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THE ORIGIN AND AGE OF SILT DEPOSITS IN THE SANDOMIERZ BASIN

Abstract

The following types of silt deposits were distinguished: 1. Silty covers of periglacial weathering 0.5–2.0 m thick, dated at 15–12.5 ka BP, 2. Deluvial–eolian silty-sandy deposits 4–12 m thick, dated at 34–12.5 ka BP, 3. Submoraine loessified muds up to 10 m thick, dated at ca. 430–570 ka BP, 4. Loesses up to a dozen or so metres thick, accumulated mainly during the Vistulian and Wartanian Glaciations.

Silt deposits cover vast areas in Poland (Fig. 1). They are more widespread than loesses; they occur even in northern Poland within the extent

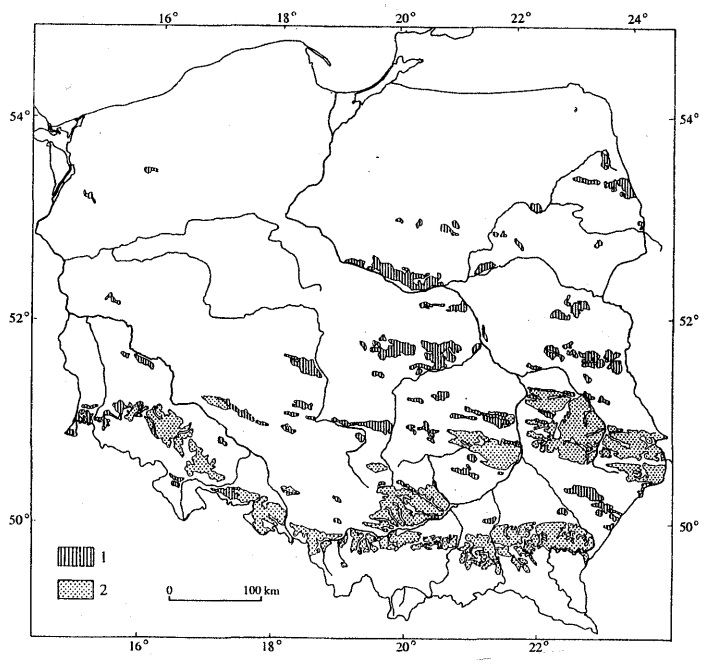

Fig. 1. Distribution of silt deposits in Poland (according to the Map of Polish Soils 1:1 000 000, Wyd. Geol., Warszawa 1974)

1. silts of different origin; 2. loesses and loess-like deposits

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of the Vistulian Glaciation. They are variously named and different origins are attributed to them. Different opinions about their origin are based on some rational data because different genetic types of silt deposits are found. I want to discuss this problem on the example of the Sandomierz Basin.

From among silt deposits in Poland the earliest studied were probably those in the Sandomierz Basin. V. Hilber is considered to be the first who investigated the silt deposits in this region. He defined them as "lossantlicker Lehm" of eolian origin (HILBER, 1882). REHMAN (1891), ŁOMNICKI (1900), MICZYŃSKI (1907) AND BUTRYM (1908) also described these deposits. During the last fifty years, separate papers focusing on them have been published by DOBRZAŃSKI, MALICKI (1949), BUTRYM (1968), BOROWIEC (1974), WOJTANOWICZ (1971), BUTRYM, RACINOWSKI (1983). LASKOWSKA-WYSOCZAŃSKA also expressed her opinion (1971). I mention here only the researchers who worked in the Sandomierz Basin. I take no account of papers dealing with loesses near Przemyśl and Jarosław, and also review papers and cartographic works of different kind and scale in which the silt deposits are mentioned.

