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ABSTRACT OF Ph.D. THESIS

**Facial and geochemical diversity of flood plain alluvia of the upper
Kamienna river valley (Kielce Upland)**

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The aim of study is the determination of facial and geochemical variability of flood plain alluvia of the upper Kamienna river valley between Skarżysko-Kamienna and Wąchock as a base for recognition of natural environment changes. In this dissertation very big emphasis was put on show the meaning of natural and anthropogenic factors which recorded in alluvia in vary degree, on 8.5 kms section, as test section for the whole upper Kamienna catchment.

Based on the obtained sedimentological, geochemical and micromorphological results, within investigated flood plain following groups of deposits has been distinguished: channel alluvia, overbank alluvia, alluvial fans deposits and lacustrine deposits. A seperate group are buried soils, preserved in alluvia.

Channel alluvia divided on lag deposits, point bar alluvia and medial bar alluvia.

Lag deposits. These deposits are a coarse-clastic (gravelly-sandy or sandy-gravelly), weakly sorted material. Deposits lie mainly in the bottom of profiles. Alluvia are connected with short transport during violent floods. Elements concentrations in them are usually low, and their chemical properties is conditioned primarily by natural factors (eg. geological structure, textural features, rock-weathering processes, deep migration into profile).

Point bar alluvia. These channel alluvia are the best recognized on this area. Deposits are built above all from well sorted sandy deposits. The tendency of fining upward sequence is well visible which is typical for meandering river. Locally silty laminae, recognized macroscopic and in microscopic picture, are preserved. Micromorphological analysis shown that sedimentological processes in forming of point bar alluvia features had prevailed. Point bar alluvia are characterized by low abundance

of organic matter, carbonates and elements. In place with subfossil tree (K7 profile) increase of participation of $<63 \mu\text{m}$ fraction and values of geochemical parameter had place. An increase of elements concentration in upper part of facies (eg. K4 profile) was stated. It may be results of elements depth migration into profile, postsedimentological processes, and also from lateral infiltration of river water. Point bar alluvia are uneven-aged. In these case the Late Glacial (TL 12.9 ± 1.9 ka; KIE-903), the Eoholocene (TL 8.5 ± 1.3 ka; KIE-904), the Atlantic (TL 6.1 ± 0.9 ka; KIE-902), the Subboreal (4600 ± 70 BP cal. 3620-3130 BC; 730 ± 70 BP cal. 1150-1420 AD), the Roman Period (TL 2.2 ± 0.3 ka – KIE-901; 2160 ± 40 BP cal. 354-92 BC – MKL-3795; 2020 ± 40 BP cal. 120 BC-70 AD – MKL-1371; 186-45 BC – TK_K1) and the Early Medieval (OSL 1.6 ± 0.25 ka – UJK-OSL-74; OSL 1.3 ± 0.2 ka – UJK-OSL-75) facies has been distinguished.

Medial bar alluvia. These deposits are recognized in form, created upstream bridge in Marcinków. This form are built from sandy deposits, in proximal zone (in river current) built from sands with single gravels, whereas in distal zone (in river bank) from silty sand deposits. The quite high elements concentrations occur, especially next to river bank where a fine material absorbed elements more intensively than in proximal zone. This material comes from flood plain area, probably also from slopes and tributaries.

In channel alluvia subfossil trees (black oaks) from the Roman Period are preserved. They are results of lateral migration of meandering channel, caused by increase of fluvial activity. Together 5 *in situ* trunks and 11 redeposited trunks has been stated. Numerous the Roman Period sites of black oaks were identified in Central Europe valleys.

Overbank deposits were divided on proximal flood plain alluvia, levee alluvia, backswamps alluvia and palaeochannel fills alluvia.

Proximal flood plain alluvia. These deposits have differentiated grain size, from sandy fraction, to silty fraction, with advantage of sandy sediment. Alluvia were accumulated during variable fluvial activity, in the condition conducting of fine material deposition the most. An increase of coarse fraction was caused probably by human impact (deforestation). Thickness of these deposits oscillates between 10 and 80 cm that show that flood plain alluvia could be susceptible on blur during next floods. These deposits are transformed in significant degree by soil-forming processes and

bioturbations. Charcoals, occurring here, can testify to historical human activity, however they can have a natural origin. In this deposits elements concentrations are variable. Flood water stagnation, big participation of fine fraction and organic matter conducive an increase elements accumulation. Human activity within Old-Polish Industrial Region had essential impact on increase of element accumulation, mainly Fe, Mn, P and trace elements.

Levee alluvia. These deposits are rare on the flood plain area. In K19 profile they marked as alternating sandy, sandy-silty and silty-sandy deposits. The occurrence of 6-7 floods rhythm has been stated. Elements concentrations are quite low, but variable. Chemistry of these deposits are dependent on the participation of fine fraction and organic matter, but it are not dependent on human impact. These alluvia come from the Middle Ages (after 1790±70 BP cal. 80-390 AD; MKL-4116).

