



INTERDISCIPLINARIA ARCHAEOLOGICA

NATURAL SCIENCES IN ARCHAEOLOGY

homepage: <http://www.iansa.eu>



Natural and Anthropogenic Changes in the environment in the Middle Ondava Basin (Eastern Slovakia) during the Neolithic Period

Tomasz Kalicki^a, Marek Nowak^{b*}

^aDepartment of Geomorphology, Geoarchaeology and Environmental Management, Institute of Geography, Jan Kochanowski University in Kielce, ul. Świętokrzyska 15, 25-406 Kielce, Poland.

^bInstitute of Archaeology, Jagiellonian University, ul. Gołębia 11, 31-007 Kraków, Poland.

ARTICLE INFO

Article history:

Received: 5. March 2014

Accepted: 20. December 2014

Key words:

Eastern Slovak Lowland
the middle Ondava river Basin
Neolithic
alluvial history
geoarchaeology

ABSTRACT

The paper summarizes the geomorphological results of a research project focused on palaeogeographical and archaeological characteristics of a Neolithic settlement in the middle Ondava Basin (north-west part of the Eastern Slovakian Lowland). Investigations on an Early Neolithic (ca. 5500–5100 BC) settlement in Moravany were carried out as part of the project. Palaeogeographical studies were carried out in the neighbouring territory of this site. The Holocene alluvia detected there were much younger than the Neolithic and no distinct traces of the activity of Neolithic people were recorded. Extremely important data were obtained in Kladzany. The general structure of the river valley records the erosional phase of the end of the Pleistocene. In the Early Holocene, the Ondava river cut off the upper part of the palaeochannel fill during lateral migration. A slow process of aggradation was noted during the Neolithic since soil-forming “kept up” with the sedimentation. A change in the rhythm of the overbank deposition occurred after 5,830±40 BP which led to the fossilization of the soil by an over 1 m thick layer of silts. It is difficult to determine whether it is related to human activity.

1. Introduction and basic aims of the study

The area of investigation is situated in the north-west part of the Eastern Slovak Lowland (Figure 1). Palaeogeographical studies were carried out *on site* and *off site* in the neighboring territory of the archaeological site of Moravany, *i.e.* in the valley of the small river Šarkan, in its alluvial fan, in the Topľa and Ondava floodplain near Moravany (Kalicki *et al.* 2005; Nowak *et al.* 2009, 418–421) and near Kladzany, ca 12 km north of Moravany (Nowak *et al.* 2010, 159–163). The results of the research project focused on the palaeogeographical and archaeological characteristics of the Neolithic settlement in the middle Ondava Basin (Kalicki *et al.* 2004; 2005; Nowak *et al.* 2010) will be presented in this paper. First and foremost, the geomorphological aspects of these results will be discussed. As regards the absolute chronology of the period

under discussion, the broadly understood Neolithic (*i.e.* also including the Eneolithic) covers roughly the range between 5500 and 2500/2300 BC. Within the project, excavations on the Early Neolithic settlement at Moravany were carried out. The primary topic of our interest was therefore this period, which is dated at ca 5500–5100 BC (see Nowak *et al.* 2010, 206–208). From the archaeological perspective, the Early Neolithic is characterized by the presence of the Eastern Linear Pottery culture (Kalicz, Makkay 1977; Šiška 1989; Kozłowski (ed.) 1997), which is the first Neolithic culture in Eastern Slovakia. It should also be mentioned that over the course of the research a great deal of data related to other prehistoric and historic periods was obtained.

2. Methods

Geomorphological and geological mapping around the archaeological site at Moravany and field prospection in the

*Corresponding author. E-mail: mniauj@interia.pl

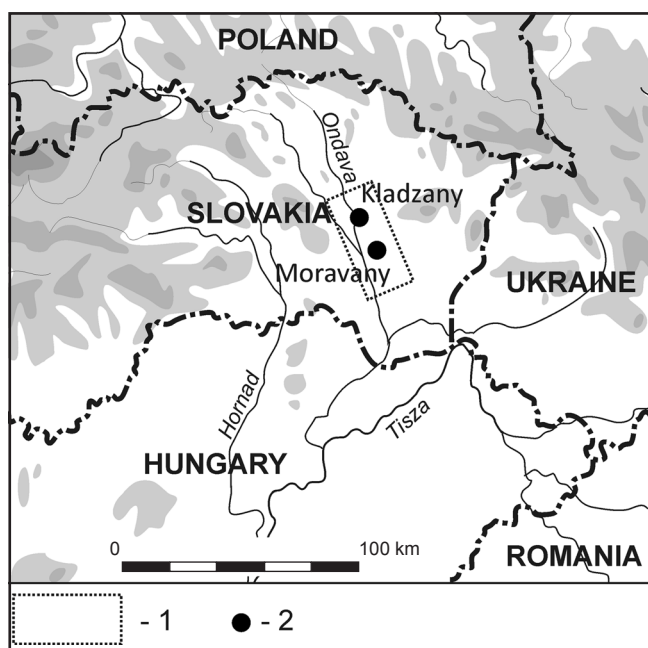


Figure 1. Location of the study area (1) and the sites mentioned in the text (2).

Topľa and Ondava river valleys were carried out. Samples for sedimentological analyses, micromorphological studies and ^{14}C datings were taken from the geological outcrops and borings. Grain size analyses by the sieve method in the case of coarser sediments and by the laser method (Fritsch Analysette 22) in the case of fine sediments were

performed. The grain size parameter distribution was calculated according to the Folk-Ward formulae. For micromorphological analyses, performed by A. Budek, undisturbed blocks were collected in Kubiena tins in a vertical arrangement from the buried soils. The samples were acetone-dried and impregnated with epoxy resin and the thin sections were prepared. Archaeological excavations at the Early Neolithic settlement in Moravany were carried out. A number of archaeological and palaeoenvironmental analyses were executed (Nowak *et al.* 2010) along with the field studies.

3. Results of the off site research

Palaeogeographical studies were carried out in the valley of the small river Šarkan, in its alluvial fan, and in the Ondava floodplain (Figure 2) (Kalicki *et al.* 2005; Nowak *et al.* 2009, 418–421). It should be emphasized that the Šarkan valley is situated directly next to the Early Neolithic settlement of Moravany dating to ca. 5500–5300 BC (Nowak *et al.* 2010, 206–208). One would consequently expect to find traces of its existence in the discussed valley, in the mid-Holocene period.

3.1. The Šarkan valley near the Moravany site

The discovery of black layer at the top of Tertiary sediments in the Šarkan valley indicates that buried soils were partly preserved on the slopes of the valley. They were dated at $19,890 \pm 120$ BP. The bottom of the valley is filled with silts

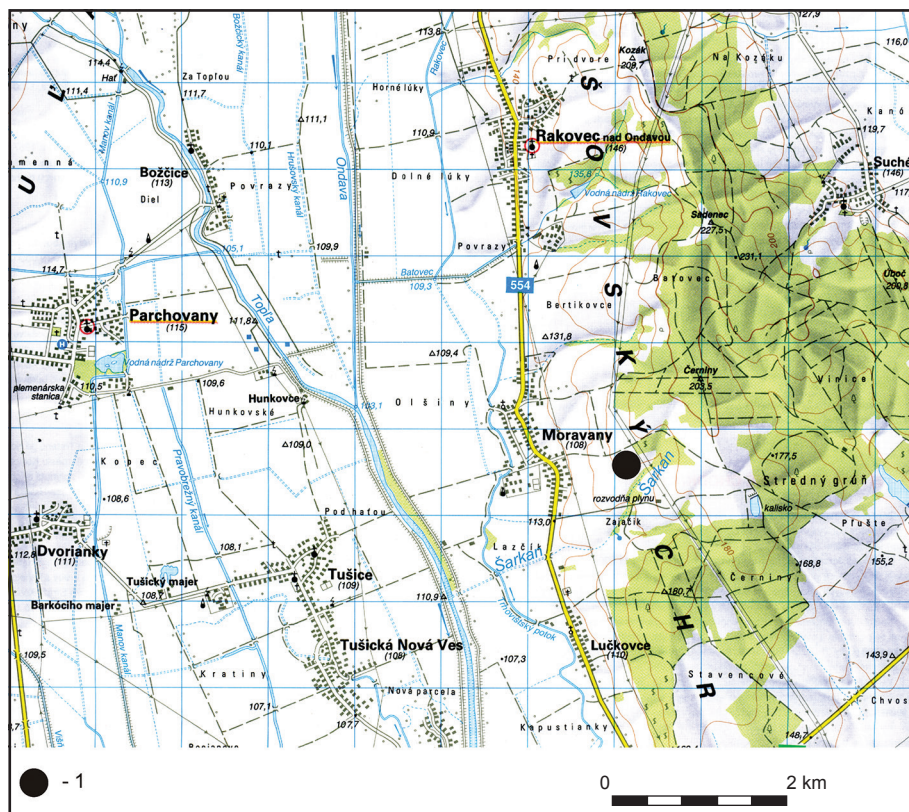


Figure 2. Location of the site Moravany (1).

