flint. Tools that had worn out were reused after reshaping. Flint tools are represented by rectangular scrapers, flake scrapers with an arched or straight working edge, leaf-shaped arrowheads, tanged arrowheads, and triangular arrowheads with a flat base or notch. Flint wedged axes appeared, as well as stone scaphoid and tanged axes that reflect Corded Ware Culture influence [Mikljaev, Semenov, 1979, P. 13–15, Figs. 6-7].

Pottery of the North Belorussian Culture was made using the “S” technique, sand and organic material was used as admixture, and the thickness of vessel walls varied from 5 to 6 mm. Unfortunately, owing to the conditions of preservation, the shape of the vessels cannot be reconstructed. Rims are straight with flat and mostly non-ornamented edges. Bases are round, though the occasional example is flat. The ornamentation system was similar to that of the preceding period but the amount of pottery with cord ornamentation increased two-fold. Raw material changed; yellow-grey flint replaced black flint as the predominant material. The change of raw material source can be explained either by flooding of former flint sources or the disruption of cultural contacts with regions from where the raw materials previously used were obtained. Tools were made from flakes. Scrapers with a rectangular working edge, T-formed scrapers, leaf-shaped arrowheads, tanged arrowheads, and arrowheads with a flat base or notch, are

typical of the North Belorussian Culture. Types of cutting tools are analogous to those of the preceding period.

Figure 2.20. View on the site Serteya II.

Figure 2.21. View on the site Serteya II. Remains of pile-construction № 1.

The following categories of objects were found at different sites. They occur sporadically, and so are presented together. Artefacts of bone and antler are represented by daggers made from elk ulnae, needle-shaped arrowheads, arrowheads with a biconical blade and flat haft element, uniserial harpoons with two holes in the haft element, borers

with the metapodium reformed into a finial (one of which is ornamented), chisels, hoes of elk antler, bone spoons, denticulated stamps, and tools made of boar incisors. During the Late Neolithic the quantity of bone and antler tools decreased compared to the preceding period; however, the types are continuous.

Figure 2.22. Process of underwater excavations on the site Serteya II. Underwater photo.

Figure 2.23. View on the site Serteya II. Underwater photo.

The most representative collection of wooden artefacts comes from the sites of Usviaty IV and Serteya II. “Mallets” are the most abundant category unique to the Middle Neolithic. They are made of ash, oak and maple, and have an oval or rectangular head and handle. There is a hollow on each side of the head, resulting from use. Other categories are represented in both the Middle and Late Neolithic: bent axe-handles made of oak and

associated shafts of ash, hoes made from maple and plough made from oak , and parts of oak spades. Several objects can be interpreted as paddles, they were always made of maple; one example measures 162 cm long with an elongated blade and a handle edge decorated with two ducks' heads. Large dishes and ladles were made of ash, whereas small ladles, spoons, and spatulas were made of maple. The fragmentary remains of bows show that they were made of hazel, ash, and pine. Arrowheads of pine, and skis and sledge runners of ash were all recovered. Nets were made of juniper and bilberry roots, and ropes were made from lime bast and rhizomes of juniper and bilberry. Small sacks made of birch bark filled with sand, stones or fragments of pottery were used as sinkers for fishing and attached to birch bark twine. Mats were woven from fresh willow shoots, and birch and willow branches were used as plugs to patch holes in the bottoms of pottery [Kolosova, Mazurkevich, 1998, P. 52–54].

