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GEOLOGICAL OBSERVATIONS AND PALEOENVIRONMENTAL RECONSTRUCTION IN THE AREA OF SOMONA ARCHAEOLOGICAL SITE, BERETTYÓÚJFALU, EAST HUNGARY

Zoltán FARKAS[1] Ferenc KOCSIS-BURUZS[1] & János KALMÁR[2]

[1]*Salisbury Archeology Ltd, Budapest: farkas.zoltan@salisburykft.hu; kocsisbg@salisburykft.hu*

[2]*Hungarian Geological and Geophysical Institute, Budapest, johannkalmar@gmail.com*

Abstract: The target of this study is the geological documentation of the environmental changes in this area, from the beginning of Late Pleistocene to historic times. The Berettyóújfalu — Somona area is situated on the northern border of the Nagy Sárrét wetland, functioned as local basin of Derecske Trench, collecting the sediments of the Berettyó–Kőrös river system. On the north, the platty, E–W oriented ridge of older, Late Pleistocene deposits forms the border line of the wetland. Both Neolothic and historic settlements got favourable natural conditions by extended pasture fields and sources of wetland. In this area, sedimentological, mineralogical and paleontological (sporo-palynological) analyses were performed. In this way, the Late Pleistocene sediments of the river of the Old Tisza (Tisa) were separated from Holocene deposits, originated from Apuseni Mts. by the river of Berettyó (Barcu). While in Nagy Sárrét, the whole Holocene is documented, but in Somona area, only the Borela–Atlantic transition appears. The climatic conditions varie from the cold and dry steppe in the final phase of Ice Age, until the Preboreal, Subatlantic and Boreal climatic phases, i.e. and the morphology of the area evaluated from the large floodplain, to the E-W oriented elevation with neotectonical origin. The last changes in the landscape of this area were caused by the regularization of Berettyó-Kőrös river system, which leaded to the drainage of the whole Nagy Sárrét.

Key words: river of Berettyó (Barcău), Nagy Sárrét wetland, Archeology, Palynology, Late Pleistocene, Atlantic climatic phase, Paleoenvironmental reconstruction

1. INTRODUCTION

In the summer of 2015, on the pathway of M4 Highway in Berettyóújfalu, Somona area, archeological excavations were executed. In a 150×400 m area, a Neolithic and an Early Medieval settlement were identified. Apart from artefacts and tools, the excavations bring new data about the Late Pleistocene and Early Holocene deposits of the northern margin of Nagy Sárrét — one of the active sinking area of the Eastern Pannonian Basin. By the ground-follow observation and by the sedimentological, mineralogical and palynological sampling, new data were generated about the fluvial sedimentation implied the paleoenvironment evolution of the settlements, from the Pleistocene/Holocene transition to present days.

2. THE NAGY SÁRRÉT: GEOLOGICAL AND HUMAN HISTORY OF THE AREA

The Nagy Sárrét (*Great Muddy Meadow* in English) district of the Tiszántúl region is situated in the Eastern part of the Great Hungarian Plain, around the triple point of Békés, Hajdú-Bihar and Jász-Nagykun-Szolnok counties. Its name derived from the large, rather impenetrable wetland occuping the lower segments of Berettyó (Barcău), Ér (Ier) and Sebes Kőrös (Crişul Repede) rivers before the regularization of them. The basement of the Cenozoic formations is represented by Hercinian aged medium and high stage metamorphic formations: mica-schist, paragneiss, amphibolite, orthogneiss and biotitic granites (Tisia Composite terrain, Criş-Bihor subunit, Szederkényi, 1988).

Figure 1. The lower segment of river Berettyó–Barcău in both side of the Hungarian–Romanian state border, with the location of the research area (stripped)

The post-rift Derecske Trench has individualized after Badenian and Sarmatian aged siliciclastic--carbonatic deposits with rhyolite tuffs (Hajduszoboszló Formation), i.e at 8.2 Ma — and the sinking is continuous until 6.8 Ma (Juhász, 1994). Thus, the Early Pannonian sandy–?marly lake sediment filling (Peremarton Formation) and the upward situated Late Pannonian and Pliocene fluvial–deltaic, mainly sandy deposits (Algyő Formation) filled the Derecske Trench. The total thickness of the Pannonian and Pliocene deposits reaches 6600 m.

The Nagy Sárrét was individualized as a local basin of Derecske Trench during Late Pleistocene, mainly in Tardeglaciar (11–13 ka B.P.), following the reactivation of sinking due to sinestral deplacement of Szarvas–Dévaványa tectonic line (Nádor et al., 2007). Collecting the alluvial products of newly formed Ier, Barcău and Crişul Repede rivers, 300–500 m predominantly fine grained sediments were accumulated. During the wet and warm periods of Holocene, the tectonical sinking was equilibrated by alluvial (and organic) supply and a large march formed by a network of natural channels and stagnant water ponds.

The Berettyóújfalu–Somona area is situated on the northwestern border of Nagy Sárrét, where the Holocene is compressed to ~2 m thick fine grained sediment.

Following the final sequences of the geological events in Nagy Sárrét area the archeologic and historic data articulate the history of human presence from the beginning of the Early Holocene to present days.

The wetland, with rich water supply was inaccessible in terrestrial means, protecting the inhabitants of the small settlements against from invaders and „officials", too. By the regularisation of main rivers during the end of the XIXth century, the wetland was transformed to agricultural terrains and small dwellings, in stable settlements.

3. THE PAST AND THE PRESENT OF RIVER BARCÃU – BERETTYÓ

The evolution and the main characteristics of river Barcău – Berettyó explain the peculiarities of the sedimentation on the NW border of Sárrét.

During the Pannonian, a radial network of water flows emerging from Apuseni Mts. formed. In the Early Pliocene, the northern Transylvanian Lake was separated from Pannonian Basin by the rising of Someş Plateforme, and modifying the pattern of the hydrographic network. Later, in the Pleistocene, the rivulets flowing northward from the northern slope of Rez (Plopiş) Mts. were captured progressively by the river Old Barcău – Berettyó. On the other hand, the northern branches of river Barcã were depleted by the regressive erosion of river Crasna and by the effluents of river Someş, resulting the asymmetric shape of the Romanian segment (Şumălãu, 2010).

The building up a 150km long fan deposit by the rivers Ier (Ėr), Barcău (Berettyó) and Triple Criş (Hármas-Körös), during the filling of Derecske basin, began 1.9 Ma ago. The deposit reached the actual configuration in 14–18 Ka B.P. (Thamó-Bozsó et al., 2002, Thamó-Bozsó & Ó-Kovács, 2007). Because of the tectonic reactivation of the zone (Gábris & Nádor 2007), an accentuated erosional activity is marked on the Atlantic–Subboreal limit.

Leaving Rez (Plopiş) Mts., the river Barcău and its left affluents flow away as a mild, low-hill rivulet with the max. 3‰ slope until Sãlard. In that area before the regularization, the river Berettyó divided to a few branches, meandering between the marshes and ponds of Nagy Sárrét wetland. The actual riverbed is a man made trench with 0.4‰ slope dug between 1895–1897 (Gallacz, 1896; Dóka, 1997). A few former riverbed segments and the pathway of the last (unregularised) riverbed appear as a range of scoops and wet depressions (Félegyházi, 2001).