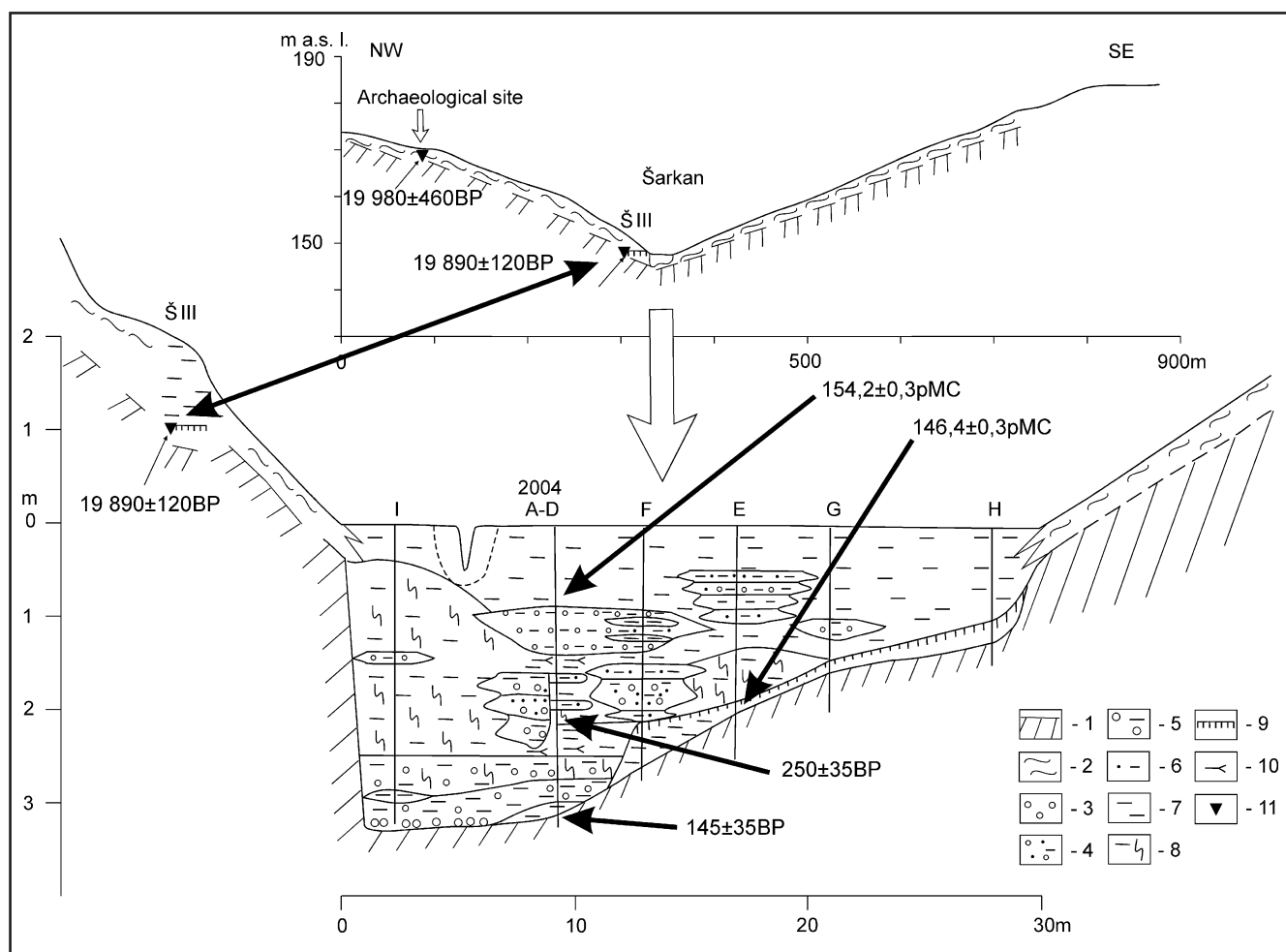


Figure 3. Section across the Šarkan valley near the Early Neolithic site at Moravany: 1 – Tertiary clays, 2 – slope deposits (deluvia), 3 – gravels, 4 – sandy gravels with silts, 5 – silty gravels, 6 – sandy silts, 7 – silts, 8 – organic silts, 9 – buried soils, 10 – detritus, 11 – radiocarbon datings.

with numerous charcoals and plant macroremnants. Several layers with a sandy-gravel admixture could be distinguished in the 3 metre thick silty member. These deposits, at various levels, reflect the channel changes during the infilling of the valley. All data, including radiocarbon dating and archaeobotanical analyses, made it possible to establish the course of events caused by climatic fluctuations and human impact. In summary, five main stages of the development of the valley can be distinguished during which the perennial creek turned into an episodic creek (Figure 3):

- It was a periglacial valley deeply incised in the Tertiary bedrock in the Last Pleniglacial.
- It was a deep valley with a perennial creek during most of the Holocene.
- The filling processes only began during the Little Ice Age. The deposits were originally transported to the alluvial fan, as suggested by the date pointing to the 15th – 17th century AD.
- The accumulation of alluvial filling of the valley itself (ca 1 m thick), which at times was at an extremely high rate, began after the Maunder minimum (1675–1715 AD).

- The two present-day dates, the low number of plant taxa as well as the small amount of detritus at the depth of 2.15–1.14 m indicate an extremely strong slope erosion caused by human activity over recent decades and a further flash flood in the filling of the valley. This was in all probability caused by the collectivization following the Second World War, when previously separate fields were joined and the balks between them disappeared. The final stage of the development is a dry valley with a braided alluvial plain and ephemeral creek.

No evident traces of the activity of the Early Neolithic people have been recorded in this valley. This corresponds with the recent age of the Šarkan alluvial fan, covering the margin of the Ondava floodplain, as indicated by the ¹⁴C date of 365±30 BP (Poz-6323) of the lowest sediments on the Tertiary bedrock. The results of certain archaeobotanical analyses carried out at Moravany could corroborate to a degree this observation (Lityńska-Zajac *et al.* 2008). Namely, the number of cereal macroremains is surprisingly modest despite systematic sampling of the infillings of the anthropogenic features and floating almost 130 soil samples.

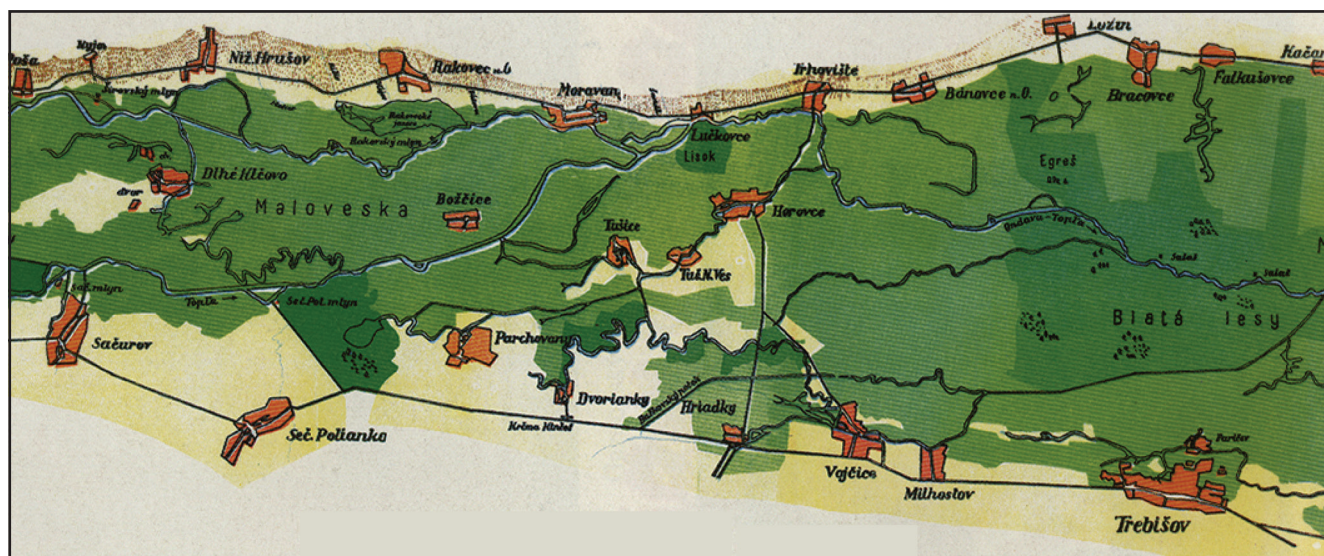


Figure 4. Part of the valley of the Ondava river in the vicinity of Moravany in 1848 (after Harbuřová 2002).