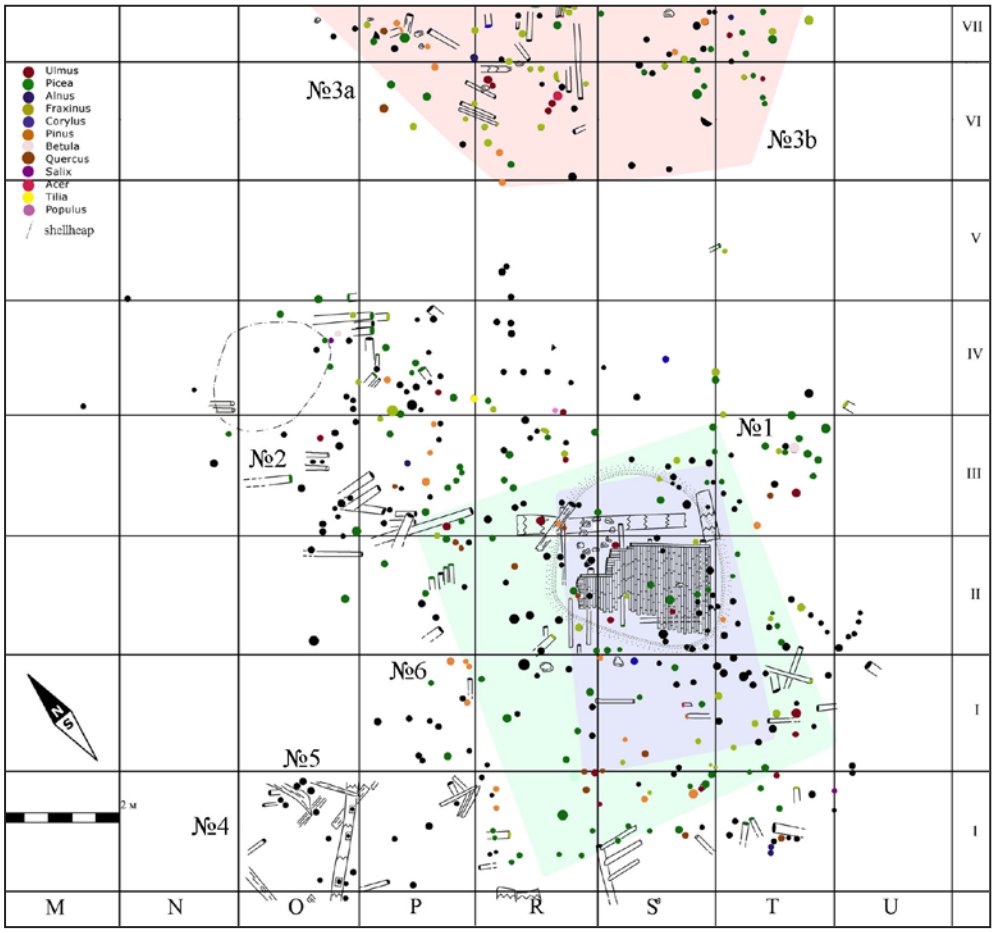


Figure 2.24. Plan of constructions on the site Serteya II.

Two trapezoidal pendants of amber with longitudinal perforation seem to imitate teeth. They come from the site of Serteya II (Construction no. 1) and belong to the Zhizhitsian Culture, and date to the middle of the 3rd millennium cal BC. Another group of amber pendants was found at Naumovo and Usviaty IV [Mikljaev, Semenov, 1979]. This group comprises oval pendants with transverse perforation, trapezoidal pendants with longitudinal perforation, and cylindrical pendants with unusual T-form perforation. These finds date to the second half of the 3rd millennium cal BC and belong to the North Belorussian Culture. Chemical analysis has shown that Baltic amber was used as raw material [Shedrinsky et al., 2004, P. 79–80; see Mazurkevich, 2006, Figs. 82-86]. The

trapezoidal amber pendants are unlike the amber ornaments of the Globular Amphora Culture, or contemporaneous materials from the eastern Baltic [Czebreszuk, 2003; Loze, 2003] since, in contrast to the last mentioned, they imitate animal teeth. The oval and cylindrical amber ornaments have some parallels with examples from the Corded Ware Culture and contemporaneous sites in Latvia and Estonia [Loze, 2003]. The main differences between the local pendants and those of other regions are in the method of fabrication, the arrangement of the perforation for suspension, and the shape of the cross-section. The original fabrication technique, the shapes of the amber ornaments, and the discovery of raw amber on the site of Serteya X suggest that the raw material was transported from the eastern Baltic to the Upper Dvina region, and that the ornaments were made locally. Local inhabitants could compensate for the lack of raw amber in the area by active use of similar, available materials– resin resembled amber (evidenced from finds of a raw material field cut through by the Western Dvina river) [Shedrinsky et al., 2004б P. 75].

Certain categories of "art objects" may have been associated with the ritual activities of the inhabitants of the pile dwellings, interpreted here as a possible "ancestor cult" – they comprise clay pots with anthropomorphic figures or signs, an anthropomorphic spatula/spoon with undulating edges, sculptural images of humans and animals, a wooden ladle with the image of a bear filled with burnt bone, which was found near the spoon, a human mask, and a zoomorphic pendant [Mazurkevich, 2006, P. 28, Figs. 26-29, 42 and 44-46]. Functional and protective qualities of specific animals or ancestors may have been transferred onto the object (i.e. a paddle decorated with ducks' heads) or onto the individual (i.e. a necklace of animal teeth, or imitations made of bone and amber) (see Mazurkevich, 2006, Figs. 85-86). However, finds of these types of artefacts are rare. The sculptural images of humans and animals have distinctive features – the accurate representation enabled us to identify the animals portrayed. Moreover, the absence of eyes, elaborated eye-sockets, cheek-bones, ears, chin, mouth and lips suggest an emotion or behavioural characteristic in the perception of the image. One example is the mimicry of human face from cultural layers in the site of Usviaty IV; this face may be associated with such emotions as tension and expectation, or with shouting. Another from Osovec II may show severity or depression, and the mask from Djazdica possibly shows severity or cruelty. The physical strength of male figures was represented by shoulder girdle muscles.

Almost all art objects from the Neolithic may be classified into two groups – sighted and eyeless figures. Most of the eyeless animals and humans come from burials or other ritual places. This fact allows us to suppose a connection between eyeless images and the semantic field of another world – the world of ancestors and the world of the dead. Usually, sighted figures are represented by animals, including birds, the eyes of which could have been inlaid, as suggested by the character of the eye sockets. Ochre may have been used as the material for encrustation; ochre was found in the eye sockets of some pendants that have the form of birds' heads. These figures may concern another semantic field – that of resurgent or living creatures that played a guarding role.

Large vessels with anthropomorphic images are very important and may be evidence of feasting. Anthropomorphic graphical signs decorating the pots of the Usviatian Culture (at Usviaty IV) may represent coded signs of a genealogical tree and/or the social structure of the inhabitants of the pile dwellings, by comparison with ethnographic examples [Carpenter, 1986]. At the site of Usviaty IV traces of funeral feasting were found; the animal eaten during the feast was specifically collected in the ladle with the head of an eyeless bear and taken out to the perimeter of the living space –

a spoon was placed nearby. The question must then be considered, for whom was it necessary to have such a feast, and when was it held? We suggest this action was undertaken for a chief who had taken under his control different aspects of social life, including ritual and economic activities.