The Barcău–Criş fan lies on a largely waved erosional surface of eolian or fluvio-eolian deposits of river Paleo-Tisa (Félegyházi, 1998; Gábris, 2002).

Because of the low transport energy, the solid debit of river Berettyó shows notable values only during the seasonal floods. Loosing the coarser grains, manly in the Romanian segments of the river, only the silty and clayey sediments reach the Nagy Sárrét. While in the center of this depression, the sediments of river Berettyó are mixed with the sediments of river Criş and, probably with thosecoming from the left branches of river Old Tisza. On the northeastern border, the sediments are coming only from the hydrographic basins of river Berettyó and Ér (Fórián, 2001). On the other hand, during the whole Holocene, in Derecske trench the tectonic activity (i.e. the sinking) overwrites the climatic induced sediment accumulation rate (Nádor et al., 2007), resulting more, than 50 m silty-clayey sediments with peat lenses. In the same time, on the NE border of the depression, only a few m thick, relatively coarser sediments were formed.

4. METHODS AND SAMPLINGS

For the presentation of the geological and morhological characteristics, the 1:10.000 topographic map section was used. Stratigraphic and sedimentologic data of four shallow mapping boreholes and some geotechnical boreholes were processed too. In the area situated nortward to river Old Berettyó between the 47. main road, the TESCO Hipermarket and the Búzakalász sand pit grund follow observations were taken. On the trench of the archeological excavation 92 observation- and sampling points were described. In the northwestern and souteastern end of the excavation, two shallow Eijkelkamp boreholes were executed (Plate I., photo 3). The stratigraphic column of two ancient dug wells was described too.

From the wall of excavation and from the Eijkelkamp boreholes samples were taken for grain size, carbonate, humus, pH and mineralogical observations. From these boreholes, the complete section of the sediments was analyzed for sporo-palynologic content. Fragments of molluska shells were identified in the sandy heap of the excavation.

During the last three months, the discovered, barren sediment of the floor of the archeological excavation was exposed to the influence of meteoric factors. The behavior of the sediments with different grain size distribution was different: in the sandy–silty sediment, the precipitation infiltrated, the predominantly clayey sediment stoped it as small ponds, while the silty sediment retained the water in pores, permitting the life of some „pioneer vegetation” (as *Convulvus arvensis*, *Matricaria inodora, Matricaria matricaria etc*) to grow in clearly contoured green patches. In this way, it was easy to draw the boundaries of the lithological varieties of the same sediment (Plate I., photo 1).

Thus, the morphological observations and the sampling should answer to the following questions:

— From where was the sediments originated?

— Where were the main characteristics of sedimentation?

— How looked like this territory in the (historical) past?

— How modified the regularization of Barcău the natural (geological) framework?

5. THE RESULTS OF THE OBSERVATION AND THE ANALYTICS

5.1. Morphological observations

The Somona archeological excavations were executed on the back of an E–W oriented large, plate ridge with 100–105 m asl., at NE to Berettyóújfalu city (Fig. 2).

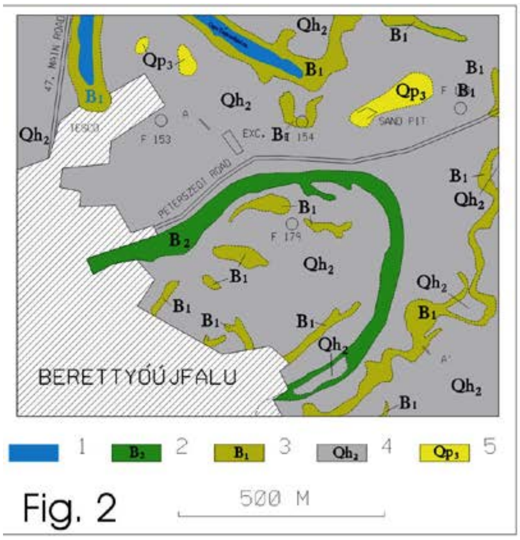
The surface of this area appears as a plane, sub-horizontal field. The SRTM sections show 0.1–0.3 ‰ gradients to SW, with narrow, steeper NW–SE zones (Fig. 3).

The micromorphology of the surrounded area of the excavation consists of N–S oriented ±30–50 cm high mould and trough lines at 10–50 m distance from each other. In the deeper segments of troughs, dark, fine (clayey) sediment was accumulated, often with small, hidrofile vegetation spots (*Scarpus lacustris, Carex paradoxa, Typhia latifolia*).

At 400m eastward from the excavation trench, small mould is rising, in which the sand pit of Aranykalász Ltd. was opened. Other two similar hillocks appear at N, close to the car park of Csapó Tanya Wetland Reservation. It seems, that they represent the emerging tops of the wind moved Late Pleistocene sand deposits.

On the plane field, 0.5–1.5 m deep, elliptical, meandering or worm-like, often branched scoops were identified. They form a large, circular riverbed. Northward, on the deeper range, parallel to Old Berettyó segment of this ancient riverbed, a horseshoe like oxbow with a large pond, with a rich vegetation rim and aquatic bird refuge is present, forming the so called *Csapó Tanya Wetland Nature 2000 Reservation*, (Fig. 2).

Southward to the Péterszegi road, segment of a meander of river Berettyó appear, as ~5 m deep riverbed with small ponds and marches. By the regularization, the meanders of Berettyó were cut down, permitting the inflow of the water only during floods. Southward to the mapped area, the plain continues, as horizontal, undreaned, black muddy agricultural fields, with the same difficulties of access, just like 300 years ago, (Móricz-Surján, 2015).



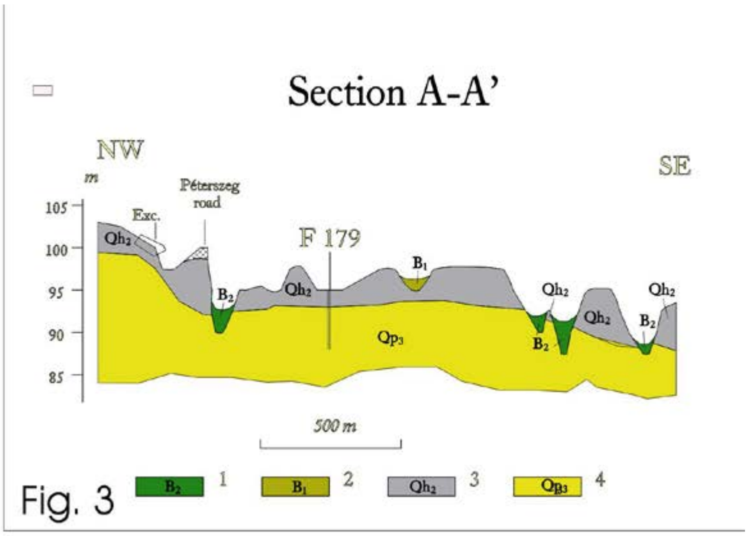


Figure 2. The geological and morphological sketch of East Berettyóújfalu. 1. Csapó Tanya wetlands' pond; 2. Depleted riverbed of the river Berettyó after regularization; 3. The traces of Old Berettyó riverbed; 4. Upper Holocene land covering sediments; 5. Late Pleistocene sediments.