This indirectly indicates that fairly small areas have been deforested in order to obtain fields to cultivate cereals.

3.2. The Ondava river valley near the Moravany site

The recent Ondava river course is extremely young and was established as a consequence of regulation and channelization of the river bed in the 19th and 20th centuries. Prior to this, the Ondava was an anastomosing river divided into at least several meandering branches, as can be seen in the historical records. In addition, almost every spring the entire plain was flooded to a significant degree. This is also evident based on historical data (Figure 4). It actually continues to

occur at present, despite the aforementioned regulations and channelization. The same phenomena must have taken place in prehistoric periods. Sections and borings across the floodplain, both older ones and those executed during our research, indicate meandering belts, located much closer to the eastern slope of the valley (Figure 5). Profiles with buried soils, black oaks, animal bones and prehistoric pottery also occur in the valley bottom in the study area.

3.3. The Ondava river valley near Kladzany

The most important results, in this respect, were obtained in Kladzany, ca 12 km north of Moravany (Figure 6)

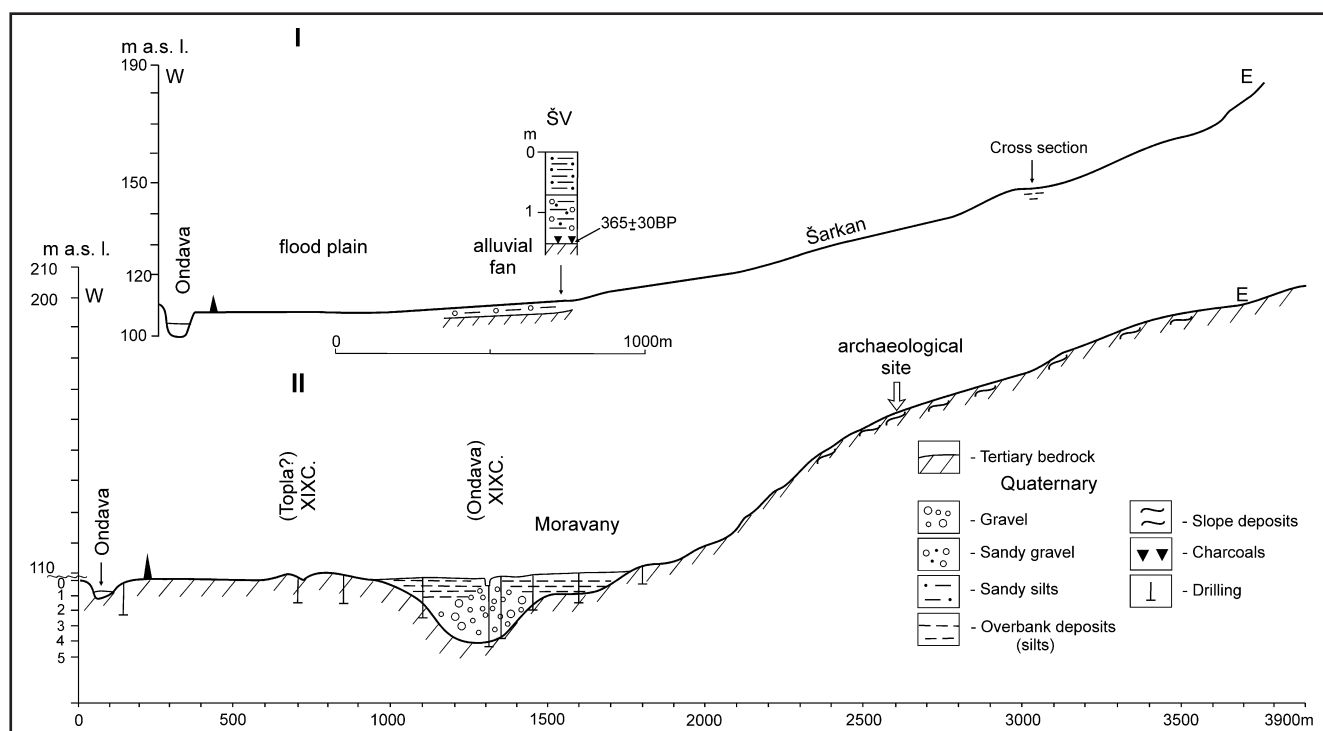


Figure 5. Longitudinal profile of the Šarkan valley (I) and a section across the Ondava river floodplain and slope with the archaeological site (II).

Figure 6. Location of the site Kladzany (1).

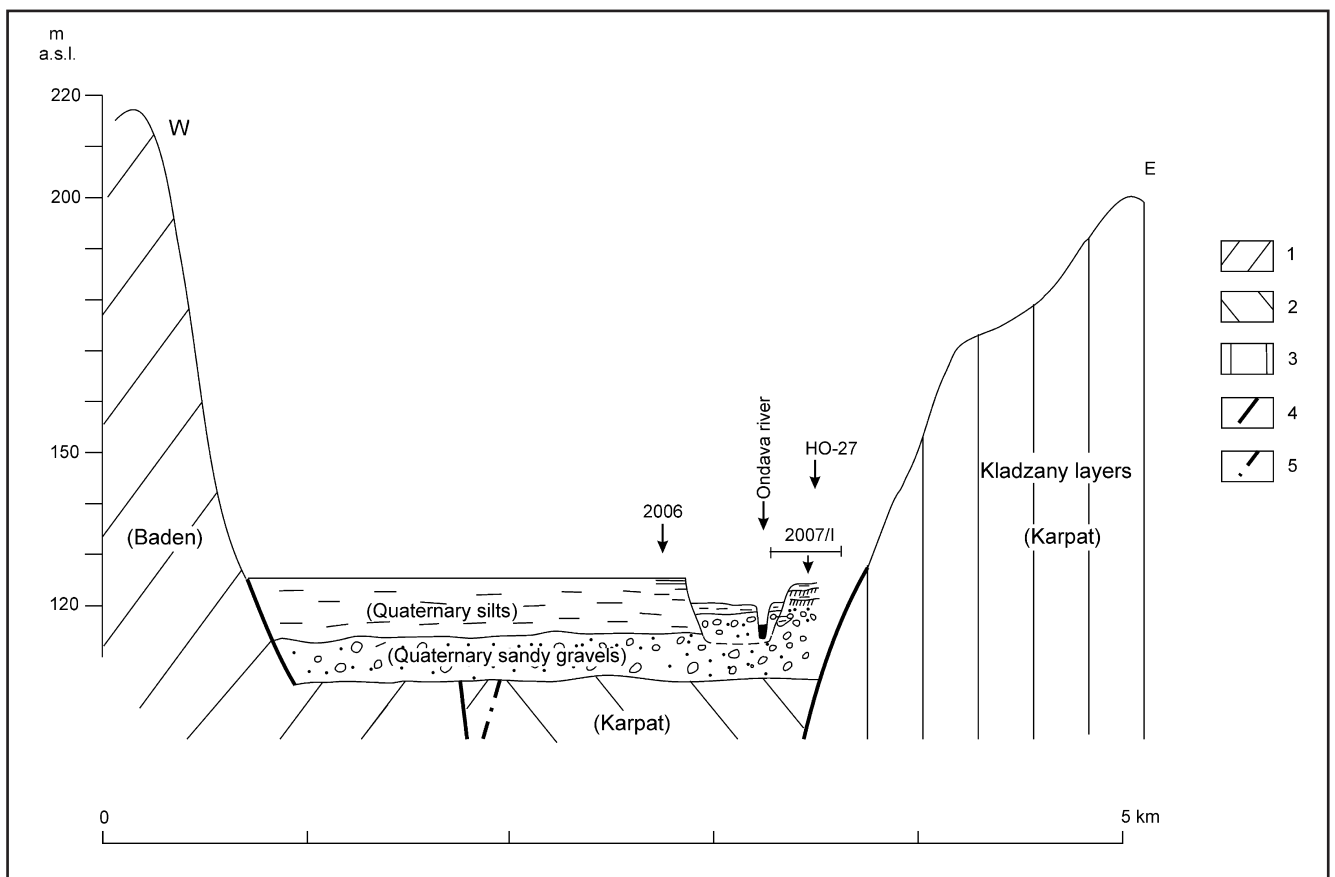
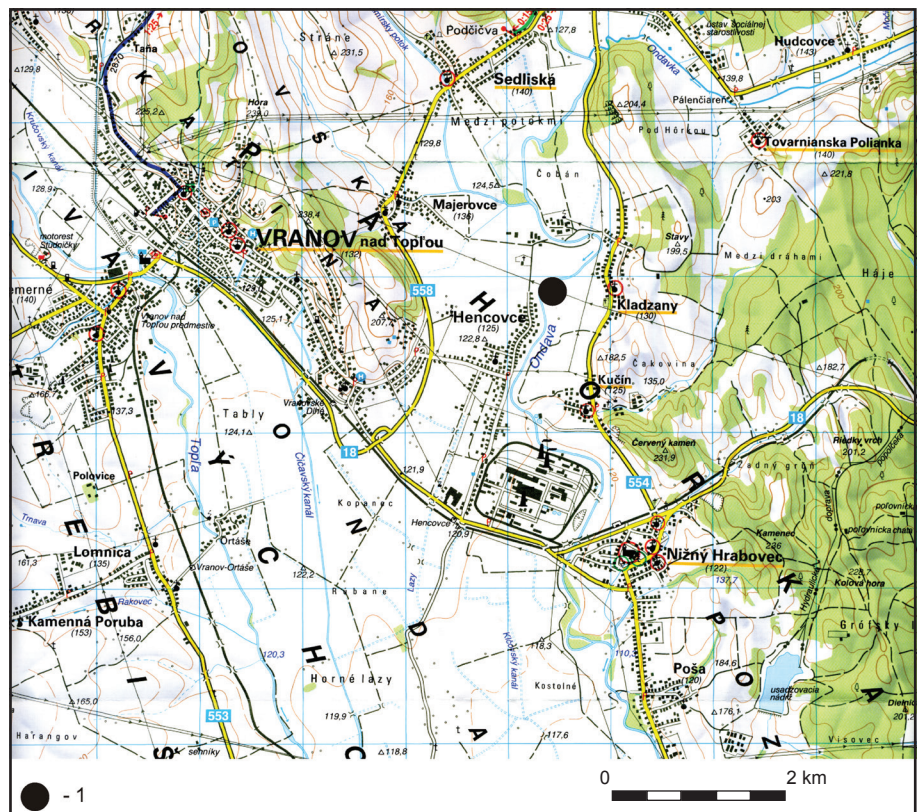