The form of the pile constructions changed through time. Part of an oval construction was found in an early horizon of Usviaty IV. Later rectangular constructions (measuring 14 x 6 m) appeared, which became typical for the following chronological horizon of Usviaty IV and the Naumovo site. Pile dwellings of the Zhizhitsian and North Belorussian cultures consisted of one or several rectangular constructions measuring 5.5 x 4.5 m. Rectangular platforms formed the base of the pile dwellings, which were elevated 50-70 cm above the surface of the shore. Logs 9-12 cm in diameter were attached to piles with the aid of ropes and supported by “horned” piles. Poles 5-8 cm in diameter were densely laid transversely on top of the logs; pine slabs *c*. 6 cm thick (without bark) were placed above them. A layer of moss would have been placed on top of the pine and a layer of coarse white sand, some 8 cm thick, was spread across the moss layer. The circular hearth placed on the sand was built with large stones. Piles 14-22 cm in diameter were placed around the periphery. They served as a framework for walls that may have been made of branches. Clay fragments found here can be interpreted as daub fragments. The presence of the row of piles in the middle of the construction may indicate the existence of a pitched roof. The platforms were encircled by garbage dumps located along one of the short walls and along adjacent parts of the long walls; fragments of baskets were found here as well (Fig. 2.25), it is likely there was a doorway in the short wall. Pile dwellings were situated along the shore and were connected by passages. All the structures faced the central part of the site, which was filled with garbage dumps [Mikljaev, 1971; Mazurkevich, 1998]. The distribution of wild boars’ faeces suggests that boars were kept for some time on the site, apparently not inside the constructions but next to them in a pen.

Figure 2.25. Remains of basket on the site Serteya II. Underwater photo.

There are very important questions concerning the reasons for the construction and the general phenomenon of pile dwellings. Perhaps the most pertinent information stems from the analysis of the landscape in which these prehistoric people chose to live. One reason suggested is the desire of the Neolithic builders to free up land that was suitable for agriculture and cattle herding, a theory that has been suggested for Central European pile dwellings [Vogt, 1977]. Furthermore, ancient inhabitants had to take into account many factors before erecting these dwellings, which functioned as year-round settlements. By the time pile dwellings appeared, the water level had fallen significantly and mires had appeared. Shores had become overgrown with alder that made it difficult to approach the lake. The lakes became eutrophic and open water would have been some 100–250 m from shore. Hence ancient people tried to settle near the water – small eutrophic stagnant lakes surrounded by mires. Dwellings would need to have been constructed over the mires along the shores, rather than in the lake, due to the risk of freezing over.

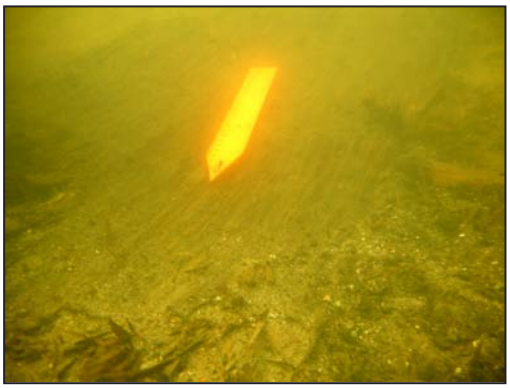
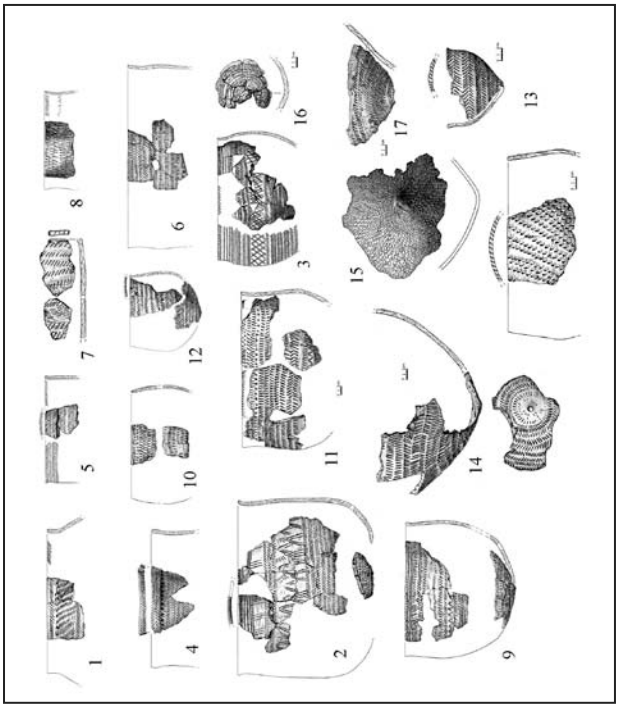
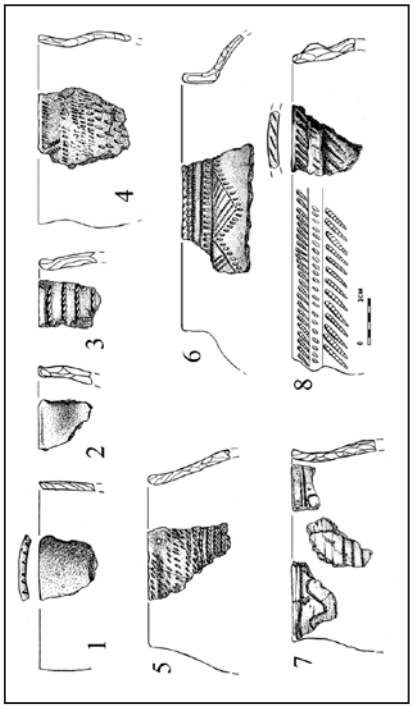