Backswamps alluvia. These alluvia are weakly recognized, only in K5 profile were preserved. They are built from silts with small amount of sands. The significant elements accumulation had place here, caused by sorption properties of organic matter and fine fraction.

Palaeochannel fill alluvia. These overbank alluvia are uneven-aged. They were accumulated in the Eoholocene (9250±60 BP cal. 8630-8300 BC; MKL-1363), the Subboreal (4600±70 BP cal. 3620-3130 BC; MKL-3738), the Roman Period (2160±90 BP cal. 396 BC-2 AD – MKL-4115; 2130±60 BP cal. 362-3 BC – MKL-2864) and in the last centuries (eg. 320±50 BP cal. 1455-1655 AD; MKL-2863). Alluvia are characterized by significant textural differentiation. They are mainly built from mineral or mineral-organic material, mixed with plant remains or organic derbis, organic deposits are much less often. Biogenic accumulation was disturbed by floods in significant degree. Micromorphological analysis confirmed macroscopic research shows on visible differences in textural features of these deposits, above all by different degree of organic decomposition and variable participation of quartz grains. Palaeochannel alluvia are usually very enriched geochemically, especially rich in macroelements (S, P, Fe). A big content of organic matter, especially in the Eoholocene palaeochannel fill (K4-K5 cross-section) conducive in elements sorption. Fine fraction played also an essential role (eg. K1-B, K21). Flood water also due to enrichment of these deposits in trace elements (eg. K8 profile). In case of the Subatlantic palaeochannel fills a long-lasting human impact played a big role. It marked as an elements increase upward sequence (K1-B).

Alluvial fans deposits were recognized only in 9 profile where homogenic sandy deposits were accumulated. The age of this form is unknown.

Lacustrine deposits were recognized on flood plain area downstream Żarnówka river where in 18th-19th century mill pond in Marcinków existed. Differentiated textural deposits, from sandy with gravels to sandy silts, occur here. Numerous slag inserts (K10 profile) showing on industrial activity of forge, rebuilt in 19th century in water-mill were recognized. These deposits, especially next to dam remains (K10), are characterized by high element concentrations, and sometimes also high values of pH (K23). It shows on human impact on chemistry of these deposits.

On investigated area two phases of buried soil fossilization were distinguished, it means the Roman Period phase (1790±70 BP cal. 80-390 AD; MKL-4116) and the Late Medieval phase (730±90 BP cal. 1150-1420 AD; MKL-1362). They are built mainly from fine deposits, with high content of organic matter. These layers are usually strongly geochemical enriched. It was noticed that younger series (the Late Medieval) has a visible higher elements concentrations than older series (the Roman Period). Human impact influenced at least indirectly on facial and geochemical features of these deposits. Micromorphological analysis is a confirmation of macroscopic research which means that these layers are indeed buried levels. It was stated based on such features as specific microstructure, presence of pores, iron nodules, illuviation processes, organic matter in vary degree of decomposition, extrements, diatoms and phytoliths.

Conclusions

In the structure of flood plain of the upper Kamienna river poligenetic and uneven-aged deposits occur. Channel alluvia, overbank alluvia, alluvial fans deposits and lacustrine deposits were distinguished.

In investigated deposits climate changes and anthropopressure recorded in very different degree.

Climate changes did not leave direct record in facial and geochemical features, and in geochemical properties of palaeochannel fills alluvia. Whereas climate changes are readable in case of the Roman Period and the Late Medieval phase of fossilization which is an often result of frequent flood episodes. Subfossil trees are also essential climatic differentiator for the Roman Period when changes of fluvial activity cause the lateral migration of meandering river which dued to buried trunks in deposits. In

investigated facies the differentiated hydrodynamic conditions led to changes in texture of alluvia (eg. laminae formation, presence of alternating layers with different grain size, presence of plant remains with variable degree of decomposition), but it should not be connected with climate factor, and rather it is a results of meteorological events. Geochemical factors of the most of investigated facies are mainly dependent on natural factors, eg. organic matter content, participation of fine fraction, geological structure, elements mobility. Floods had a big impact on elements distribution that is especially strongly visible in overbank alluvia. Natural factors in elements binding prevailed in case of deposits accumulated since the Late Glacial to the Roman Period, and the significance of these factors distinctly declined in favor of anthropogenic factors in the last centuries. Micromorphological analysis allowed to confirm macroscopic research, connected with textural differences between investigated palaeochannel fills and it allowed to ask the question that dark layers, present in alluvia, are buried soils, not plant remains or dense clusters of iron-manganese concretions. Using this method deposits creating by prevailing impact of sedimentological processes and transformed by postsedimentological and soil-forming processes, were distinguished.

It was not found that human activity of the Prehistoric Time affected on textural, geochemical and micromorphological features of investigated deposits. It shows that flood plain was not inhabited, in opposite to terrace where very numerous the Prehistoric artifacts were found. Only industrial activity of the Old-Polish Industrial Region led to changes of textural and geochemical properties of the youngest deposits. Therefore geochemical features can be stated as age indicator of deposits, accumulated in the last centuries. These deposits are exposed on historical anthropopressure in the most degree.

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