Figure 7. Schematic section of the Ondava river floodplain near Kladzany with studied profiles: 1 – bedrock (Badenian), 2 – bedrock (Karpatian), 3 – bedrock – Kladzany formation (Karpatian), 4 – faults (after Baňacký *et al.* 1987), 5 – assumed faults (after Baňacký *et al.* 1987).

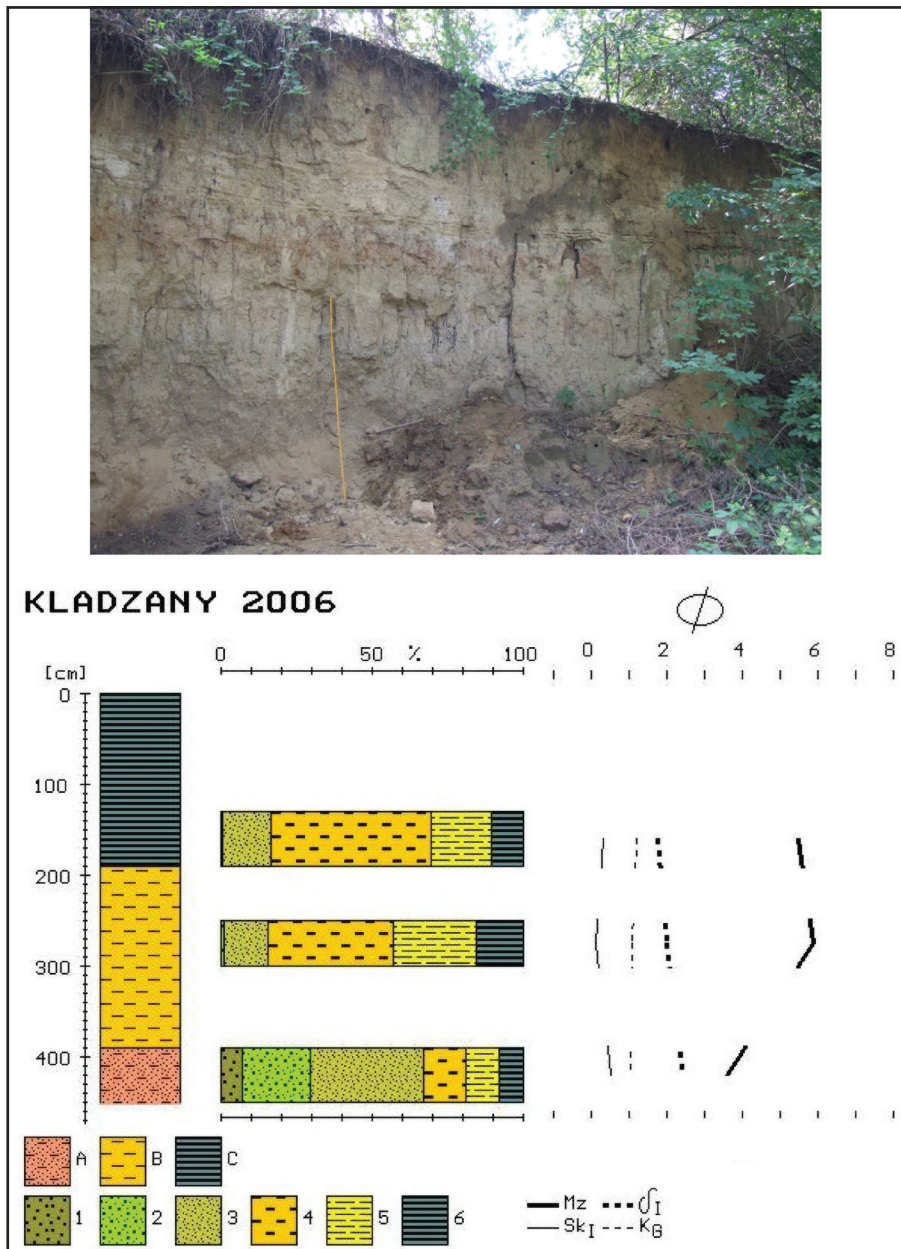


Figure 8. Kladzany 2006 profile and grain size composition with Falk-Ward parameter distribution of sediments. Sediments: A – silty sands, B – silts, C – clays; Fractions: 1 – middle and fine gravel, 2 – coarse sand, 3 – middle sand, 4 – fine sand (2 to 4 ϕ), 5 – coarse and medium silt (4 to 6 ϕ), 6 – fine silt (6 to 8 ϕ); Folk-Ward distribution parameters: Mz – mean size diameter, δ_1 – standard deviation, Sk_I – skewness, K_G – kurtosis.

(Nowak *et al.* 2010, 159–163). The overall thickness of the Quaternary sediments in the valley bottom does not exceed a dozen metres. There are two cut and fill morphological levels (terraces) each ca 1.5 m high at the bottom of the approximately 2 km wide Ondava river valley.

The higher morphological level is raised around 8 m above the river and occupies the largest part of the valley bottom. Generally speaking, this morphological level consists of silts in the upper part of the profile and sandy gravels in the lower part (Figure 7). This is particularly evident in the western part of the valley bottom (profile “Kladzany 2006” – Figure 8).

The younger part of the higher level covers the eastern side of the valley bottom. It is built of diverse facies of alluvia of some 6–8 m thick above the river (profile “Kladzany 2007A”).