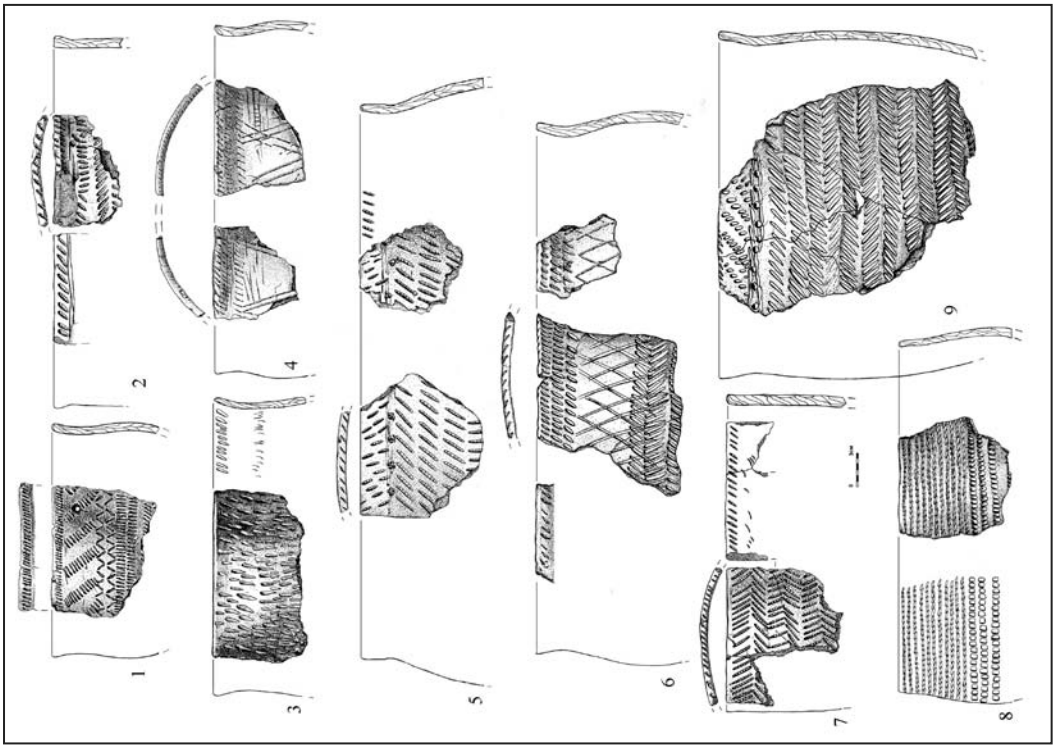
Figure 2.26–2.27. Remains of floor of the construction on the site Serteya II. Underwater photos.

Pollen and diatom analyses suggest that the Atlantic and Subboreal periods were characterized by frequent changes of water level [Arslanov et al., 2009, P. 118-120]. The erection of pile dwellings made the settlement immune to seasonal or gradual variations in water level caused by climatic changes. The geology of the region meant that the area suitable for settlement would have been either situated far from the lake or flooded periodically, becoming almost impassable due to the loamy soil. It may have also been easier to protect against mosquitoes during the period of maximum extension of broad-leaved species because of the openness of the locality.

In contrast to the rather mobile population of the Early Neolithic, whose subsistence economy was dependent on seasonal changes, the situation changed substantially in the Middle Neolithic. The combination of different types of landscape with rich natural resources made a hunter-gatherer economy effective and sustainable based in sedentary year-round villages. Therefore, judging from the pollen record, the establishment of an agricultural economy was substantially delayed. According to pollen evidence agriculture appeared in several impermanent stages. It may have represented a prestigious “package” that included not only cultivation and cattle herding, but also amber ornaments and weapons. Changes in climate, degradation of broad-leaved forests, a fall of the water level, the formation of bogs, and the reduction of lake productivity in the Subboreal may have resulted in the reduction of wild food sources, as well as restricting access to drinkable water in the region. These circumstances are likely to have contributed to the change of economic strategy – settlements becoming inhabited year







Figures 2.28–2.30. Pottery of the site Serteya II.

round, and as the population became more settled, starting to store more food and water. At that time (the Atlantic / Subboreal transition) high-capacity vessels appear and the population increased. The subsistence economy and distribution system changed, which inevitably resulted in a change of social structure [Mazurkevich, 2003].

