GEOLOGICAL STRUCTURE OF ŚWIŚLINA RIVER VALLEY NEAR DOŁY BISKUPIE (HOLY CROSS MOUNTAINS REGION, POLAND)

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The site is located in the Świślina River valley at Doły Biskupie, downstream from the "Wióry" water reservoir. It is the north-eastern part of the Mesozoic margin of the Holy Cross Mountains, where the Triassic sandstones and shell limestones, marls and clay mudstones are covered with a thick layer of the Pleistocene loess. The relief is dominated by a flat plain (Palaeogene peneplain) that cuts down the age-different structural elements - the Palaeozoic, steep Godów fold, and the highly disturbed Triassic and Jurassic rocks. It is deeply cut by river valleys with terraced bottom, i.e. Świślina river. In its basin, loess areas developed a dense network of gullies and hollow way (Fig. 1).

The Świślina River basin is located in an area where the Prehistoric metallurgy developed (bloomerys), and later, in the Middle Ages and modern times, in the Old Polish Industrial District area. Metallurgy activity was concentrated along many rivers in the Holy Cross Mountains region, including Świślina river, which is confirmed by historical data.

In the studied section, the valley has steep slopes. A two steps are marked in the valley bottom as narrow 4.5-5.5 m high flood plain and a wider terrace raised 9-11 m above the river level (a.r.l)(Fig. 1). Both levels are build of fine-fraction sediments (anthropogenic muds), grain size similar to loess, in which numerous traces of metallurgical activity in the form of slags with a diameter of up to 25 cm were found. These traces indicate very young age and anthropogenic genesis of these sediments accumulation, related to the metallurgy development [5].

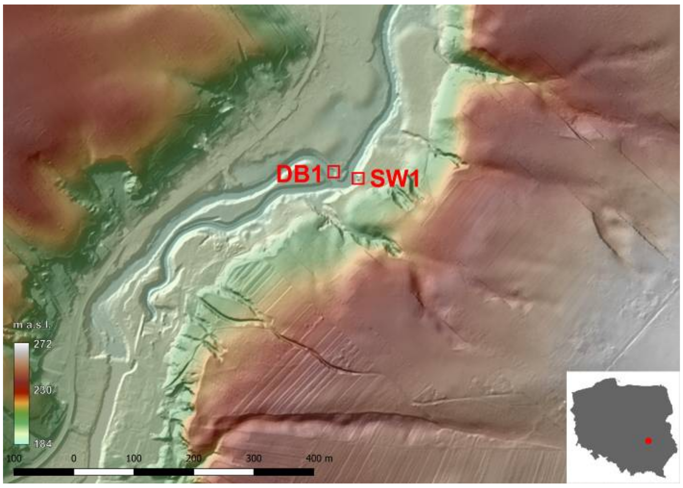

Fig. 1: The location of the study area (DB1 and SW1 profiles) in the DEM map (by K. Żurek)[2]

In 2014 and 2020, a sediment study was undertaken on the site in the left-bank of the flood plain and using specialist mountaineering equipment, in the five-meter exposure of loess on the right slope of the valley undercut by the river (Fig. 2). In addition to the standard grain size analysis by sieve and laser diffraction, the coarsest material was measured using the planimetric method. The geochemical analyzes of the flood plain alluvia were performed on the content of heavy metals such as Fe, as well as the Magnetic Spherule Separation from overbank sediments.

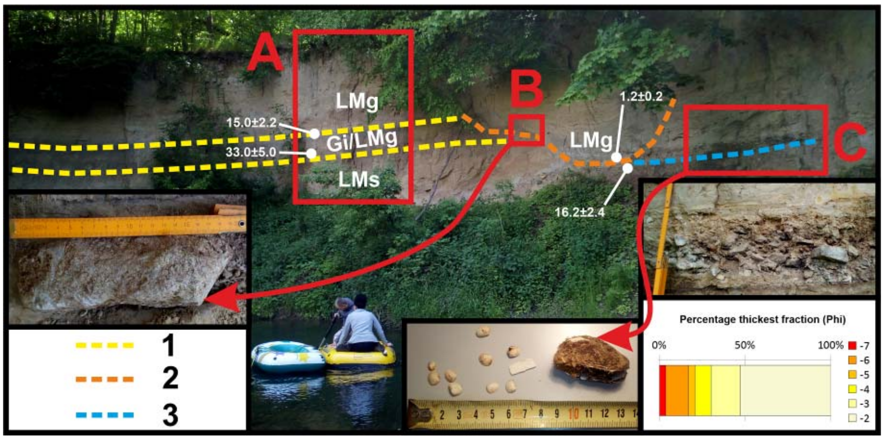

Fig. 2: The SW1 profile (photo P. Przepióra 2020) in right-bank of the river with OSL datings (in ka) 1 - buried soil complex (A) 2 - buried gully filled with loess and limestone boulder in the bottom (B); 3 - lens of non-rounded limestone fragments and malacofauna (C)

The loess outcrop is several meters wide. To the left is a complex of two buried soils (GI/LMg)(33.0±5.0 ka; UJK-OSL-132) with a low organic content separating the two loess series (LMs and LMg). The older one, directly below the buried soil, is finer and decarbonated, which may be related to the development of soil formation processes. The upper series (15.0±2.2 ka; UJK-OSL-131) is more sandy, slightly carbonate, and the carbonate content varies significantly from 0 to 5%. The graining and fluctuations in carbonate content may indicate that this is a sediment series redeposited from the plateau (Fig. 3).