Figure 3. The section A–A' 1. Sandy-silty riverbed filling of the river Berettyó after regularization; 2. Silty–sandy riverbed filling of Old Berettyó riverbed; 3. Upper Holocene sandy silt land cover; 4. Late Pleistocene fine grained silty sand; Exc: the Somona archeological excavation.

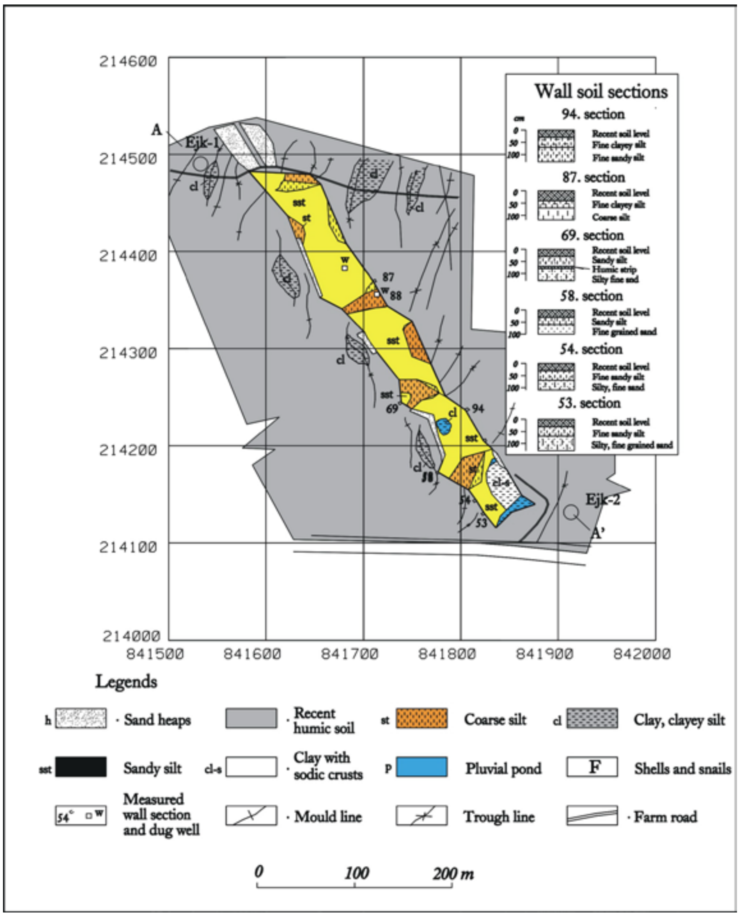


Figure 4. The geological sketch of the Somona archeological excavation and the surroundings, with the lithological columns of the measured soil sections. A–A' section line; Ejk-1 and Ejk-2: shallow boreholes.

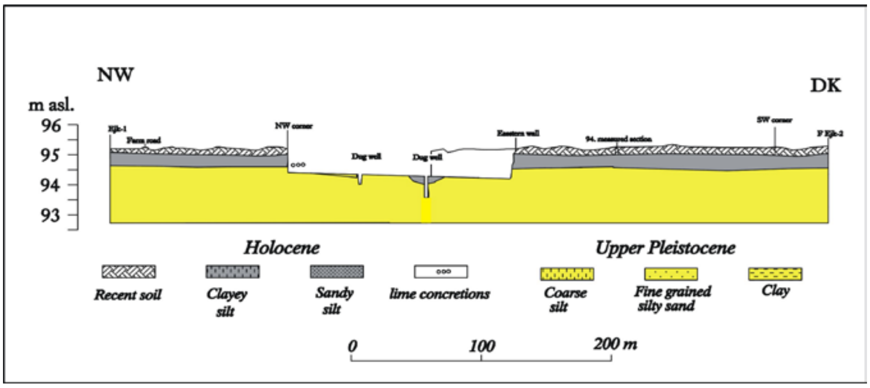


Figure 5. Geological section A–A' between the shallow boreholes Ejk-1 and Ejk-2, following (partly) the eastern wall of the excavation

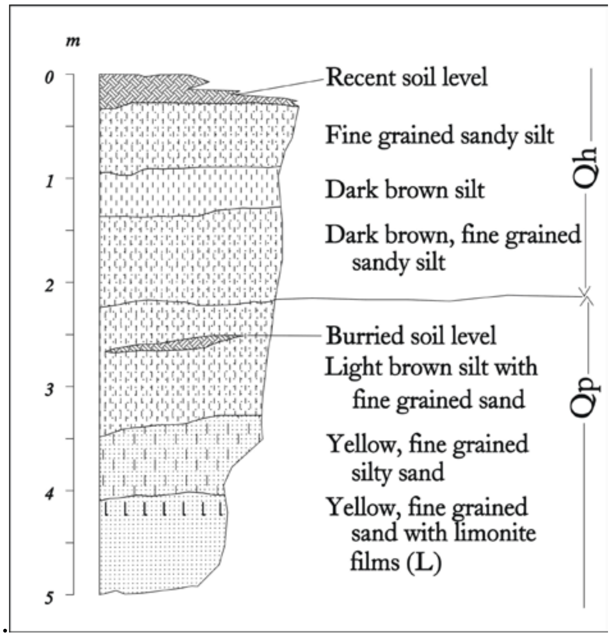


Figure 6. Lithological column of the main dug well

5.2. The geology of the archeological excavation and the surrounded area

In the walls and on the floor of the excavation, in the dug wells and in the Eijkelkamp shallow boreholes, Late Pleistocene and Holocene deposits, man made heaps and road filling appear. The fine grained, grayish yellow sand, silty sand and sandy silt appear in boreholes and in dug wells in 1.4–3.0 m depth. The whole excavation reached the Holocene-Pleistocene boundary. Thus, the archeological findings, as dug wells, kilns and pile holes were deepened in Late Pleistocene ground (Fig. 4).

Pleistocene. The close horizontal surface of the floor cuts the limit between the sandy silt and the silty sand. As we mentioned above, in the sandy silt, retaining the meteoric water, some pioneer plants grow. Mapping the green patches, the sandy silt lumps were contoured: they appear as NE–SW oriented short strips and bands (Plate I., photo 1).

In the dug well close to the eastern wall of the excavation, the succession begins with 1.3 m yellowish, light brown, unstratified sandy silt with 3–10 cm thick, discontinuous dark brown silty imbedding, probably, buried soil level (Figure 6). It lies on an erosional surface of 0.6 m yellow, fine grained, mica bearing silty sand, that passes to light grey, fine grained, mica bearing sand with 5–10 cm thick, coarser imbeddings and with reddish brown limonitic films between 4.1–4.3 m depth (Plate I., photo 4).

The Eijkelkamp boreholes touch the upper, silty level of this stratigraphic column, while the regional mapping boreholes 153, 154 and 155 traversed ~8 m sand and silty sand it is covered by 2 m thick Holocene dark silty level.

Holocene. In mapping, shallow boreholes executed in 1980 (Kuti et al., 1982), the upper1–1.5 m thick, dark gray, undivided loose level represent the Upper Holocene, similarly to Eijkelkamp boreholes documented by palynological analyses. On the wall of the excavation, and in Eijkelkamp boreholes three levels of Holocene deposits were separated (Fig. 5).