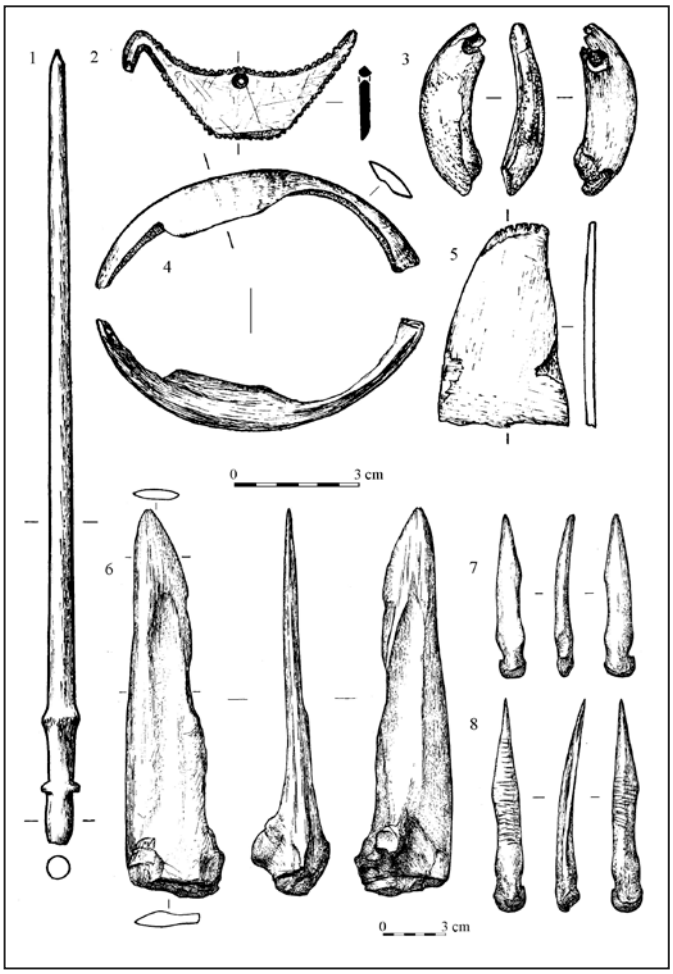


Figure 2.31.
Bone workpieces of the site Serteya II.

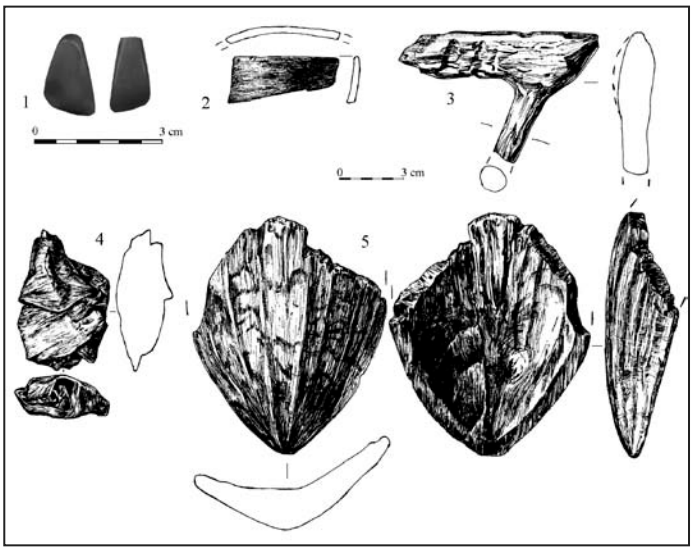


Figure 2.32.
Wooden workpieces of the site Serteya II.

Figure 2.33. Zoomorphic pendant from the construction № 3 c.

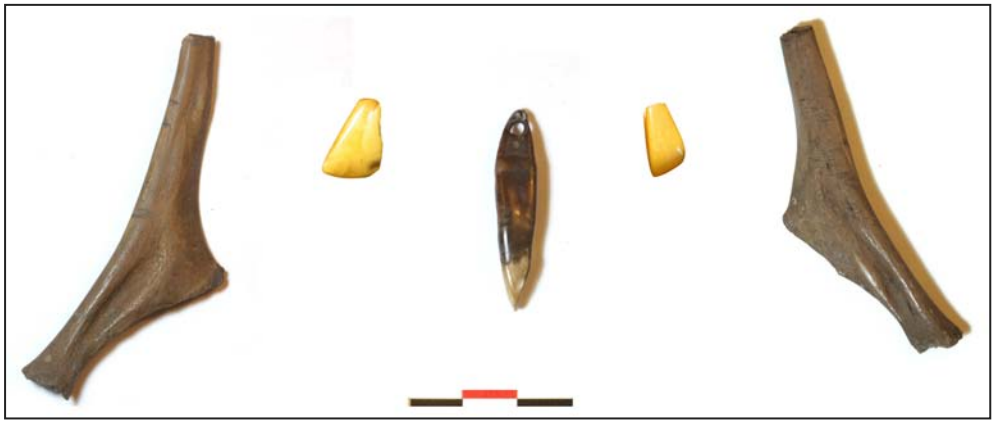


Figure 2.34. Reconstruction of necklace from the construction № 1 (bone, amber) of the site Serteya II.

From the IV mil cal BC western regions were under the constant influence of middle European cultures with productive economies, and these contacts can be traced through material culture. Ancient inhabitants began to develop new economic strategies – agriculture and animal husbandry. The new and complex economy would have affected social structure and culture in general. This likely explains the predominance of anthropomorphic sculpture in the western part of forest zone of Eastern Europe [Loze, 2003], while contemporaneous practices in the east included the widespread cult of the elk, bear, and zooanthropomorphic figures. Many, ethnographically known, traditional societies [e.g. Sahlins, 1974] offer parallels for the material culture of the Neolithic inhabitants of northwestern Russia. Thus big changes in social structure, such as the appearance of chiefdoms, can be observed based on the interpretation of material from the Middle Neolithic Usviatian Culture.

The lacustrine pile dwellings, which appeared at the first half of IV mil cal BC, were unique sites among the Middle Neolithic cultures of the forest zone of northeastern Europe. To the east and north of the Dnepr–Dvina region were sites with Pit–Comb pottery, to the south were sites with Rhomb–Pit pottery, and to the west the Late Narva Culture occurs. Judging from published data, pile dwellings may also exist on the

northeastern Baltic shores of Sarnate and Shvjantoji. The territory of pile dwelling expansion includes the basin of the upper (Serteya II, Usviaty IV, and Dubokrai V).

Figure 2.35. Man figure of the site Usviaty IV.

At the beginning of Sb-3 huge transgression took place which led to ruin of pile-dwellings of North-Belorussian culture (3650±70 (TA-634)). Climate became warmer and dryer, productivity of lakes increased. Inhabitants started to settle on the shores and islands of paleolakes creating base camps with long-term ground dwellings with several chambers with stakes with ground hearths in the same landscape conditions as in previous period (sites Serteya X, II layer 2 – № 7). Parts of fluvioglacial landscapes started to be used intensively again that is testified by sites of Uzmen culture and finds of axes.