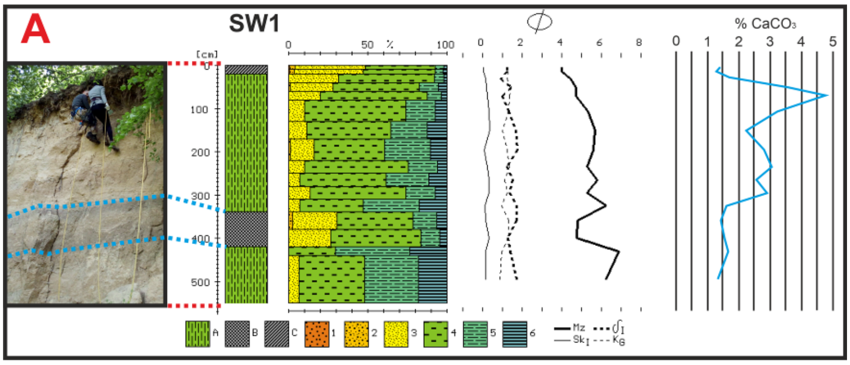

Fig. 3: The SW1 profile (photo P. Przepióra 2020) with the grain size and $CaCO_3$ concentration Lithology: A – loess, B –buried soil complex, C – A-horizon of present-day soil; Fractions: 1 – gravel (below -1φ); 2 – coarse sand (-1–1φ), 3 – medium sand (1–2φ), 4 – fine sand (2–4φ), 5 – coarse and medium silt (4–6φ), 6 – fine silt (6–8φ), 7 – clay (above 8φ); Folk-Ward's grain size distribution parameters: Mz – mean size, δ_I – standard deviation, Sk_I – skewness, K_G – kurtosis

On the right side of the outcrop, a buried gully filled with a series of upper loess (16.2±2.4 ka; UJK-OSL-130) is visible. At the bottom of its filling, there is a sharp-edged 20 cm diameter limestone boulder. In the most extreme, right-site part of the outcrop, at a height of approx. 2 m a.r.l. the lens of non-rounded limestone fragments with a maximum diameter of 10 cm is preserved (1.2±0.2 ka; UJK-OSL-129). This layer is about 25 cm thick, and in its highest part, there are undamaged shells of *Unio* and other species of malacofauna (Fig. 2). The coarse sediments are remnants of catastrophic flows (flash flood) with short redeposition of the material lead to accumulation of i.a. malacofauna shells between the rocks. This layer may be related to the Medieval catastrophic event in the past triggered by basin deforestation during the time of metallurgical activity. It could be connected also with catastrophic flash floods after dam failures are also known from other Holy Cross Mountains river valleys and accumulated very coarse cut and fill alluvial bodies [3], [4] and similar to modern flood that occurred after the „Wióry” water reservoir dam failure in 2001 [1].

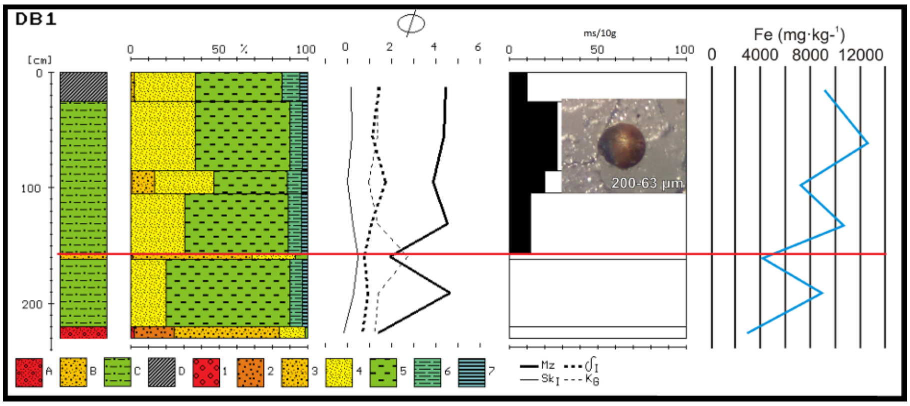

Fig. 4: The DB1 profile with the microslags (iron spherules) concentration (ms/10g - magnetic spherule per 10 g of material). The red box marks the flood layer location
Lithology: A – sands with single gravel, B – medium sands, C – sandy silts, D – soil; Fractions: 1 – gravel (below -1φ); 2 – coarse sand (-1–1φ), 3 – medium sand (1–2φ), 4 – fine sand (2–4φ), 5 – coarse and medium silt (4–6φ), 6 – fine silt (6–8φ), 7 – clay (above 8φ); Folk-Ward’s grain size distribution parameters: Mz – mean size, δ_I – standard deviation, Sk_I – skewness, K_G – kurtosis

In the DB1 profile of the floodplain, on the lag deposits (poorly rounded gravels) there are overbank sediments, silts with an admixture of sands where the numerous microscopic iron balls (spherules) was found (Fig. 4). They occur only in the upper and middle part of the profile, above the distinct sandy flood layer. This confirming that the sediments above were redeposited from the upper part of the catchment where only the Prehistoric and Medieval metallurgical activity was confirmed i.a. large slags in the sediments in the site area [5]. The geochemical analysis of the sediments in this profile showed an increase in the content of elements towards the surface, with the maximum concentration at 25-105 cm depth. This tendency, in particular in the case of iron (Fig. 4) clearly correlates with the presence of microslags, the markers of the Prehistoric and historical industry influence in this area. Increased geochemical accumulation can also be connected with a large share of the fine-grained fraction, influencing the sorption properties of the sediments, and with the reaction determining the migration of individual elements in the profile. Moreover, an inverse relationship was found between the content of the studied metals and the concentration of carbonates. The geochemical changes and microslags are an excellent marker of metallurgical activity and are helpful in the interpretation of the processes, genesis and age of alluvia at the studied site.

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