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# Loess-like silts in the Beskid Mały and Beskid Makowski Mountains, Western Outer Carpathians

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Among the Quaternary deposits of the Beskid Mały and Beskid Makowski Mts. in southern Poland, loess-like silts occurring in the Skawa River valley and the Paleczka River valley are distinguishable by their high loess index values as well as by the presence of amphibole grains and by notable amounts of biotite grains. These silts originated by aeolian sedimentation during the younger Pleniglacial of the Vistulian, corresponding to the Younger Upper Loess. The amphibole and most of the biotite was derived from deflation of a glaciofluvial cover in the Carpathian forelands and Fore-Carpathian basins. They indicate the importance of northern winds in the Plenivistulian atmospheric circulation.

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Key words: Western Outer Carpathians, Quaternary, loess-like silts, stratigraphy.

## INTRODUCTION

Previous references dealing with loess-like deposits of the Beskid Mały and Beskid Makowski Mts. in the Western Outer Carpathians comprise only a single note of Klimaszewski (1948) on a loess layer. It was 60 cm thick, mantled gravels and sands of the Pleistocene alluvial cone of the Jaszczurówka Stream in the Skawa River valley between Świnna Poręba and the outlet of this valley from the Beskid Mały Mts. (Fig. 1), and lay 22 m above the present valley floor.

In the adjacent foreland regions i.e. the Śląskie and Wielickie forelands, information on loess-like deposits is significantly more abundant. These deposits were described in the vicinity of Kęty (Jahn, 1952; Butrym *et al*., 1988), at Wadowice (Sobolewska *et al*., 1964; Grzybowski and Bińka, 1997) and at Harbutowice (Grabowski, 1999); they usually contain less of the loess fraction (0.02–0.05 mm) than does a typical loess in Central Poland, but more than do associated solifluction and deluvial deposits. According to Butrym *et al.* (1988) and Grabowski (1999), the loess indices (Nowak, 1981) in the foreland loess are comparable with the values recorded in the loess of Central Poland.

The mineralogy of the loess-like deposits in the Śląskie and Wielickie forelands has also been analysed. Citing the heavy minerals analyses of Krysowska-Iwaszkiewicz, Starkel (*cf*. Sobolewska *et al.*, 1964) noted that the loess-like loam in the uppermost western slope of the Skawa River valley near the Wadowice cemetery contains fewer garnets than the weathered flysch sandstones in the lower part of the same section. Moreover, this loess-like loam contains some amphiboles (4%) and chlorite (3%) which are "almost absent" from the flysch, as well as scarce grains of other minerals (sillimanite, disthene) which are entirely absent from the flysch. Dr. Bogusław Bagiński (pers. comm.) has observed that at Wadowice–Łazówka amphiboles constitute 4–5% of heavy minerals of the loess-like silt. In the Harbutowice borehole (Grabowski, 1999), the amphibole grains occur only in the loess-like silts or in related deposits.

Some authors have recorded very scarce amphiboles in the Carpathian flysch rocks, but according to the most credible mineralogical studies (Krysowska-Iwaszkiewicz and Unrug, 1967; Szczurowska and Tomaś, 1985) these minerals are missing from the Subsilesian, Silesian and Magura Series of the Western Outer Carpathians. Thus the amphiboles in the loess seem to be of allogenic origin. Palaeogeographic studies of the Polish Carpathians (Starkel, 1972; Zuchiewicz, 1987) suggest that these amphiboles could not be derived from the Tatra crys-