Our researches of recent years allowed us to distinguish new types of sites. The first one is fishing places with remains of constructions dated to IV mil cal BC and the middle of III mil cal BC (site Serteya I). Sites Serteya X (7300 BP), Rydnya Serteya (5780 BP) and Serteya XIV (6500 BP) can be attributed to the second type of sites interpreted as zones of shore activity where fishing facilities were left. They are situated near settlements (Serteya X, Serteya XIV) or remote from inhabited areas (Rydnya Serteya). One of the characteristic features of these sites is that their cultural layer continuer further in the nearby river. It made us to hold also underwater excavations which allowed often tracing lots of peculiarities of cultural layer that are very difficult to detect on the surface and uncovering objects in their almost original conditions.

Figure 2.36. Vessel with anthropomorphic image of the site Usviaty IV.

Figure 2.37. Raven figure of the site Usviaty IV.

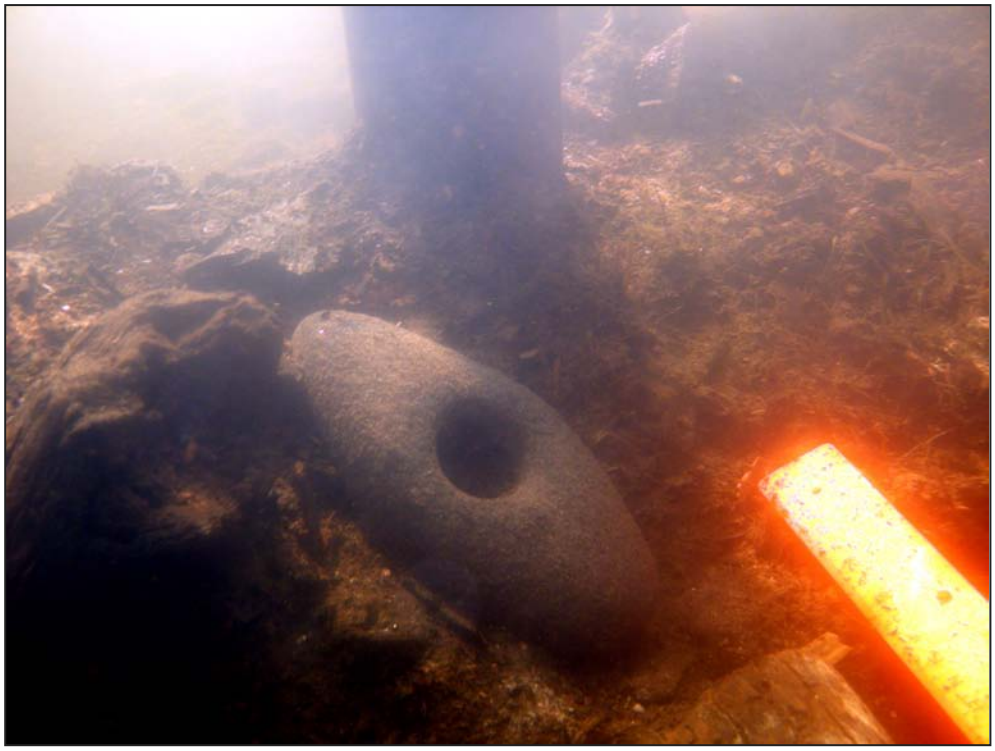


Figure 2.38. Battle-axe from the construction № 1 of the site Serteya II. Underwater photo.

Figure 2.39. Flutes of the site Dubokray V.

Underwater and ground excavations on the site Serteya I (№ 6) (Figs. 2.40-2.41) allowed us to find remains of fishing constructions which can be dated to the middle Neolithic. This date is based on the finds of pottery fragments of Usviatian culture near the construction and first ^{14}C dates made on wooden piles. Remains of vertically located pine splinters of rectangular cross-section bound by cords were found here. Their lower edges were sharpened, the upper part was broken in the past, their length now is 70 cm. This construction was dug into aleurite (that deposited at the border of Pleistocene-Holocene) on the depth of 50 cm. This construction is supposed to block the channel that connected two lakes. Concentration of sinkers and two large stones with remains of binding were found near its western side. Sinkers were made from small pebbles 7 x 3 cm covered by birch bark. Fragments of cords from fishing nets were found on some of them. Downstream remains of similar construction but in a worse state of preservation were found. Sinkers and fragments of splinters were found also in the river which can be part of described constructions.

Figures 2.40–2.41. Remains of fishing-trap of the site Serteya I.

This place was used many times in the past as fishing place due to dates made on wooden piles and horizontal construction from splinters. Fragments of pottery of Usviatian culture of the IV mil calBC found in the layer of peat covering construction dated to the III mil calBC might testify the existence of settlement nearby that has been washing away.

Remains of analogical constructions were found on the sites Rudnya Serteya, Serteya X and Serteya XIV attributed to early Neolithic but in a worse state of preservation. Two rows of piles with poles, concentrations of hazel branches and

numerous pine splinters lying in two layers were found in the layer of brown gyttja on the site Rudnya Serteya.

Early Iron age.