The specific distribution pattern of silty deposits in the Sandomierz Basin is shown on the maps (Figs 1, 2); silt deposits occur in the eastern part of the Basin and partially in the central part – between Grodzisko

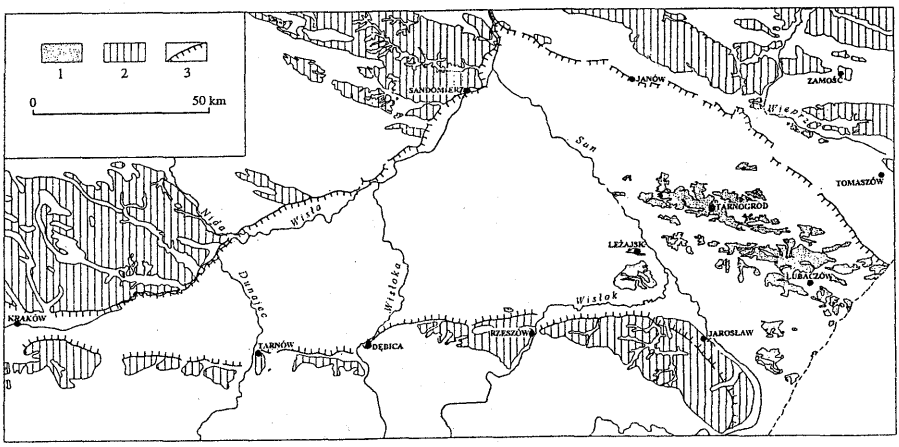


Fig. 2. Distribution of silt deposits in the Sandomierz Basin

1. silt deposits (on the basis of the Survey Geological Map of Poland 1:300 000, modified); 2. loesses; 3. escarpments

and Leżajsk. Why they are distributed in such a manner is a separate question not directly connected with my consideration about their origin. I think that dealing with the problem of silt deposit distribution, one should take into account all the paleogeographical conditions of Basin develop-

ment during the Quaternary, in it the extents of ice sheets, very varied drainage directions and also general geomorphological situation of "silty areas". Especially remarkable is the vicinity of the Roztocze and Carpathians which could have influenced the distribution of the silt deposits in the Basin.

Within the silt deposits in the examined region I distinguish the following genetic types:

1. silty covers of periglacial weathering
2. deluvial-eolian silty-sandy deposits
3. submoraine loessified silty muds
4. loesses

SILTY COVERS OF PERIGLACIAL WEATHERING

Silt deposits occur on the surfaces and slopes of elevations (planation levels) and also on the sandy Pleistocene terrace, forming thin covers (0.5–1 m). Their thickness is usually 0.6–0.7 m, and on slopes it sometimes reaches 1.5–2.0 m. Deposits of this type were examined in central Poland by DYLIK (1951, 1952), and in the Sandomierz Basin by BUTRYM (1968). Silty covers are undoubtedly the most widespread from among the types here discussed of silt deposits. They occur on very different Quaternary deposits: on tills – as for example in the Futory-Dubiki profile, on slope sands – as in the Żmijowiska profile, on glaciofluvial sands and on river sands (Fig. 3; Pl. 1, 2). Transition between silt deposits and underlying sediments is usually gradual, without distinct border.