On the walls of the excavation (e.g. in 53., 54. and 58. measured section, Fig. 4), the darker, humus-rich levels lie on lighter, slightly hardened Late Pleistocene silty sand or fine grained sand. The H/Pl limit is marked by a discontinuous level of Ø 10–35 mm white-grayish, rounded or irregular, hard lime concretions and on the eastern wall, by a thin, limonitic band.

The Holocene aged dark sediments began with discontinuous, partially eroded brown, compacted, fine grained, finelly stratified level of sodic clay and silty clay in SE part of excavation, retaining the rainwater in small, temporary ponds (Plate I., photo 2). This level passes gradually toward NW in silt and sandy silt (69. measured section) in the borehole Ejk-2, in the 87. and 94.

measured sections. On the cap of the sequence a black, buried soil level was conserved.

The second level appears in all observation point as brown–greyish brown, rugged or compact silt or silty sand, passing southward in silty sand with clayey films (measured sections 53. and 54.). Small, irregular lime concretions appear in the NW wall of the excavation, in the lower part of the sequence.

The recent soil cover — classified as medow chernozem — measuring 15–50 cm is dark bown or grayish brown silt with or without sandy and/or clayey inbedings. In the western wall of the excavation, under 20–30 cm soil level, Ø<1 cm light gray, rounded or grape like lime concretions and white lime powder appear.

Heaps and fillings. The material of the mechanical excavation was deposited on the northern end of the work, in two 4–5 m high, prism-like heaps.

Up to the western wall of the excavation, 0.5–1.2 m high, prism like heaps were formed, containing a mixture of gray and yellow silt, sandy and silty soil cobbs. Around the 74. observation point, fired and fresh adobe pieces, crushed ceramic and mammal bone fragments, whole and splinted Mollusk shells were found — probably as the rests of an ancient dunghill.

The filling of the Péterszegi road was executed by the mixture of sand and angular rock fragments. The crushed microdiorit porphyre comes from the quarries of Crişul Repde valley, opened in the '60s of the XIXth century, for railway constructions, mainly on the Budapest–Oradea–Cluj line — and later, for road modernization in the former Bihar county (Szőllősi, 1943).

5.3. Analytical results

On the samples of the excavation (wall, borehole and heap samples), grain size, mineralogical, pedological and paleontological (pollen and shell) analyses were performed.

Grain size, carbonate and pH Based on 79 grain size analytical results of 153, 154, 155 and 179 mapping boreholes (Kuti et al., 1982), Ejk-1 and Ejk-2 boreholes and the samples taken from the eastern wall of the dug well, in the sand–silt–clay ternary diagram the Pleistocene and Holocene deposits are plotted in two connected fields (Fig. .7/A), because in the Pleistocene deposits there are silty inbeddings and in the Holocene ones, sand lenses and films appeare. In the coars–medium grained–fine grained sand ternary diagram (Figure 7/B) the samples of Pleistocene and Holocene sediments are seprated the best. Thus, the Pleistocene deposits show dominant sandy character, while in the Holocene, the silty character predominates.

All of the analysed samples show slightly acide character (pH<6). The sieved samples (for separateing the lime concretions) are carbonate free, except a few samples with 1.5–2.0% carbonate.

Mineralogy The mineralogical composition of Ø0.1–0.2 mm sand fraction was analysed with binocular Zeiss microscope (Table 1.).

In all samples, the main, dominating mineral is quartz, but with different aspect and shape in the Pleistocene and Holocene deposits.

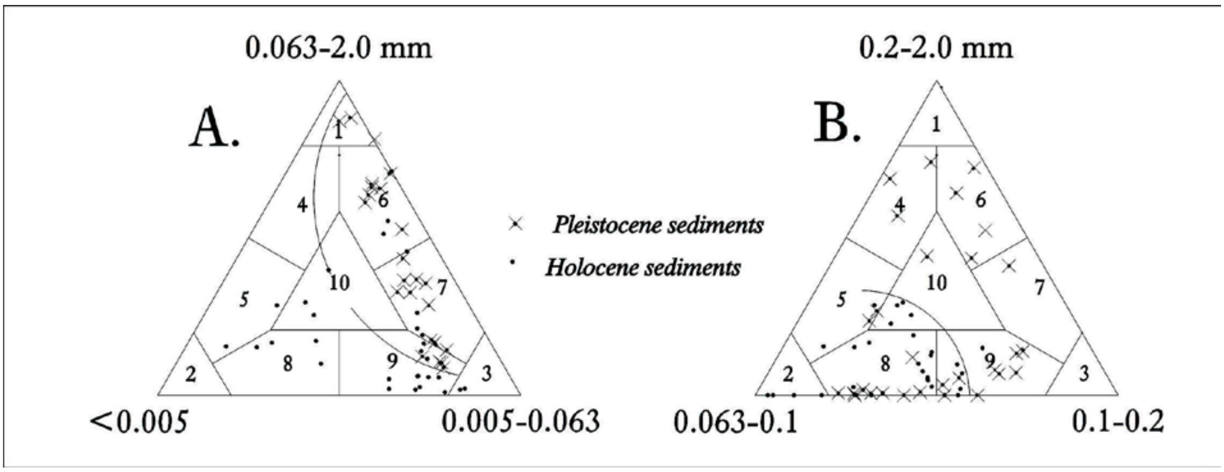


Figure 7/A. The distribution of Pleistocene and Holocene sediments after sand–silt–clay diagram. The Pleistocene samples are grouped in sand (1), silty sand (2), sandy silt (7) and at the limit of sandy silt and clayey silt (9. fields).

Figure 7/B. The distribution of sand fractions. The Holocene samples are grouped in fine grained (2), fine+coarse grained (5), fine+medium grained (8) and in mixed sand (10) fields. The divisions of the diagram were adopted after Füchtbauer and Müller (1970).

Plate I

Photo 1: View of excavation, showing the grass covered silty and the uncovered sandy-silty Pleistocene sediments. Photo 2: Outcropping sodic clay with branched erosional trenches leading to the pluvial pond on the left side of the picture. Photo 3: Géza Kutasi drills the Ejk-2 shallow borehole. Photo 4: The main dug well with ancient hydrostatic level (NH). Photo 5: Micrograph of lime concretion from 74. measured section. In micritic carbonate background, small pores and a crushed snail piece (cs), thin section, II nichols. The sand fraction of Pleistocene samples (photo 6) and Holocene samples (photo 7)

q, quartz; qv, volcanic, hemihedral quartz; kf: potassic feldspar; pl, plagioclase; b, biotite; hb, red hornblende; e, epidote; g, garnet; z, zircon; t, titanite; l, limonite; p, slightly limonitized pumice; mk, micritic lime concretion; ch, chloritic schist fragment. Photo 8: *Unio pictorum* L., whole shell. Photo 9: *Unio* splinted shell fragments. Photo 10: *Cepaea hortensis* (Fér.) shell.

Plate II.