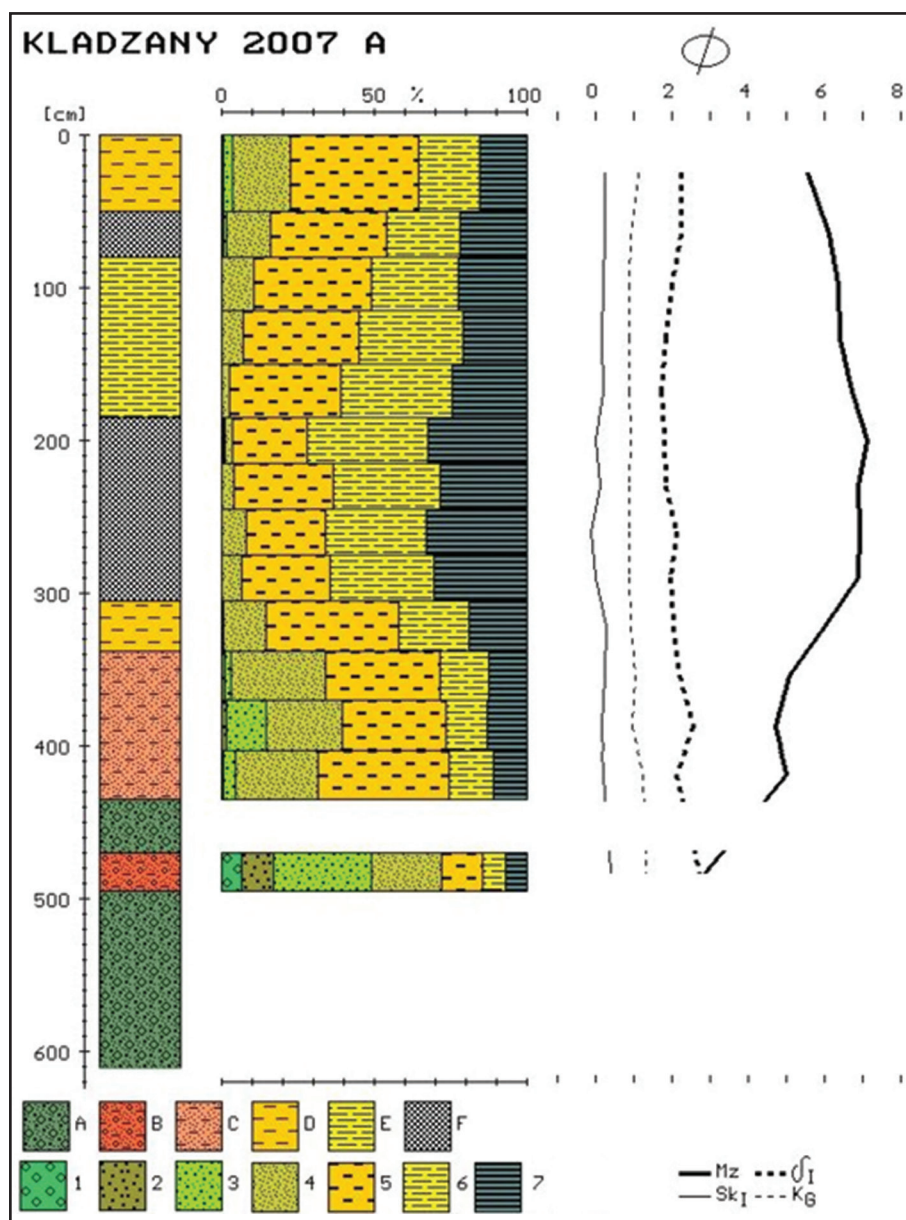
In the profile “Kladzany 2007A” (Figures 9 and 10) in the lower part (depth 4.35–6.1 m), channel sediments appear,

gravels of a diameter 4–6 cm with sands. Irregular fragments of organic silts and clay balls were recorded in their bottom part (5.2–5.4 m). The organic silts from such a clay ball were dated at 9940±50 BP (Poz-22257). Numerous pieces of wood and detritus appear in the sandy layer (4.7–4.95 m).

Channel alluvia are covered with a thick series of fine clastic, overbank deposits with buried soils. Several members could be distinguished in this series:

- The lower one (depth 4.35–3.05 m) is built of silts with distinct remains of gley processes.
- A thick layer of buried soil (depth 3.05–1.85 m), well developed, with prismatic structures. This testifies to a longer period of time for soil and depositional processes which worked here simultaneously and remained at a relative equilibrium. Grey brown silty groundmass occurs in all the thin sections (Figure 11).

Figure 9. Kladzany 2007A profile and grain size composition with Falk-Ward parameter distribution of sediments. Sediments: A – gravels and sands, B – gravels and sands with silty admixture, C – silty sands, D – silts; E – clayey silts, F – buried soils. Fractions: 1 – middle and fine gravel, 2 – coarse sand, 3 – middle sand, 4 – fine sand (2 to 4 ϕ), 5 – coarse and medium silt (4 to 6 ϕ), 6 – fine silt (6 to 8 ϕ), 7 – clay (above 8 ϕ). Folk-Ward distribution parameters: Mz – mean size diameter, δ_1 – standard deviation, Sk₁ – skewness, K_G – kurtosis.



The coarse material consists of rough quartz grains; with extremely rare feld-spars, micas and glaukonites. In the humic horizon, well decomposed, amorphous humus is dominant in the groundmass and plant fragments with a well preserved tissue structure occur. Diagenetic processes are indicated by typical iron nodules visible in thin sections. Clay coatings in channels are well preserved but weakly developed in the bottom clay movement. In the thin section from the upper part of the buried soil (Figure 11: 3), the grey-orange groundmass consists of unsorted quartz grains and silty undifferentiated material. There are well preserved pedo- and diagenetic processes, represented by typical, amboidal and digitate iron nodules, iron hypocoatings in channel and orange groundmass saturated by iron hydroxides. The clay movements in the thin section are poorly developed. Traces of

fresh biological activity occur in the groundmass like earthworms filling in a channel or fresh organic matter. On the basis of these micromorphological data, we have concluded that brown soil forming with lessive processes took place here. In the lower part of the buried soil (depth 2.95 m), bones, daub, Early Neolithic pottery and charcoals were found. The charcoals were dated at 6,130±40 BP (ca 5200–5000 cal BC). This soil developed during the mid-Holocene as a typical fluvisol to at least 5,830±40 BP (ca 4800–4600 cal BC) since such a date marks the top level. This date is, however, possibly slightly older when compared to the actual age of the layer, as the soil fossilization should be dated to the decline of the Atlantic period. Radiocarbon dating of buried soils could, in general, overestimate the actual age of the burial by as much as the steady-state age of the soil or soil horizon.

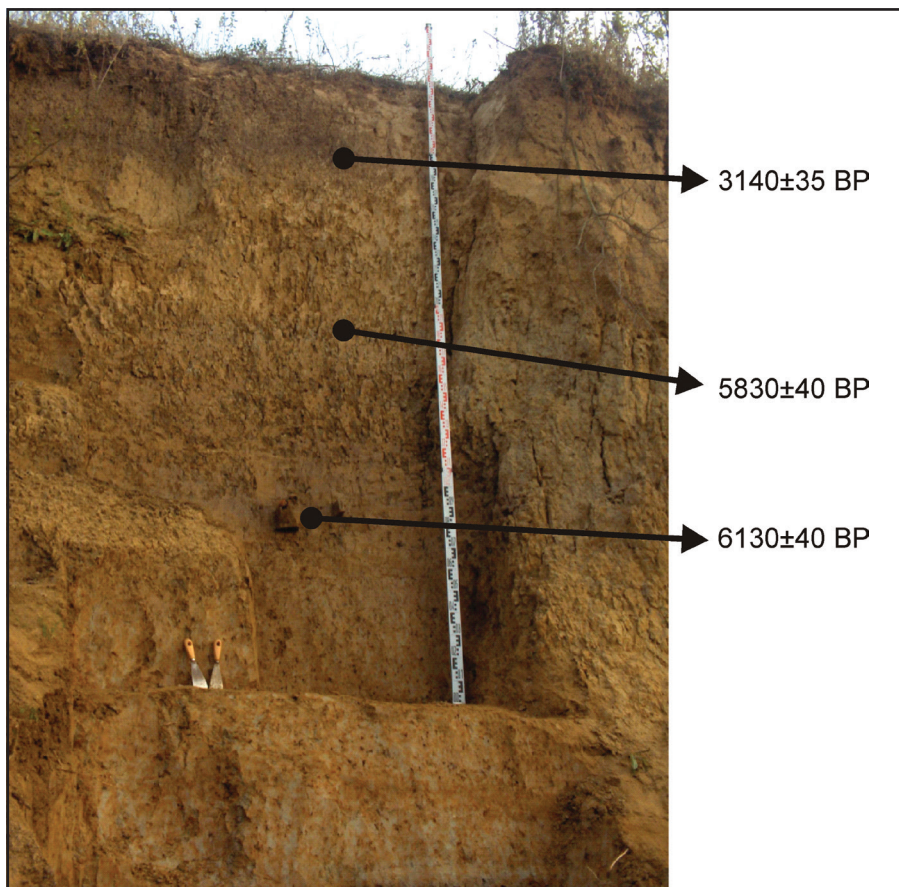


Figure 10. Kladzany 2007A profile with radiocarbon dates.