Abrupt climate change occurred at the border of Subboreal and Subatlantic periods – humidity increased, fall of temperature and big transgression can be traced that made inhabitation in this microregion impossible. It is testified by absence of human influence on paleolake and sites at early stage of Dnepr-Dvina culture. Population of overgrown lake depressions was renewed in Sa-2. Hill-forts of the middle stage of Dnepr-Dvina culture are situated on the edges of depressions on the entrance to the valley. Some sites are situated inside of the lake depressions. Decrease of broad-leaved forests is traced in the middle stage of Dnepr-Dvina culture existence. It can be connected not only with climate change but also with increased influence of man on the nature: cattle pasture and cut-over land in order to make ploughed field. Increase of grass pollen included cereals and weeds can be traced at the most pollen diagrams. During Subatlantic period thermophilic flora elements gradually disappear – firstly elm, then lime and oak. Hazel and alder grew in the river valleys. Pine, fir and birch dominated.

Methods of investigation of sites situated on mineral shores.

Sites of early-late Neolithic situated on mineral shores of lake basins do not contain rich remains of the Past. Ancient organic materials, traces of constructions, pits, fire-places are very poorly preserved on these sites. The processes of soil formation on these types of sites were very slow, cultural layer does not exceed generally 20-30 cm. Thus, one cultural layer which cannot be divided due to lithologic characteristics or its color may include several horizons of inhabitation dated to different time. However these sites still save rich information about ancient people life but in order to uncover these “invisible” traces of the Past hidden by sand one must use different methods of investigation. Following methods were used in the excavation of sites Serteya 3–3, Serteya L, Serteya XXXVII and Serteya XXXVI (№ 7) from 2003 year:

- 3D fixation of finds and coded recording due to type of the find in order to make planigraphical-stratigraphical models of their distribution;
- Analytical investigations of the character of distribution in the layer of different chemical elements – indicators of anthropogenic systems;
- Magnitometric method for investigation of supposed territory of the site and capometric methods for investigation of different horizons of cultural layer.

In the course of archaeological excavations methods of samples selections and capometric measurements were elaborated.

Analytical investigations of the character of distribution in the layer of different chemical elements – indicators of anthropogenic systems, their comparison with archaeological material allows determining of functional zones and gives us the possibility to interpret them as life space or remains of dwellings, fire places, household pits, and manufacturing/household areas. Definite complex of chemical components and microelements (P_2O_5, CaO, K_2O, MnO, LOI, Ba, Sr, Rb), connected with the human activity and accumulated in the cultural layer, was distinguished on multilayer Neolithic sites (Fig. 2.42).

With the help of geomagnetic method and more precise methods of measuring of magnetic sensitivity by capometer (Fig. 2.43) one can find traces of non-readable constructions in the course of excavations and gain data for the interpretation of spots,

pits existed in the Past [Hookk et al., 2010]. More precise measurements with the help of capometer allows distinguishing several horizons with different traces of magnetic anomalies. This method allows distinguishing different anomalies from different layers fixed by magnetic prospection which could have appeared to be laid upon each other. Thus we can trace several horizons of one site inhabitation which are equal to different anomalies. Analyses of distribution of archaeological finds, pits, constructions including those which are reconstructed due to magnetic data, and their comparison with geochemical anomalies and data of capometer survey allows us to distinguish functional zones and probable function of different objects and to determine role which the territory of the site played in different time. This complex of methods gives the opportunity to create relative chronology of the past both of the site and while comparing different sites between each other.