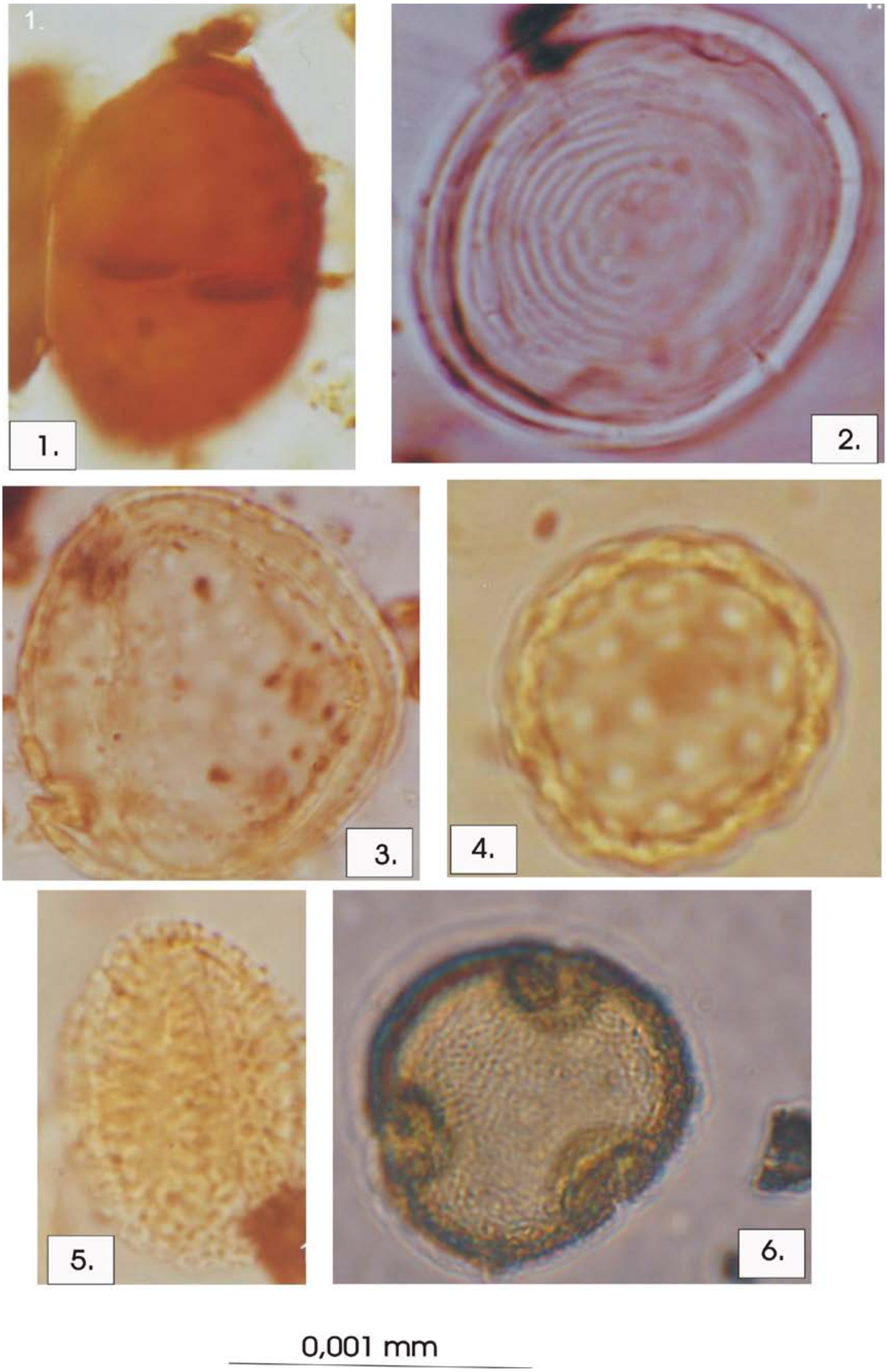


Photo 1: *Fungi* sp. Ejk-1, sample 3, 80–100 cm. Photo 2: *Concentricystes* sp. Ejk-2, sample 2, 35–80 cm. Photo 3: *Phleum pratense* L. Ejk-1, sample 4, 80 cm. Photo 4: *Chenopodium bonus-henricus* L. Ejk-1, sample 2, 50–80 cm. Photo 5: *Salix* sp. Ejk-2., sample 2, 35–80 cm. Photo 6: *Fagus* sp. Ejk-2., sample 2, 35–80 cm

Table 1. Mineralogical composition of Ø0,1–0,2 mm sand fraction of the samples

Samples,depth in cm	Minerals, %						Rock fragments	Limonite grains and crusts	lime concretions
	Quartz	Feldspars	Muscovite	Biotite	Amhibole	Accessories			
Pleistocene sediments									
Ejk-1, 80–140	91	4			x	mg,ep, zr,gr,tu	1 v, qm	1	3
Ejk-1, 140–180	95	3	x	x		mg, hy, zr, ru	v, qm		2
Ejk-1, 180–200	94	2	1	x	x	au, zr, gr,tu, ru	qm,p	x	3
Ejk-2, 180–200	85	5			1	mg,zr, hy, st	4:v, qm, st	1	4
Dug well 350-420	90	4	x		1	mg, zr, ti, tu	2:v, ch, sl	x	3
Holocene sediments									
Ejk-1, 20–50	93	3	2		1	mg,ti, zr, ru	2:st, qm	2	
Ejk-1, 50–80	95	3	x	2		mg, zr,,tu	3:ch,st, qm		2
Ejk-2, 20–30	90	6	2	x	1	zr, gr, ep, ru	qm,v	x	1
Ejk-2, 80–110	89	5	3		1	mg,zr, gr	:(qm, st, sh	x	1
Dug well, 100–125	90	4	3	1	1	ti, zr, tu	sh, ch, sl	1	

Accessories: au, augite; ep, epidote; gr, garnet; hy, hypersthene; mg, magnetite; ru, rutile; st, staurolite, ti, titanite; tu, tourmaline; zr, ziron. **Rock fragments**: v, volcanic rocks; sh, shale; sl, silt; p, pumice; qm: mica bearing quartzite; st, sandstone; ch, chert.

In the Pleistocene sand samples (Plate I., photo 6), white, light gray and yellowish, well rounded and polished, isometric or slightly elongated grains with metamorphic origin appear, together with translucent, angular, often euhedral volcanic quatz grains. In the Holocene samples (Plate I., photo 7), the angulated, splinty grains appear together with well rounded and polished ones, frequently with limonite and/or carbonate coatings. The grains have metamorphic origin; no volcanic quartz grains were found.

Feldspars appear in both stratigraphic level. The Pleistocene samples contain slightly sericitized orthoclase and microcline and fresh, clear, hemihedral sanidine and sericitized plagioclase. The sand fraction of the Holocene deposits contains fresh and sericitized, anhedral, angular fragments of microcline and plagioclase and rounded, coated grains of the same minerals.

The micas and chlorite form plattyor lens like, corroded grains and sheets, with characteristic euhedral biotite in the Pleistocene samples. In the Holcene ones, chloritized, irregular biotite nodules appear. In both sand fraction, red amphibol prisms and dark, oxidized pyroxene grains were identified.

Beased on the list of accessory minerals, notable difference appears between the Pleistocene and Holocene samples. In the first group, zircon, garnet, staurolite, tourmaline and rutile appear, while in the Holocene samples, apart these minerals, epidote, zoizite, titanite, kyanite and dark, well polished sphaerules were identified.