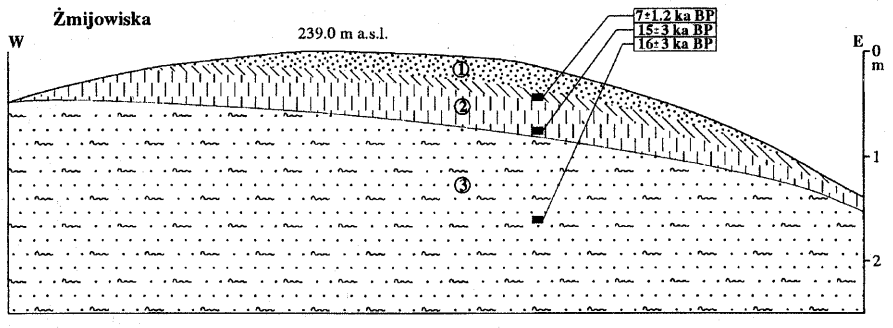
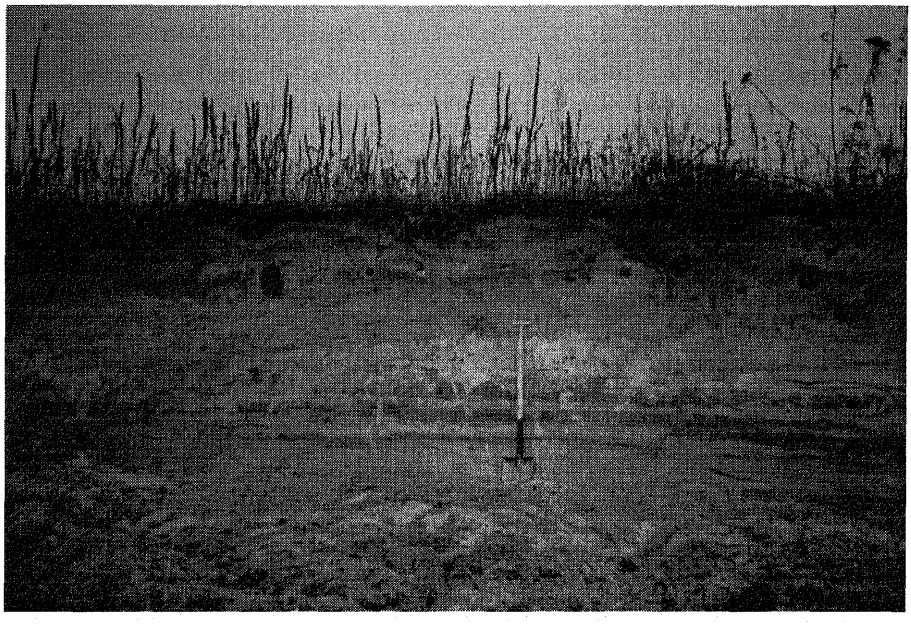


Fig. 3. Profile of the sand-pit at Żmijowiska

1. eolian silty-sandy deposits; 2. silty covers of periglacial weathering; 3. sandy-silty slope deposits with rhythmic bedding. Subfossil humus horizon is marked by diagonal hachure

Lithological features of the silt deposits are rather differentiated. BUTRYM (1968) distinguished (according to the soil classification) the following lithological types: silt-like formations, silt formations, clayey silt



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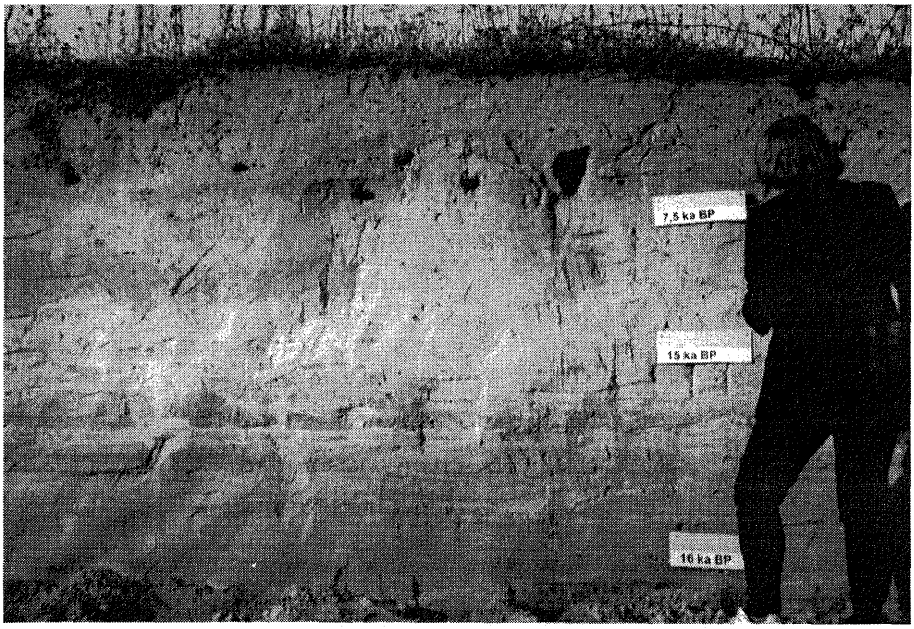
Pl. 1. Profile of the sand-pit at Żmijowiska; general view



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Pl. 2. Part of the Żmijowiska profile; silty covers with the TL datings

formations, silty sands and silty loams. Average content of the "loessy" silt fraction 0.02–0.05 mm is 28%. According to R. L. FOLK and W. C. WARD indices, the silt deposits analysed in the Futory-Dubiki and Żmijowiska profiles are weakly sorted (δ_1=1.30; 1.42), with positive skewness (Sk_1=0.13; 0.20) and very leptocurtic distribution (K_G=2.29; 2.58).