The radiocarbon date of the humus horizon is always younger than the beginning of the soil formation and older than the youngest organic substances in the buried soil (Pazdur 1982).

- Thick overbank deposit layer, mainly clayey silts (depth 1.85–0.8 m).
- Buried soil (depth 0.8–0.5 m) with a prismatic structure, however, less developed than the mid-Holocene soil. In the thin section from this depth the groundmass is similar to the above. Diagenetic processes commonly occur. There are typical iron nodules, iron and clay hypocoatings in the channels and rarely on the mineral grains. Appearing clay coatings are deformed or destroyed. This soil resulted from brown soil formation with traces of lessive processes in wet conditions, as evidenced by well-developed precipitation of iron oxides. The top of this soil was dated at 3,140±35 BP (ca 1500–1400 cal BC).
- Silty overbank deposits (depth 0.5–0.0 m).

The lower morphological level is a cut and fill terrace with two alluvial bodies. The alluvium of the older body is in superposition because of the covered rest of the alluvium of the older terrace. The best record of its development is visible in profile “Kladzany 2007B” (Figure 12). The erosive base rock is built of channel gravels (depth 4.6–4.15 m) and above there are remnants of the Late Glacial palaeochannel fill (depth 4.15–3.8 m), dated to 10,940±50 BP. The upper

part of this palaeochannel fill is in all probability the origin of the irregular organic silts fragments and the clay balls found in profile “Kladzany 2007A”, because this base deposit is eroded and covered with a series of younger gravelly-sandy channel alluvia (depth 3.8–0.7 m). Small interbeddings (10–35 cm) of silts or sandy silts appear in their precincts. The silty overbank series (depth 0.7–0.0 m) constitutes the topmost part of the profile.

The youngest accumulation within this morphological terrace (younger body) constitutes channel alluvia with numerous subfossil trees (AMS radiocarbon dating: 164.51±0.43pMC) in the lowest part and with bones in the upper part, located on the border between the channel and overbank sediments (profile “Kladzany I”).

The general structure of the river valley near Kladzany (Figure 13) records the erosional phase at the end of the Pleistocene, which eroded the Tertiary base rock and cut the eastern part of the valley forming a deep depression, which is evidenced by the palaeochannel dated at 10,940±50 BP. During the Early Holocene, lateral migration of the Ondava river cut the upper part of the palaeochannel fill. In the Late Holocene, a series of alluvia building a lower morphological terrace appeared. The type of sediments, dominated by channel and overbank facies, confirms a greater flow within the river channel, which was narrowed and stabilized by resistance to the side erosion fine clastic series.

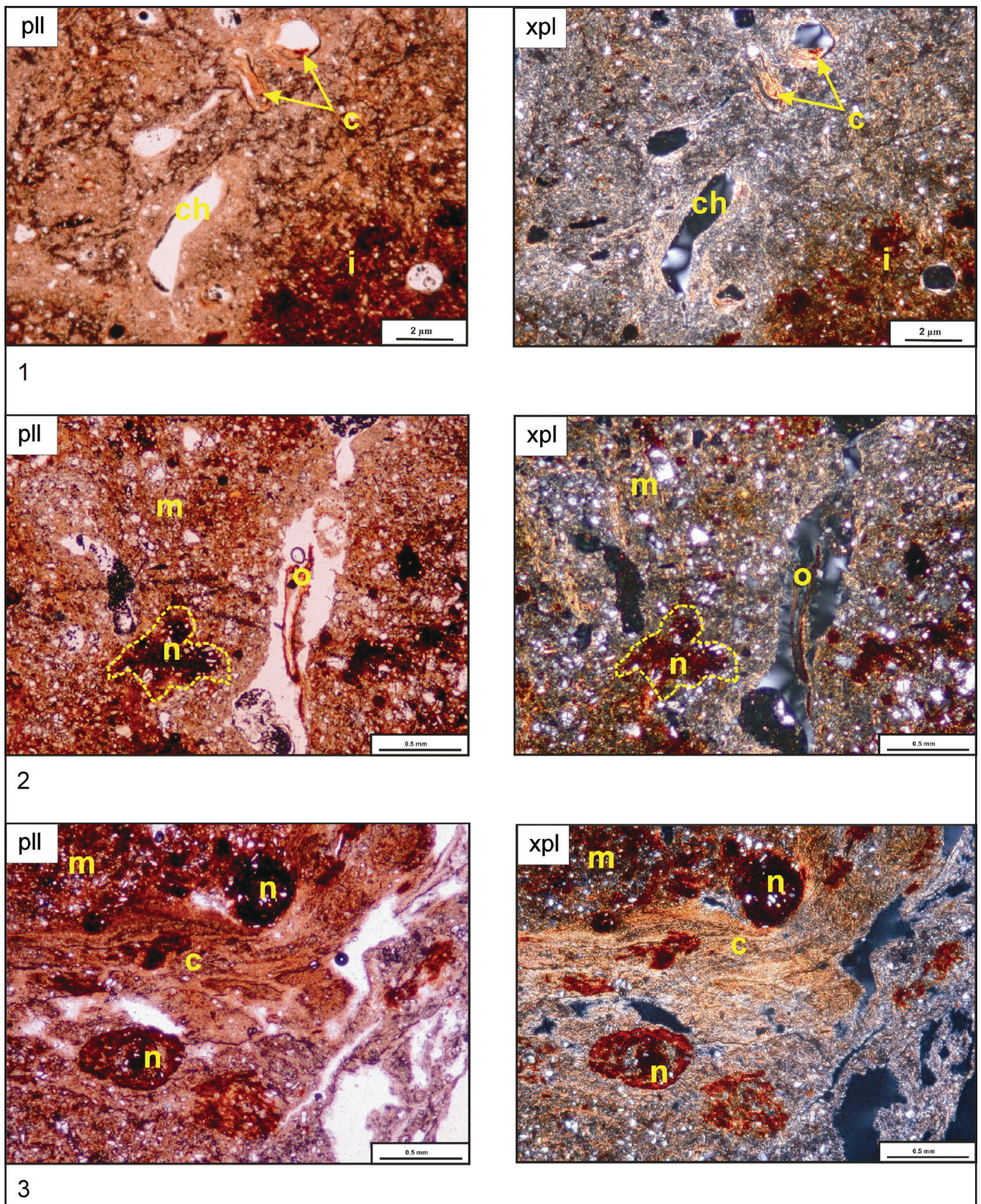


Figure 11. Kladzany 2007A profile: thin sections of the sediments from “lower” buried soil: lower (1–2) and upper (3) part (by A. Budek). 1. pll – plane polarized light, xpl – cross polarized light, c – clay coatings, ch – channel, i – iron impregnation of groundmass. 2. pll – plane polarized light, xpl – cross polarized light, m – groundmass, o – organic matter in channel, n – amiboidal iron nodules. 3. pll – plane polarized light, xpl – cross polarized light, m – groundmass, n – typical iron nodules, c – clay coatings.