The characteristic rock fragments of the Pleistocene sand are rounded pumice grains. In the Holocene samples, notable amount of metamorphic rock fragments as chlorite schists, mica-schists, chloritized amphibolite and quartz–feldspar–mica composite grains (gneiss probably) appear. In samples of Eijkelkamp boreholes, gray, irregular lime concretions were concentrated in the sand fraction. In both sand sample, limonite crust and concretion fragments are present, too.

The mineral composition of lime concretions was examined in thin sections. The lime concretion from the NW corner of the excalation (Pl/H limit) is grayish, with brown–reddish patchs, irregular–globular, compact and hard. It consists fine grained (micritic) carbonate, with 0.1–0.2 mm recrystallization zones. Corroded quartz, mica flakes and dark minerals appear as small inclusions. One fragment of a lamellar gastropod shell appears, too (Plate 1., photo 5).

The second lime concretion level was taken in the Western wall of the excavation, under the recent soil level, i.e. from the actual lime accumulation of the chernozem. The irregular, spongious, gray concretion is formed by fine, micritic, coalescent carbonate with quartz grains and 1–2 mm pores with black and soft soil filling. Th mineral composition of Ø<0.063 mm fraction was determined by diffractometric analyses (Table 2).

Table 2. The mineral composition of Ø<0.063 mm fraction

Samples, cm	Minerals, %												Amorphous
	Montmorillonite	Illite+muscovite	Montmorillonite-illite mixed layer	Kaolinite/chlorite	Quartz	K-feldspars	Plagioclase	Anathase	Calcite	Trona	Gypsum	Goethite	
Pleistocene sediments													
Ejk-2, 180–200	6	9	2	10	55	3	tr			4	5	3	3
Dug well, 350–420	3	2		3	77	4	3	1			2	3	2
Holocene sediments													
Ejk-1, 50–80 cm	6	7	3	5	60	4	3		2		2	3	5
Ejk-2, 20–30 cm	7	4	2	4	70	3	2	tr	2			2	4
Ejk-2, 80–110 cm	3	3	2	5	70	3	2		1		3	5	3

In the fine fraction of the Pleistocene samples, the quartz dominates, with small amount of feldspar, illite/muscovite and montmorillonite. In dark brown sodic clay of Ejk-2 sample (180–200cm), with notable amount of Na-carbonate, the main clay mineral is the kaolinite.

In the Holocene samples, among the clay minerals, the basal reflections are high both for illite and montmorillonite, indicating the randomly spreading lattice parameters of them (i.e. "pedologic" clay minerals, Mehring, 1975). The calcite seems to be the result of lime precipitation in the C accumulation level of both soil section. In all samples, gypsum and goethite, as secondary minerals are present. Note the relatively high amount of amorphous phase in the Holocene samples, tied probably to the humic soil colloids of these dark sediments.

Palynology. From Ejkelkamp boreholes, five samples were taken for palynological analyses.

1. Sample 4, Ejl-2 borehole: light brown, hard, wet sandy silt, with rare lime concretions and limonite films, with the following palynomorphs.

Artemisia sp.	10 ex.
cf. *Riccia* sp. (corroded.)	3 ex.
Pinus? (fragments.)	3 ex.
Unidentified pollen fragments	>100 ex.

Artemisia is the only, paleontologically interpretable form, that appear in cold desertic environment, without extended vegetal cover, with possible pine forest islands in zone. The abraded state and the fragmentation of the palinomorphes suppose fluvial transport. Thus, the samples marked probably the Late Würm glacial period, but the accurate dating is not possible.

2. Sample No. 4 Ejk-2, 80–110 cm: dark brown, fine, compact clay, with sand filme, the first level up to Pleistocene sediments, containing the following sporo-palynomorhs:

Fungi	66 ex.
Algae	
Concentricystes sp.	30 ex.
Bryophyta	
Palustriella sp.	55 ex.
Pteridophyta	
Lycopodium annotinum L.	1 ex.
Ophioglossum vulgatum L.	14 ex.
Polypodium vulgare L.	1 ex.
Dryopteris sp.	1 ex.
Gymnospermae	
Pinus silvestris L.	8 ex.
Picea sp.	1 ex.
Angiospermae	
Inula salicina L.	4 ex.
Artemisia vulgaris L.	2 ex.
Senecio sp.	2 ex.
Centaurea sp.	1 ex.
Lychnis flos-cuculi L.	1 ex.
Chenopodium album L.	1 ex.
Chenopodium hibridum L.	4 ex.
Chenopodium sp.	13 ex.
Polygonum aviculare L.	1 ex.
Corylus avellana L.	10 ex.
Fagus silvatica L.	5 ex.
Salix alba L.	1 ex.

The mushrooms and the mosses are the main components of this association, in where the *Palustriella* appears in free meadows both in wet and dry conditions (Boros et al., 1993). Subdominant *Concentricystes* marks the disturbed, partly eroded state of the soil. The Pteridophytae association characterizes wet meadows and march margins.

The scarce number of tree pollens as *Pinus silvestris* and *Fagus* silvatica can be explainedby the distance from forest areas, with fluvial transport (Járainé-Komlódi, 1987, Vancea, 1975). The dark color of *Corylus avellana* pollen grains *indicate* fluvial transport, too (Digerfeldt, 1972). The increased amount is a climatic indicator for the beginning of the optimal climatic peak of the Holocene. After Danielsen (1969), in inhabitated environment, the *Corylus* pollen marks the conscious human acivity: the presence of nut plantation in plane, tree poor regions (for food and for building material).

The high plant association *Inula salicina* — *Lychnis flos-cuculi* — *Stellaria graminea* — *Senecio* sp. is frequent in swamp and wet meadow environment with *Salix alba.* The *Chenopodaceae* appear in opened, sunny plains, with shallow groundwater table with *Artemisia vulgaris*. These plants were characterized by Taylor et al., (1994) as pre-agricultural indicators. Note, that *Artemisia vulgaris* differs from the dry, cold climatic *Artemisia* species of Pleistocene species (Behre, 1981; Járainé Komlódi, 2000). The same authors present *Polygonum aviculare* as the indicator of the early agricultural activity.

Sample 3, Ejk-2, 80–140 cm: the covering layer of the Neolithic settlement: light brown, slightly sandy clay or clayey silt, with the following microflore:

Fungi	118 ex.
Algae	
Concentricystes sp.	20 ex.
Bryophyta	
Bryophyta dif. sp.	7 ex.
cf. Riccia sp.	1 ex.
cf. Sphaerocarpos sp.	2 ex.
Pteridophyta	
Ophioglossum vulgatum	3 ex.
Ophioglossum sp.	6 ex.
Angiospermae	
Phleum pratense	10 ex.
Compositae	1 ex.
Fusite?	>100 ex.

In this sample, a scarce and badly conserved association was found.

The *Concentricystes* marks disturbed, partly eroded soils, in which they appear as pioneer species (Morzadek & Kerfourn, 1998). The species of this alga form characterizes the beginning of the Subboreal phase (Sümegi et al., 1998).

Sphaerocarpos grows in sandy, baren soils, while *Riccia* is an indicator of the human presence — like the *Phleum pretense* grass (van Gell et al., 1981). *Compositae* appear in pastures or in trodden terrains (yards, pathways, see Sümegi et al., 1998).