Just as DYLIK (1951, 1952), I relate the origin of these silt deposits with rock weathering in periglacial conditions. Specific loess-like deposits were formed as a result of frost degradation process. I had a possibility to study such kinds of deposits on Spitsbergen and I found this process to be very common and effective.

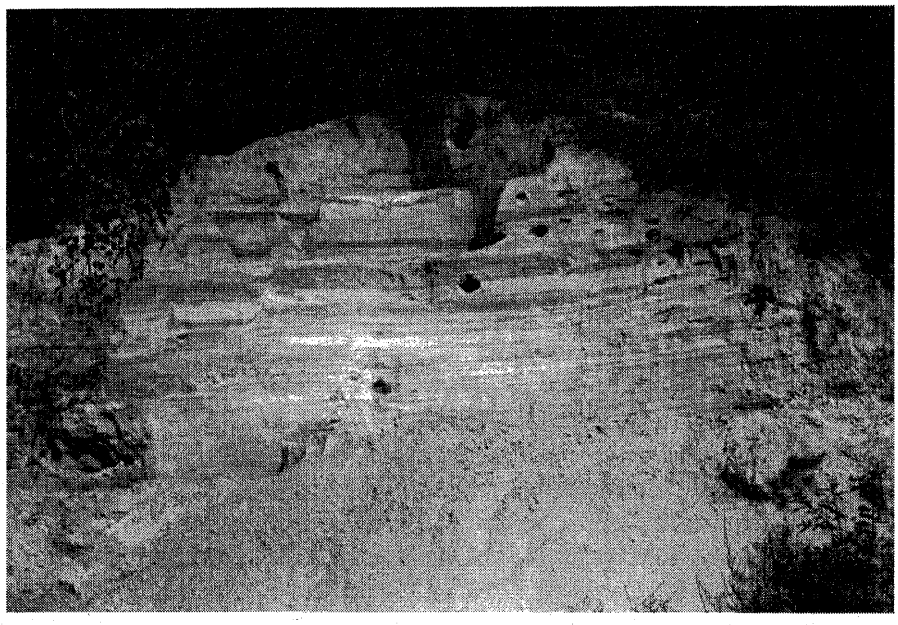
Taking into account the origin and conditions of occurrence of silt deposits, I can consider their age. They were undoubtedly accumulated in the Pleistocene, during the final phase of the last glaciation, because they covered the Pleistocene terrace which had been finally formed in the Vistulian. Certainly they belong to the youngest Pleistocene deposits; only sands of inland dunes can be younger. Inland dunes in the eastern part of the Basin (in the catchments of the Lubaczówka and Szkło rivers) contain a lot of silt fraction, even over 30% (WOJTANOWICZ 1970). They can be named silty dunes built of silt formations according to soil classification (in the Nowa Grobla dune on the Lubaczówka river the M_z = 3.10–3.14φ). The silty material occurring in dunes could derive from the here discussed silty covers. Therefore, the lithology of dunes is the next data defining the age of the silt deposits.

The TL dating of the silty cover in the Żmijowiska profile (15 ka BP) probably determines the beginning of its formation period. The end of this period corresponded to the start of the dune forming process at 12.5 ka BP. Thus, the silty covers were probably accumulated between 15 and 12.5 ka BP.

DELUVIAL-EOLIAN SILTY-SANDY DEPOSITS

So far these deposits have not been distinguished in the Basin or wrongly identified with loesses. However, they are neither loesses nor the silty covers discussed above. They are 4–10 m thick and characterized by distinct stratification typical for slope deposits with rhythmic bedding (silty and sandy layers). Apart from different grain size, the rhythmic bedding is expressed by different colours: lighter layers are yellow and darker – brown. These deposits are decalcified or with very small carbonate contents. In the vertical section something like erosional surfaces can be seen, and also remains of soils, soil sediments or only horizons with plant vegetation traces.