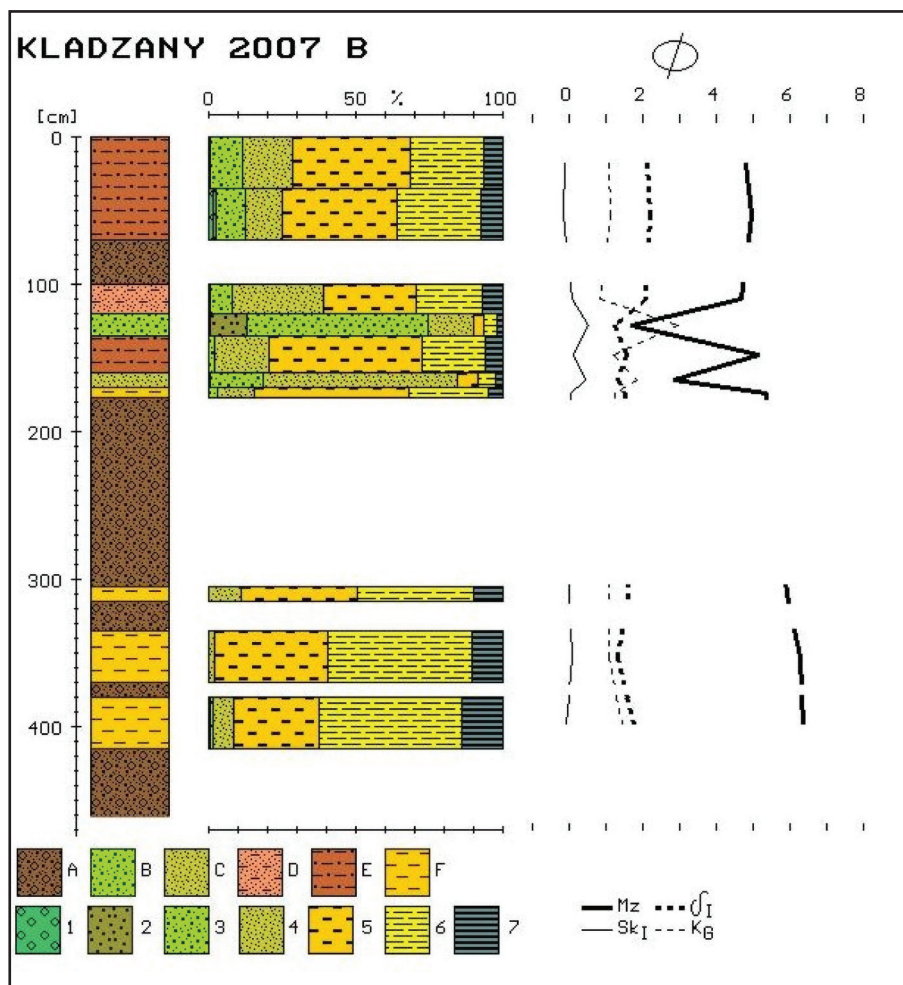


Figure 12. Kladzany 2007B profile and grain size composition with Folk-Ward parameter distribution of sediments. Sediments: A – gravels and sands, B – coarse and middle sands, C – fine sands, D – silty sands, E – sandy silts, F – silts. Fractions: 1 – middle and fine gravel, 2 – coarse sand, 3 – middle sand, 4 – fine sand (2 to 4 ϕ), 5 – coarse and medium silt (4 to 6 ϕ), 6 – fine silt (6 to 8 ϕ), 7 – clay (above 8 ϕ). Folk-Ward distribution parameters: Mz – mean size diameter, δ_I – standard deviation, SkI – skewness, K_6 – kurtosis.

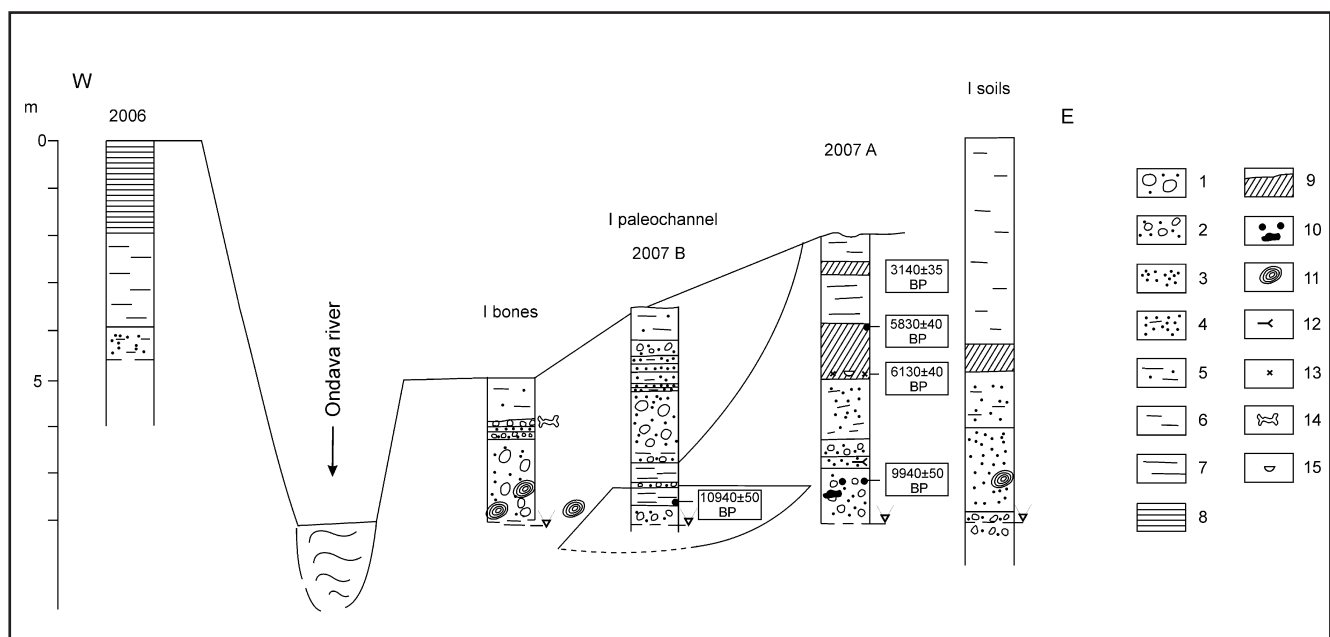


Figure 13. General section across the Ondava river valley near Kladzany: 1 – coarse gravels with sands, 2 – gravels with sands, 3 – sands, 4 – silty sands, 5 – sandy silts, 6 – silts, 7 – clayey silts, 8 – silts with horizontal bedding, 9 – buried soils, 10 – clay balls, 11 – subfossil trees, 12 – detritus, 13 – charcoals, 14 – bones, 15 – pottery.

4. Discussion

At the beginning of the Neolithic, the level of the floodplain was about 3 m lower as compared to the present-day bottom of the valley. The plain and its outlying area were in all probability already exploited by humans in that period, judged on the basis of at least four archaeological sites linked to the Eastern Linear Pottery culture, i.e. Moravany, Sečovská Polianka, Sedliská, Vranov nad Topľou (Kotorová-Jenčová 2004; Pavúk 2004; Nowak *et al.* 2010). As we have already indicated, direct confirmations of human presence have also been demonstrated by ceramics found in the lower part of the fossil soil in Kladzany, dated to the end of the sixth millennium BC. Significantly, the beginning of buried soil formation actually divides the Neolithic period (*sensu stricto*), which lasted ca 5500–4500 BC. This is, however, not necessarily associated with the disappearance of the Neolithic settlement, as evidenced by the presence of the Bükk culture in the area (at least two sites – Rakovec and Vranov nad Topľou), which can be dated at ca 5100–4800 BC (Gačková 2004; Kotorová-Jenčová 2004; Pavúk 2004). It should also be emphasized that eleven sites with materials described only generally as “Neolithic” were also founded within the discussed area (Gačková 2004; Kotorová-Jenčová 2004); i.e. it is highly probable that some of them could actually belong to the Eastern Linear Pottery culture and some to the Bükk culture. Alluvial sedimentation prior to the end of the sixth millennium BC cannot in contrast be connected with the Early Neolithic settlement since it is a process that probably began earlier than around 5500 BC. In summary, it seems possible to confirm the observation suggested above in the case of Moravany, as to the absence of the impact of Early Neolithic people on the environment. In other words, the described sedimentation processes which refer to that period do not reflect anthropogenic activity.

A slow process of aggradation (1.2 m of sediment) can be noted during the Neolithic since soil-forming “kept up” with the sedimentation. A change in the rhythm of overbank deposition occurred after 4800–4600 BC which led to the fossilization of the soil by an over 1 m thick layer of silts. The question consequently arises as to whether the latter phenomenon could be related to human activity. A supporting argument is that the above date could roughly correlate with the beginning of the Eneolithic (see e.g. Chmielewski 2008, 72–81). It is known that in the Eastern Slovak Lowlands, in contrast to other regions of eastern Slovakia, the Early and Middle Eneolithic (represented by Tiszapolgár and Bodrogkeresztúr cultures; ca 4500–3750 BC) are not associated with a demonstrable decrease in human settlement (Šiška 1968; 1972). The Late Eneolithic Baden culture is also present in the Eastern Slovak Lowland (Horváthová 2010). On the other hand, however, and this is an argument against, one has to admit that in the north-west part of the Eastern Slovak Lowland, the Eneolithic settlement is fairly scanty (only four culturally unidentified sites for a period of over 1500 years). What is more important, the location of the profiles in Kladzany is of the kind that records rather the

situation in areas north of the Eastern Slovakian Lowland where the archaeological remains of these Eneolithic stages are even more scarce. There are actually no confirmed Early and Middle Eneolithic sites there (Pavúk 2004). To complement the picture, it should be mentioned that the phase of floods, which can be correlated with the fossilization of the older, middle Holocene soil, has been well recorded in numerous valleys in Central Europe (Kalicki 2006).