The high number of fusite fragments explains the scarcity of the microflora. It seems, that a firestorm burned the vegetation as it happened during the drought periods in reed marshes (Bănică, 1997). There are not evidences, that this firestorm was connected to human activity.

Sample 3., Ejk-1, 50–80 cm brown, soft, clayey silt, covering all excavation area. The Medieval archeological objects traversed this level. The microfloristic association is the following:

Fungi	161 ex.
Algae	
Concentricystes sp.	15 ex.
Bryophyta	
Batramia sp.	6 ex.
Peltolepis sp.	2 ex.
cf. Riccia sp.	3 ex.
cf. Sphaerocarpos sp.	3 ex.
Pteridophyta	
Ophioglossum vulgatum	18 ex.
Ophioglossum sp.	2 ex.
Dryopteris sp.	1 ex.
Polypodium sp.	1 ex.
Gymnospermae	
Picea sp.	10 ex.
Pinus sp. (corroded)	5 ex.
Angiospermae	
cf. Helianthemum sp.	1 ex.
Centaurea sp. (corroded):	3 ex.
Carduus sp.	5 ex.
Chenopodium hybridum	5ex.
Chenopodium botrys	2 ex.
Chenopodium album	8 ex.
Chenopodium bonus-henricus	6 ex.
Chenopodium sp.	17 ex.
Artemisia sp. (corroded)	12 ex.
Luzula sp.	1 ex.
Fagus sp.	5 ex.
Carpinus cf. betulus	8 ex.
Polygonum sp.	2 ex.
Sorghum cf. bicolor	2 ex.
Salix sp.	6 ex.
Sinapsis cf. arvensis	2 ex.
Fusite?	>100 ex.

In this sample, a rich and various sporo-polinic association was identified. Mushrooms, moos and pteridophytae spore association indicates wet, mainly acidic soils.

It is probable, that the pine, beech and hornbeam pollen grains were coming from the large woods of Apuseni Mts., transported both in water flows (e.g. corroded pollen grains), and by E–W oriented spring winds (Vancea, 1975).

Chenopodium album characterizes the early stage of Intra-Carpathian agriculture during Late

Neolithe and Early Bronze Age, (Taylor et al., 1994), with maximal frequency in Vatya and Koszider stage of Middle Bronze Age (Sümegi et al., 1998). The presence of the panic (*Sorghum cf. bicolor)* pollen confirm the agrarian character of these communities.

Sinapsis arvensis appears frequently in spicate crops in acide, silty soils and in wayside associations, together with *Artemisia* and *Centaurea* (Behre, 1981).

Another pigweed specie, *Chenopodium bonus henricus* and *Carduus*, after Dejtéri-Borbás (1990) are characteristic for pasture fields.

The notable amount of fusite, and the lack of burned pollen grains may be interpreted as domestic use of fire.

Sample 1., Ejk-2, 20–35 cm: dark brown, soft, humic, silty soil. The sample contains recent (living) corn, barley and sunflower pollen grains, without stratigraphic value. The main microflora forms are presented in Plate II.

Malacological analysis. The whole and fragmented Mollusca shells from the sandy heap were determined as follows:

Unio pictorum (Linnaeus, 1758) 2 ex.
Unio pictorum (fragments) 5 ex.
Cepaea hortensis (Féruss., 1821) 1 ex.

Unio pictorum L. (Plate I., photo 8) belonging to *Unionidae* genus is a wellknown fluvial shell, lives in sluggisg rivers, lakes and ponds with sufficient oxygen supply. The crushed fragments (Plate I., photo 9) indicate, that this kind of shellwas available as proteine rich food (Gulyás, 2011).

The *Cepaea hortensis* (Plate I., photo 10) is a typical garden snail, classified in *Helicidae* family of *Pulmonata* order. This species is widespread in Central and Western Europe, in sandy-grassy meadows, bearing the colder, humid conditions. From a long time, it is present in vegetable- and flower gardens.

6. DISCUSSION

Using the field and analytical data, a tentative for the stratigraphy and the paleoenvironmental reconstruction is presented.

6.1 The stratigraphic scale

The sandy–silty complex, opened in Aranykalász sand pit, and where mostly the archeological objects were deepened represents the top of the Late Pleistocene. Based on the scarce microfloristic data the most detailed stratigraphic localization is not possible; it is probable, that the last cold phase of the Tardeglacial is presented.

Whereas in Nagy Sárrét, Holocen sedimentation is continuous, in Berettyóújfalu, the sedimentation is coming after an erosional gap, comprising Preboreal, Boreal and Atlantic phases. Besed on the palynological data, the first level of the Holocene deposits was sedimented during the wet and continuously cooling transition between Atlantic and Subboreal stage.

In the Neolitic, the lak of sedimentation and erosion of the older sediments can be noticed. The last sedimentation took place during the Bronze Age (3000–1500 B. Chr.), covering the whole northeastern margin of Nagy Sárrét.

On the margin of Sárrét, Berettyó carved its riverbed into this last alluvial plain. Two stages (B_1 and B_2) of meandering river appear; the last one is Old Berettyó after the regularization.

6.2. Sedimentology

The structure and the grain size distribution of the Pleistocene sediments refer ing to North Carpathian origin and fluvial and/or eolian transport. Such sediments, terminating the Ice Age climatic cycle, were identified in the whole Tiszántúl region (Cserkész-Nagy, 2014), with the internal structure determined both by climatical and neotectonical changes (Timár, 2003).

Estward from Berettyóújfalu city, the major structural element is the E–W oriented, platty ridge, emerging the Late Pleistocene sandy–silty sediments 2–8 m up to Nagy Sárrét level. This structural element continues eastward, forming an arc-like range of platforms that separates the Ér (Ier) and Berettyó (Barcău) hydrographic basins on the Romanian side of the state border (Fórián, 2001). On the other hand, these "major" structural elements shear through the small scale structure of the sediments, i.e. the space position and NE–SW orientation of the sandy, silty and clayey sediments (as it can be seen on the bottom of the excavation and in the Aranykalász sand pit). It is proven, that the ridge materializes the last, Holocene neotectonical event.

The analysed Holocene sediments come from the northern Apuseni Mts and from the southern Sălaj Basin, filled up with the same detritic material in the Pliocene (Paucă, 1961). The further mineralogical analyses confirmed this hypothesis (Thamó-Bozsó & Ó-Kovács, 2007).

The temporary stop of uplift in the mountain block led to the equilibrated profile of Barcău (Şumălău, 2010), i.e. to low transport energy. Thus, the alluvial supply of Sárrét is limited to flood transported fine grained sediments. The baren, eroded Berettyóújfalu ridge was put under waves only during "cathastrophic" floods, explaining the discontinuity and the small thickness of the Holocene sediments.

The small scale structure of the Holocene sedments is evidenced by N-S oriented troughs and moulds, mapped by us in the surrounding agricultural fields. How can these micro-morphological forms be explained?