These deposits were found in the Radruż profile, in the Młodów profile near Lubaczów, in the Grodzisko Dolne profile, in the environs of Leżajsk



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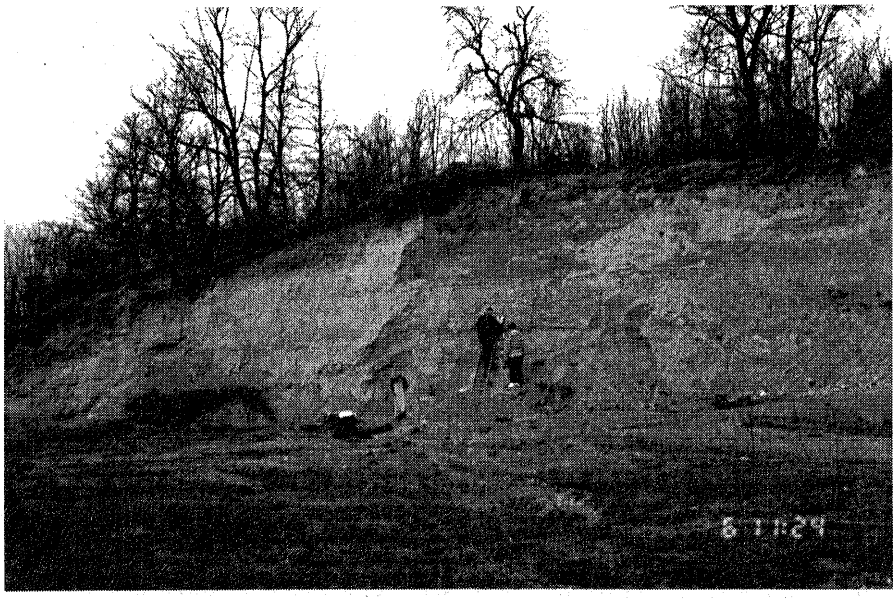
Pl. 3. Profile of the deluvial-eolian silty-sandy deposits at Radruż; dune sands from the top to a depth of 1.2 m



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Pl. 4. Profile of the deluvial-eolian silty-sandy deposits at Grodzisko Dolne; TL datings at white plates: top one – 18 ± 4 ka BP, bottom one – 25 ± 5 ka BP

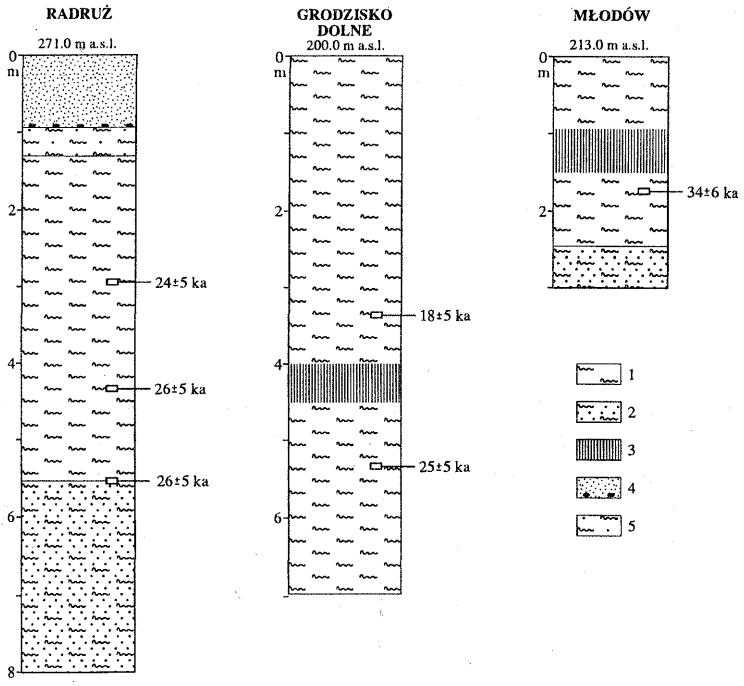


Fig. 4. Profiles of the deluvial-eolian silty-sandy deposits

1. silty-sandy deposit; 2. sandy-silty deposit; 3. soil horizon; 4. dune sand with denudation gravel pavement; 5. loamy sand

and Tarnogród (Fig. 4; Pl. 3, 4). Near Grodzisko and Leżajsk the ravines developed within these deposits.