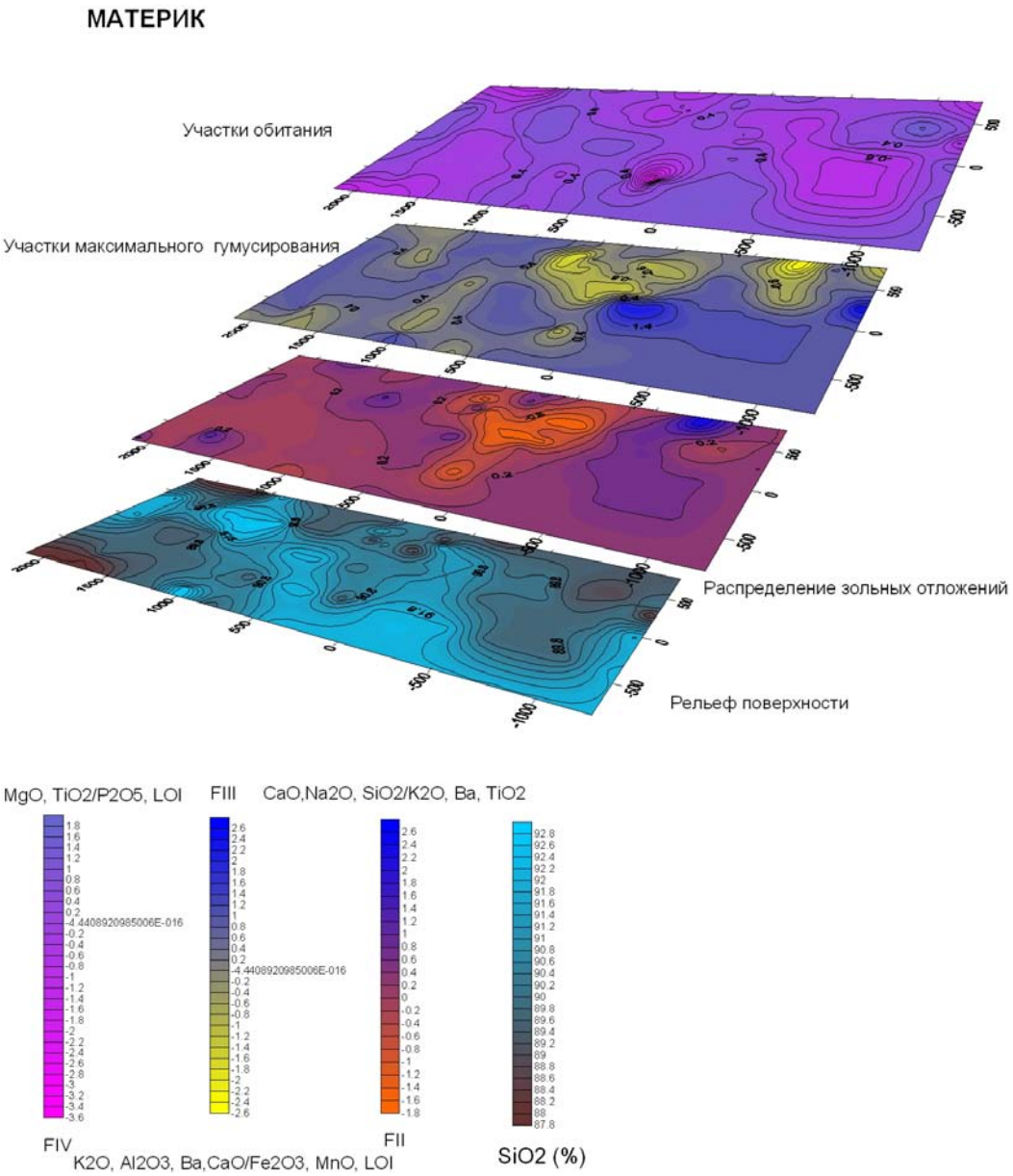


Figure 2.42. Example of reconstruction of different zones of economical activity basing on geochemical analysis on the site Serteya 3–3.

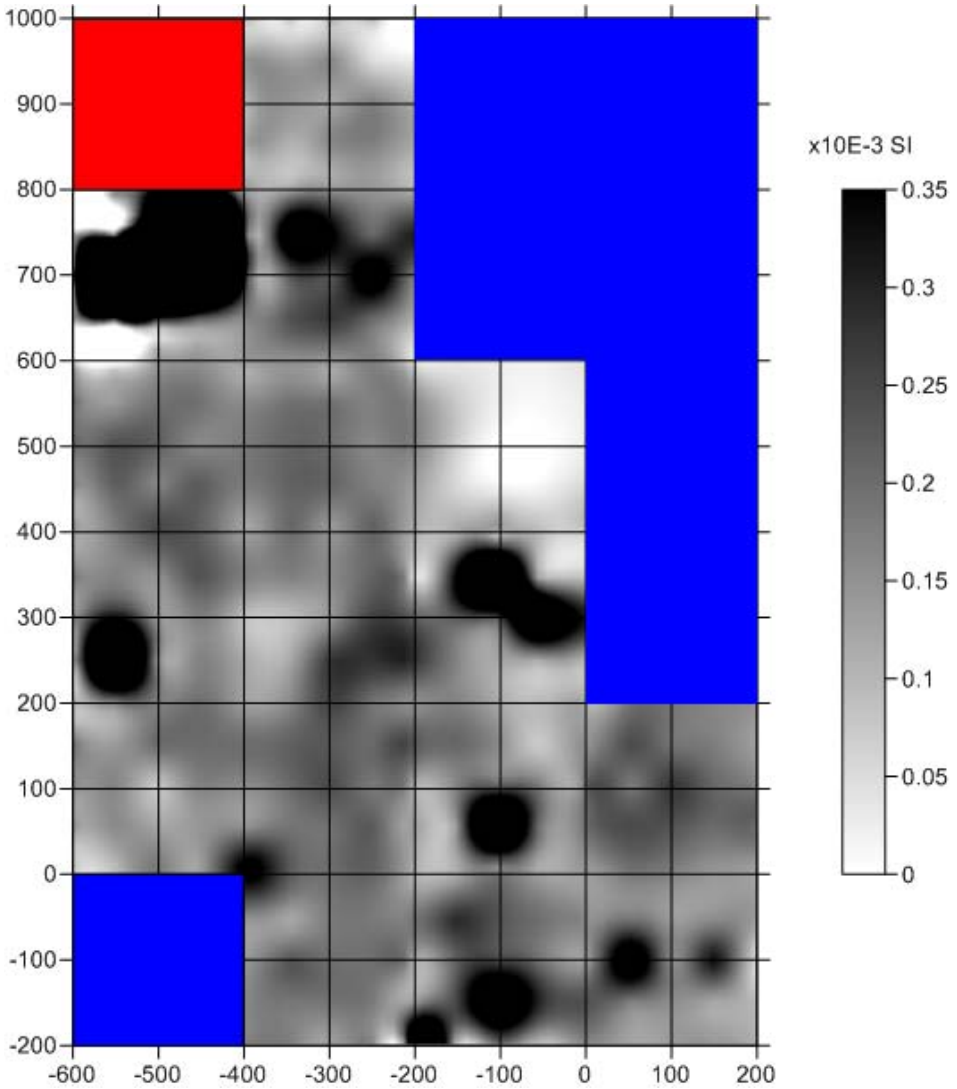


Figure 2.43. Example of cappametric analysis of the site Serteya XXXVI with the remains of roundish construction.

Unique combination of different elements of paleolandscapes and geological structure of this region created favorable conditions for inhabitation here in the beginning of Holocene and continued almost uninterrupted till now. Conservation of such features of environment as high lake productivity, favorable landscape and climatic conditions, high animal population, proximity to raw and water sources during long period of time made this region comfortable ecological niche for inhabitation in various periods.

These observations became the base for the project of genetic typing of modern inhabitants and its comparison with ancient genetic material found on these sites.

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FOR NOTES