After Collinson (1986) the sedimentation in the flood plain began when the flood culminated, and continued until the withdraw of the flood wave toward the stable riverbed. In this moment, highly branched, secondary water and muddy water flow channels were formed, moving a part of newly formed, plastic sediments. In this way, between the channels, moulds and backs of finer sediment remained, while in the channels, the coarser ones appeared. On the dried flood plain, wind and rain areal erosion put down these irregularities, but the modern, mechanized agriculture put in evidence the small scale structure of the sediment. Under the heavy engines, the fine, clayey sediments flow asunder, while the coarser, silty–sandy channel fillings form small moulds and ridges

6.3. Environmental changes in Berettyóújfalu area

The history of the documented environmental changes began in the Tardeglacial phase of the Late Pleistocene, when the dry and cold steppe covered with scarce, herbaceous vegetation and without the presence of human activity. According to the observations of Borsy et al., (1991); Tímár (2003); Botău (2012) and Cserkész-Nagy (2014) in the surrounded areas, the cold climate, with 14–17°C summer temperature passes gradually to a drier period 13–11,000 years ago. This corresponds on the Romanian time scale to the Dryas, or Second Pine stage in Romanian Carpaths (Pop, 1960).

At the moment, in Eastern Hungary, there are not indications about any human presence in the Pleistocene, but in close to the Romanian highlands, a few Late Pleistocene sites were documented (Cârciumaru, 1980).

Note, that in Berettyóújfalu area, the Pleistocene/Holocene limit (boundary) is visible, due to the presence of the erosional surface under the Holocene sediments.

The lack of the Preboreal, Boreal and Atlantic climatic phases in the research area is tied to the increased erosion activity during the wet, precipitation rich Atlantic phase, when the tectonic activity restarted in Derecse Trench (Timár, 2003).

In this period, in Szeghalom 5 borehole, the sediment filling of Sárrét seems to be continuous, showing progressively warming climate, first with dry, but warm steppe vegetation, followed by moderate oak forests and ended with the so called "Hazelnut time" optimum climatic peak 7.000 years ago. For this time, in the southern Pannonian Basin, the first settlements of Körös–Starćevo Neolithic culture were signalized (Gulyás, 2011).

The Neolithic settlement of Somona site, dated by the ceramics as Alföld culture (Boreal-Atlantic transition time) was localized on the back of a small, Late Pleistocene, flood-free elevation, in the border of the former Nagy Sárrét wetland. In the pollen association of the surrounding soil cover, pre-agricultural and pasture palinomorhes were identified. Herbaceous, open meadow vegetation grew under the moderate amount of precipitation and mild equilibrate seasonal variation of the mean temperature, and with the dominant, E–W athmosphaeric circulation. The bone rests and the household vessels indicate that for the inhabitans both the livestock breeding and the wetland hunting and fishing assure the susistence, with an incipient agriculture around the settlement.

Up to such Neolithic settlements, occupying the same elevated points of the wet surroundings, a range of younger sites were identified, from the beginning of the Criş culture, until the late Bronze age both in the Hungarian and the Romanian side of the state border (Dumitraşcu, 1974). Using a network of dry (car routes) and wet (boat or raft channels) lines these settlements communicated each other, explaining their cultural unity in the Pannonian Basin (Arbogast et al., 2006).

The presence of the two dug wells arise the question: close to river Old Bererettyó, why did they dug (wih primitive tools, in hard sandy earth!) some 4–5 m deep wells? It is probable, that the inhabitans of "Somona village" knew, that the water of Old Berettyó and the adjacent ponds were proper for livestock, but not for drinking water since it can cause infection. For us, in the dug well section, the level of the (ancient) groundwater table was conserved by the limonite precipitation at ~4 m under the actual surface (Plate I, photo 4). Note, that in the surrounded mapping shallow boreholes (F 153, 154 and 155), the stabilized groundwater level was situated at the depth of 2.0–2.4 m (Kuti et al., 1982). The last measurements in the dug wells of Tiszántúl, performed in 1997 by the Geological Institute of Hungary, show depth to 3.0–3.5 m in Eastern Berettyóújfalu, close to the Neolithic value.

In the covering, silty level of the Neolithic settlement the effects of an extended firestorm were evidenced. As we said, there are not prooven that such events connect to human activity. Rests of burned plant and fossil wood firestorms are mentioned in the whole Phanerozoic, far before the human presence on the Planet Earth (Bănică, 1997).

The last documented Holocene level — and implicitly, the recent land cover — is dated to the relatively wet and progressively warming period proceeding the Sub-boreal–Subatlantic transition (3.000 years B. Chr.).

The Gepida settlement, put in evidence in Somona excavation is one of the site of migrating people in the III–V. century A. D., living on the northern boarder of the largely extended Nagy Sárrét.

Contemporaneously with the Late Neolithic–Early Bronze aged Ottomani (Ottomany) culture, a part of the settlements (with not too peaceful inhabitans) were fortified and connected to a network of all-season usable roads. These ones were reactivized later, in historical times, mainly during (and after) the Great Migrations — and were modernized after 1870, with stone material from Crişul Repede and Someş quarries (Szőllősi, 1943).

The geological history of our research area was closed in time by the regularization of the river Berettyó. These works were proposed in 1803 and in 1822 (Huszár, 1822), they were accepted and organized in 1870 and were finalized in 1897 (Dóka, 1997; Babák, 2010). It is important to know, that the regularization works were clamed in the wet period closing the so called "Little Ice Age", but they were finalized during the end of the 1800's, in the driest period of the last centuries.

7. CONCLUSION

The Somona archeological site is situated at east from Barattyóújfalu city (Eastern Hungary), on the border of Nagy Sárrét wetland. The Nagy Sárrét is one of the local sinking area of Derecske Trench, reactivated periodically during the Late Holocene. The filling alluvia was transported by E–W directed water flows, including river Berettyó (Barcău). This water flow collected the detritic material with its affluents both from Rez (Plopiş) Mts. and from southern Sălaj (Szilágy) Basin.

The objects and buildngs of the archeological site werebuilt in the Late Pleistocene sandy–silty sediments of river Old Tisza (Tisa), that forms a platty, E–W oriented ridge. From the covering Holocene, the Preboreal, the Boreal and the Atlantic climatic phase are missing, while in the Nagy Sárrét profile, the whole Holocene is documented.

In the Somona excavation, the first, palinologically documented level belongs to the transition between the Atlantic and the Subboreal climatic phase and it is contemporaneous with the Alföld Neolithic culture, not older, than 6.000 years B. P.

The last Holocene level, with rich microfloristic association was sedimented during the Bronze Age (3.000–1.500 years B. Chr.) The sedimentological study of the Holocene levels confirms that the origin of the detritic material is the Apuseni Mts.

Based on sedimentological and paleontological observations on the excavation site and in the surrounding area, the evolution of the climatic phases was documented. Thus, at the end of the Pleistocene, in Tardeglacial (13–11 ka B. P.) the cold and dry climate changes to progressively warming Holocene, until the "Hazelnut-period" climatic optimum.

In the Somona Neolithic settlement, belonging to Alföld culture, the advantage of open pasture land and many fountained wetlands were combined.

The similar sites around the Nagy Sárrét appear both in the Late Neolithic and in the Bronze Age. A part of the Actual road networking both side of the Romanian–Hungarian state border inherits the communication lines between those Prehistoric settlements.

The geological evolution of the studied area was stopped by the regularization of Berettyó and Criş rivers, turning the Nagy Sárrét wetland in cultivated fields.

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