On the basis of granulometric analysis the discussed deposits from the Radruż, Młodów and Grodzisko Dolne profiles can be recognized as silt formations. However, they have rather differentiated granulometric indices: $M_z = 3.10 - 4.46\varphi$; $\delta_1 = 0.55 - 1.99$, $Sk_1 = -0.41 - (0.41)$, $K_G = 0.91 - 5.56$.

The occurrence on the sides of valleys and slopes of plateaux as well as the structure and texture, indicate that these are slope deposits. Their other features, such as large content of silt and low compactness (these are loose deposits), point to the activity of the eolian factor – so they are considered to be of deluvial-eolian origin. However, these deposits are even more poligenetic because silt material was prepared by periglacial frost weathering of protogenetic and syngenetic character. Silt determines the loess-like character of the deposits. They are similar to the silty loess-like deposits described by TURKOWSKA (1996) in the environs of Łódź. They can be of the same origin and probably the same age. The TL datings of the deluvial-eolian deposits in the Sandomierz Basin indicate that they were formed during the Plenivistulian and Late Vistulian, just as

the deposits near Łódź. In the two most representative exposures in the Basin, the discussed deposits were dated at 26 ka BP and 24 ka BP (at Radruż), and at 25 ka BP and 18 ka BP (at Grodzisko Dolne). In the other exposure (at Grodzisko Miasto, in ravine) a sample taken from the depth of 3.5 m was dated at 12.5 ka BP. In the Młodów profile the paleosol (probably from the Denekamp) occurs over the deposit dated at 34 ka BP. Therefore, the age of the TL dated deposits is comprised between 34 and 12.5 ka BP.

SUBMORAINE LOESSIFIED SILTY MUDS

These deposits are rather common in the Sandomierz Basin. The muds were accumulated in the Pleistocene lakes or ice-marginal lakes. They occur mainly under tills which confirms that their origin was connected with glaciations of the area. It was evidenced in the profiles at Giedlarowa, Hucisko, Krzeszów, Futory-Dubiki (Fig. 5, 6; Pl. 5. 6), and in many bore profiles carried out for the Detailed Geological Map of Poland 1:50000, some sheets of it were published. The variable thickness of muds reaches 10 m and more. In the environs of Hucisko near Leżajsk they are exposed in a vast area and exploited in many brick-yards. A thin cover of glaciofluvial sands and tills overlies the muds only in places.