Another archaeological observation should be mentioned here, however, which could be a kind of argument in favour. The Eastern Slovak Barrows culture, dated at ca 2500–2300 BC, that is to the very end of the Eneolithic, is represented by numerous barrows, both in the study areas and in the upper Ondava basin (Budinský-Krička 1991; Jarosz 2011). It remains an open question as to what the level of deforestation connected with building these barrows was, but it seems reasonable to take into account at least some level of it. In such a case, the effects of this activity could superimpose on natural processes and locally intensify them. It should also be recalled that in the older literature the fossil soils of, described as the Late Atlantic ones (?), were hinted at at this place. They were dated in the Topľa valley to 4,720±300 BP (Božčice) and in the Ondava valley at 4,200±900 BP (Kladzany) whereas the lower and upper ones were referred to as the Preboreal and Subboreal, respectively (Baňacký *et al.* 1987).

5. Conclusion

In light of the data presented herein, it would seem that traces of human impact on the environment during the (Early) Neolithic period in the area under consideration are not apparent in practice. This reflects a type of settlement and economic behaviour which does not demand exploitation of large parts of the landscape. Contrary to popular belief, a situation of this kind is quite often reported in the Balkan Peninsula, the Carpathian Basin and in Central Europe (e.g. Willis, Bennet 1994; Stankovianský 2003; Bogaard 2004; Grygiel 2004). Increased attention began to be paid to this phenomenon in archaeology particularly after the publication of the seminal paper by K. Willis and W. Bennet in 1994. They demonstrated that the first clear palynological evidence of human activity in the Balkans was surprisingly late. These evidences are usually only associated with the developed Eneolithic and with the Bronze Age.

References

- BAŇACKÝ, V., VASS, D., KALIČIAK, M., REMŠÍK, A., POSPIŠIL, L. 1987: *Výsvetlivky ku geologickej mape severnej časti Východoslovenskej nížiny v mierke 1:50,000*. Geologický ústav Dionýza Štúra, Bratislava.
- BOGAARD, A. 2004: *Neolithic Farming in Central Europe. An Archaeobotanical Study of Crop Husbandry Practices*. Routledge, London-New York.
- BUDINSKÝ-KRIČKA, V. 1991: K otázke skupiny východoslovenských mohýl. *Východoslovenský Pravek* 3, 96–111.

- CHMIELEWSKI, T. 2008: Uwagi o chronologii względnej i absolutnej wczesnego i środkowego Eneolitu na obszarze Polski południowo-wschodniej i zachodniej Ukrainy. *Przegląd Archeologiczny* 56, 41–100.
- GAČKOVÁ, L. 2004: Okres Michalovce. In: *Archeologické dedičstvo Zemplína*. Zemplínska spoločnosť, Michalovce, 261–426.
- GRYGIEL, R. 2004: *Neolit i początki epoki brązu w rejonie Brzeźcia Kujawskiego i Osłonek. Tom I: wczesny neolit, kultura ceramiki wstęgowej rytej*. Fundacja Badań Archeologicznych im. K. Jazdzewskiego & Muzeum Archeologiczne i Etnograficzne w Łodzi, Łódź.
- HARBULOVÁ, Ľ. (Ed.). 2002: *Dejiny obce Moravany*. Michalovce.
- HORVÁTHOVÁ, E. 2010: *Osidlenie badenskej kultúry na slovenskom území severného Potisia*. Archaeologica Slovaca Monographiae, Studia, Nitra.
- JAROSZ, P. 2011: Kurhany ceramiki sznurowej na pogórzach w wysoczyznach karpackich. In: Kowalewska-Marszałek, H., Włodarczak, P. (Eds.): *Kurhany i obrządek pogrzebowy w IV–II tysiącleciu p.n.e.* Instytut Archeologii i Etnologii Polskiej Akademii Nauk & Instytut Archeologii Uniwersytetu Warszawskiego, Kraków-Warszawa, 255–277.
- KALICKI, T. 2006: *Zapis zmian klimatu oraz działalności człowieka i ich rola w holocenijskiej ewolucji dolin środkowoeuropejskich*. Instytut Geografii i Przestrzennego Zagospodarowania Polskiej Akademii Nauk, Warszawa.
- KALICKI, T., NOWAK, M., VIZDAL, M. 2004: Geomorphology and palaeogeography of Early Neolithic site at Moravany (eastern Slovakia). *Geomorphologia Slovaca* 2/2004, 62–69.
- KALICKI, T., KOZŁOWSKI, J. K., NOWAK, M., VIZDAL, M. 2005: A settlement of the Early Eastern Linear Pottery culture at Moravany. In: Gál, E., Juhász, I., Sümegi, P. (Eds.): *Environmental Archaeology in North-Eastern Hungary*. Archaeological Institute of the Hungarian Academy of Sciences, Budapest, 187–206.
- KALICZ, N., MAKKAY, J. 1977: *Die Linienbandkeramik in der Grossen Ungarischen Tiefebene*. Akadémiai Kiadó, Budapest.
- KOTOROVÁ-JENČOVÁ, M. 2004: Okres Vranov nad Topľou. In: *Archeologické dedičstvo Zemplína*. Zemplínska spoločnosť, Michalovce, 121–186.
- KOZŁOWSKI, J. K. (ed.). 1997: *The Early Linear Pottery Culture in Eastern Slovakia*. Polska Akademia Umiejętności, Kraków.
- LITYŃSKA-ZAJĄC, M., MOSKAL-DEL HOYO, M., NOWAK, M. 2008: Plant remains from Early Neolithic settlement at Moravany (Eastern Slovakia). *Vegetation History and Archaeobotany* 17, Supplement 1, 81–92.
- NOWAK, M., MOSKAL-DEL HOYO, M., LITYŃSKA-ZAJĄC, M., KALICKI, T., KOZŁOWSKI, J. K., LITVINYUK, G. I., VIZDAL, M. 2009: A settlement of the Early Eastern Linear Pottery Culture at Moravany (Eastern Slovakia) – Preliminary report on seasons 2004 and 2006. *Recherches Archéologiques Nouvelle Serie* 1, 407–428.
- NOWAK, M., KOZŁOWSKI, J. K., KACZANOWSKA, M., VIZDAL, M., KALICKI, T., MOSKAL-DEL HOYO, M., BUDEK, A., LITVINYUK, G., LITYŃSKA-ZAJĄC, M., SOBIERSKA, E., WYSZOMIRSKI, P. 2010: Early Neolithic in the upper Tisza basin: New data from Moravany, Eastern Slovakia. *Eurasian Prehistory* 7, 159–219.
- PAVÚK, J. 2004: Mladšia a neskora doba kamenná. In: *Archeologické dedičstvo Zemplína*. Zemplínska spoločnosť, Michalovce, 41–54.
- PAZDUR, M. F. 1982: *Badanie dokładności datowania metodą 14C późnopleistocenijskich i holocenijskich osadów organicznych*. Zeszyty Naukowe Politechniki Śląskiej 741, Seria Matematyka-Fizyka 41.
- STANKOVIANSKÝ, M. 2003: Gully evolution in the Myjava Hill land in the second half of the last millennium in the context of the Central European area. *Geographia Polonica* 76, 89–107.
- ŠÍŠKA, S. 1968: Tiszapolgárska kultúra na Slovensku. *Slovenská archeológia* 16, 61–175.
- ŠÍŠKA, S. 1972: Gräberfelder der Lažňany-Gruppe in der Slowakei. *Slovenská archeológia* 20, 109–175.
- ŠÍŠKA, S. 1989: *Kultúra s východnou lineárnou keramikou na Slovensku*. Veda, Bratislava.
- WILLIS, K. J., BENNET, K. D. 1994: The Neolithic transition – fact or fiction? Palaeoecological evidence from the Balkans. *The Holocene* 4, 326–330.