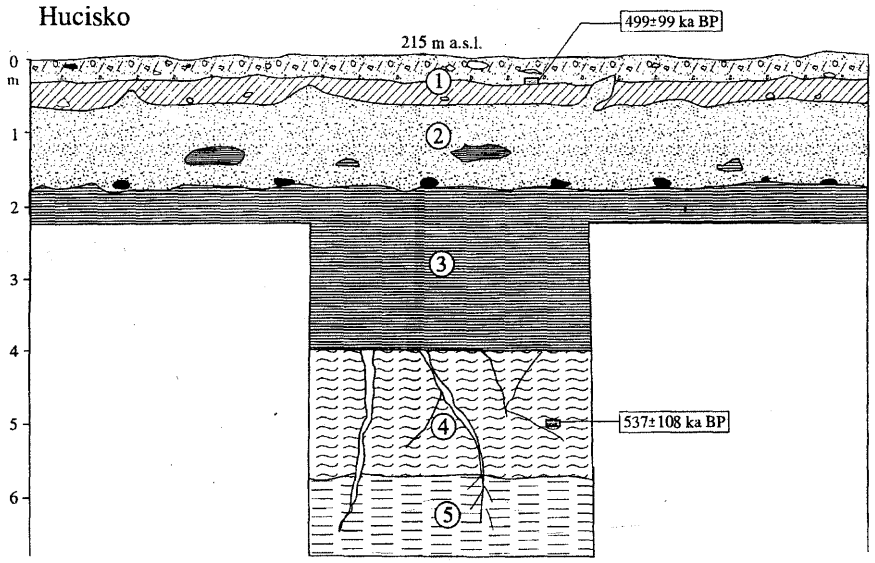
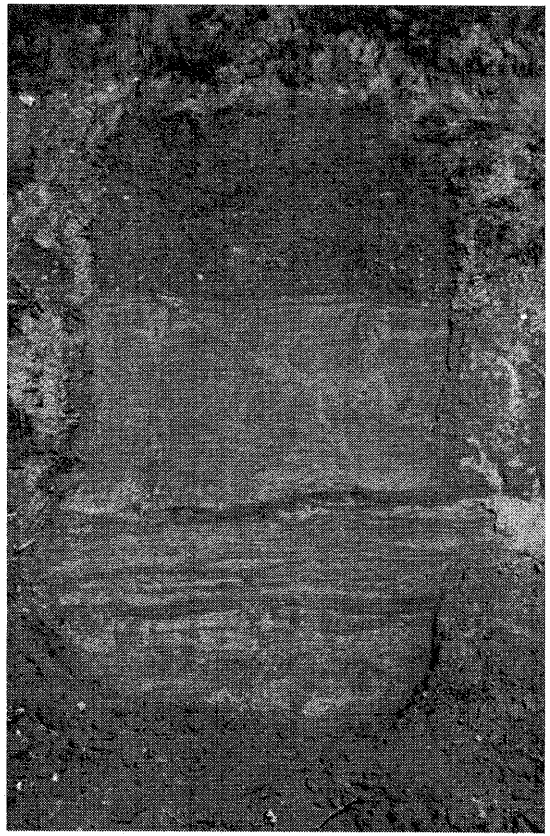


Fig. 5. The Hucisko profile with loess-like muds (TL dated at 573±108 ka BP) under till and varved clays

1. till, sandy at the top, weathered, with great amount of gravels; 2. medium-grained sands, in the lower part with the detached blocks of varved clays, with gravels at the bottom; 3. grey varved clays; 4. loess-like muds with ice wedges; 5. clays



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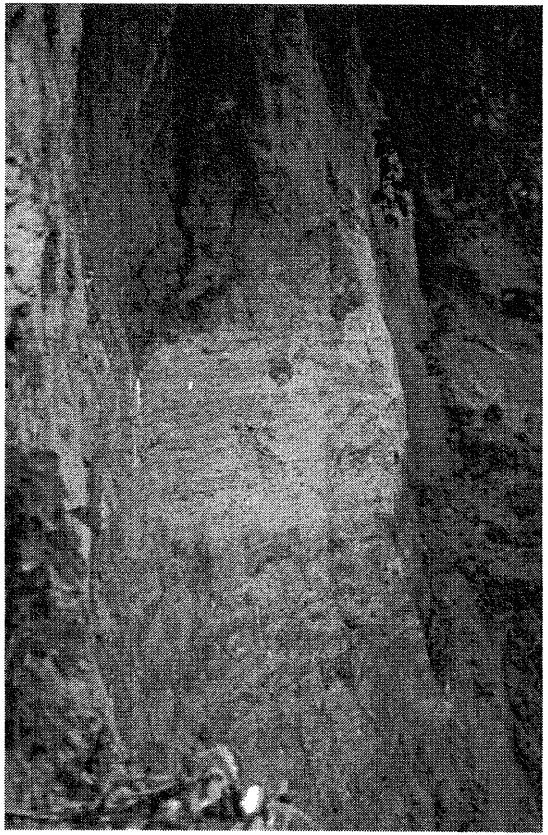
Pl. 5. Part of the profile of the submoraine silty muds at Hucisko; varved clays over the bipartite mud layer



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Pl. 6. Profile of the submoraine muds at Krzeszów

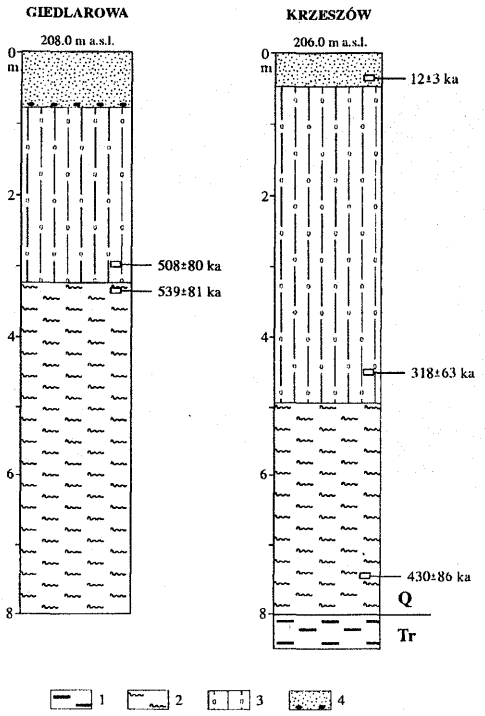

Fig. 6. Profiles with the submoraine loessified silty muds

1. Krakowiec clays (Tertiary); 2. silty muds; 3. till; 4. medium-grained sand.

On the basis of granulometric analysis results, these muds can be defined as clayey silt formations or silt formations. The content of "loessy" fraction 0.05–0.02 mm is high (40–50%), and mean grain diameter M_d is 0.010–0.018 mm. Granulometric indices according R. L. FOLK and W. C. WARD are the following: $M_z = 5.82-6.65\varphi$; $\delta_1 = 2.14-3.04$; $Sk_1 = 0.43-0.47$; $K_G = 1.29-2.15$. Thus, the discussed deposits are very weakly sorted, with very positive skewness, and leptocurtic or very leptocurtic distribution.

In comparison with loesses the muds are much more weakly sorted and contain much more of the clay fraction and more of the sandy fraction. They are loessified, with a typical yellowish colour. The material of the muds was undoubtedly affected by periglacial frost weathering. However, it is difficult to recognize if it happened before or after sedimentation.

The age of the muds results from their name – "submoraine muds". They were TL dated in the Giedlarowa profile at 539–560 ka BP, in the Hucisko profile at 573 ka BP, and in the Krzeszów profile at 430 ka BP. In the whole area of the Basin such muds could be probably connected with several glacial periods so their age could range within several hundred thousand years.

LOESSES

Loess, i.e. the subaerial eolian deposit occurs in the southern periphery of the Sandomierz Basin – near the Carpathians. It is the so-called Piedmont Loess Plateau which forms the belt parallel to the Carpathian margin from Dębica to Przemyśl. Thickness of the loess ranges from 2 to 15 m, and sometimes it reaches 20 m. Different relief forms are covered by the loess, in it the Pleistocene middle terrace of the San river valley between Przemyśl and Jarosław, which is called the loess terrace – it is visible in the loess profile at Buszkowice (ŁANCZONT 1994, 1995). The Vistulian loess at Buszkowice contains 35–47% of the "loess" fraction and is characterized by the following granulometric indices: $M_z = 5.59-5.74$; $\delta_I = 2.18-3.23$; $Sk_I = 0.45-0.54$; $K_G = 1.32-2.03$. It is a carbonate loess with a $CaCO_3$ content up to 9.7%.

In the central part of the Basin the loess occurs as one loess patch near Krzeszów (WOJTANOWICZ 1971). It is the Vistulian loess of a thickness up to 8 m, with a content of the "loess" fraction ranging from 43 to 47% and characterized by the following granulometric indices: $Mz = 4.85-5.40\varphi$; $\delta_I = 1.78-1.89$; $Sk_I = 0.30-0.35$; $K_G = 1.57-1.87$. It is a carbonate loess; the $CaCO_3$ content ranges from 6 to 8%. I do not agree with the opinion of LASKOWSKA-WYSOCZAŃSKA (1971) about the occurrence of loess between Grodzisko and Leżajsk. These are loess-like deposits – as it was formerly found by DOBRZAŃSKI and MALICKI (1949). In my opinion these are deluvial-eolian silty-sandy deposits, and in places silty covers and submoraine lessified muds.

The age of the loess is differentiated. The loesses occurring in the San river valley were formed during the Vistulian and Middle Polish Glaciations – mainly the Wartanian. Outside the San river valley, loesses from the older glacial cycles can also occur.

Translated by M. Wilgat

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