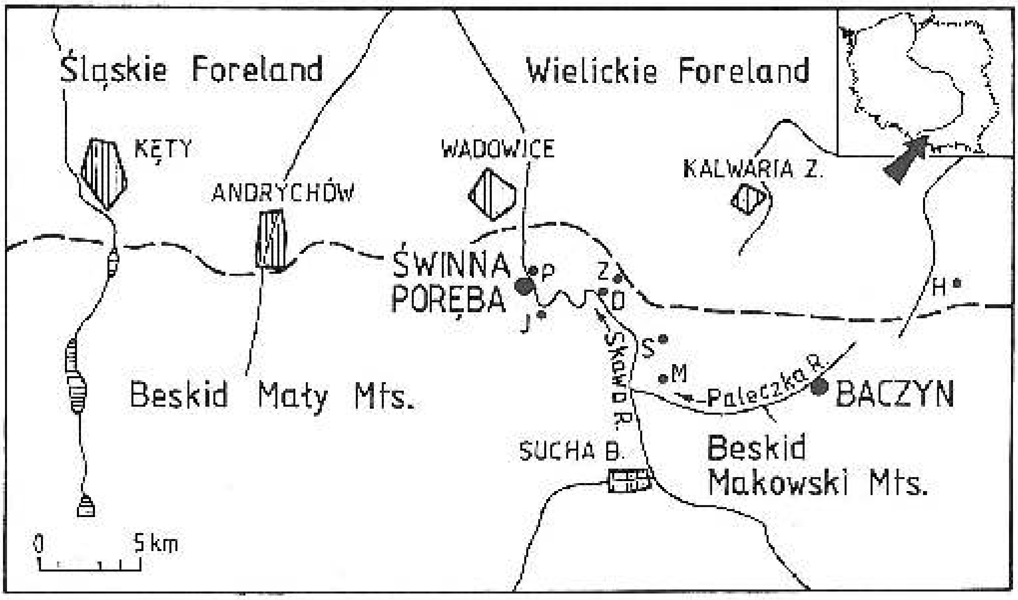


Fig. 1. Location of the sections of Świnna Poręba and Baczyn described in the text and of other sites mentioned in this paper

D — Dąbrówka, H — Harbutowice, J — Jaszczurówka stream alluvial cone, M — Marcówka, P — Świnna Poręba — nearby sites, S — Sosnówka, Z — Zagórze

talline massifs and therefore their source might be connected with glaciofluvial deposits of Scandinavian provenance covering the Carpathian forelands and Fore-Carpathian basins, with transport of the mineral grains subsequently by wind. A similar source and mode of transport was suggested by Grabowski (1999) for the increased biotite content and presence of epidote in the loess-like deposits at Harbutowice.

In these foreland sites the loess-like deposits are related to the Vistulian; therefore they are an equivalent to the Younger Loess (*sensu* Maruszczak, 1991). In the Skawa River valley side at Wadowice, Starkel (*cf.* Sobolewska *et al.*, 1964) determined only a single layer of "a loess-type deposit" (located in the uppermost part of the section) and referred it to the Late Glacial. In the Wadowice–Łazówka section, Grzybowski and Bińka (1997) also described a layer of loess-like silts in the uppermost part of the section but related to the younger Pleniglacial, therefore corresponding to the Upper Younger Loess; however, some traces of loess-forming processes were also found in the Interpleniglacial deposits. At Harbutowice, Grabowski (1999) described similar loess-like deposits related to the younger Pleniglacial, but further down, below the Interpleniglacial deposits, there are other loess-like silts related to the older Pleniglacial, therefore corresponding to the Lower Younger Loess.

## LOESS-LIKE SILTS IN THE SKAWA RIVER VALLEY

At Świnna Poręba, roughly 2 km south from where the Skawa River valley leaves the Beskid Mały Mts., there is a recently studied section of the Quaternary deposits (Fig. 2). The bottom surface of these deposits (18 m above the present Skawa River) is considered as an erosional socle, cut in the Lower Istebna beds (I) by the Skawa River during the Early Glacial of the Vistulian (Grzybowski and Śniadek, 1997). This socle is overlain by the following Quaternary deposits:

1. Alluvial gravels, sands and silts deposited in the Skawa River channel during the Early Glacial.

2. Silts, peaty silts and sands laid down in an oxbow lake; palaeobotanical data, especially the presence of *Picea omoricoides*, indicate that these deposits are related to the Brörup Interstadial (Grzybowski and Śniadek, 1997; Bińka and Grzybowski, 1999).

3. and 4. Silts and loams containing locally sandstone debris; these are probably connected with Plenivistulian washout and solifluction.

The alluvia (1) and oxbow-lake deposits (2) have been described (Grzybowski and Śniadek, 1997; Bińka and Grzybowski, 1999) and only their heavy minerals composition needs to be compared with that of the younger deposits, and that of the flysch. The absence of garnet in the weathered Lower Istebna beds (Table 1, sample 1) is most probably connected with a relatively low content of this mineral in the non-weathered rock, whereas the high content of garnet in the alluvial sand (Table 1, sample 2) indicates that the Skawa River then eroded other flysch rocks, in which these minerals were more abundant, e.g. the Middle Godula or Krosno beds. A clayey silt in the uppermost part of the oxbow-lake deposits (Fig. 3, complex A, sample 3) has a mean grain diameter of *Mz* = 6.3 $\phi$, a standard deviation of $\delta_I$ = 3.6 and a very low loess index of *L* = 0.4.

The oxbow-lake deposits are cut by a denudational surface and overlaid by sandy loams that contain an increasing upward amount of local (Lower Istebna) sandstone debris (Fig. 3, complex B). There is thus an increased content of coarse material in samples 4–6 (Fig. 3) and an increase in standard deviation (from 2.9 to 5.1); loess indexes are similar to or even lower than in the underlying silt. A mineralogical analysis of sample 4 has

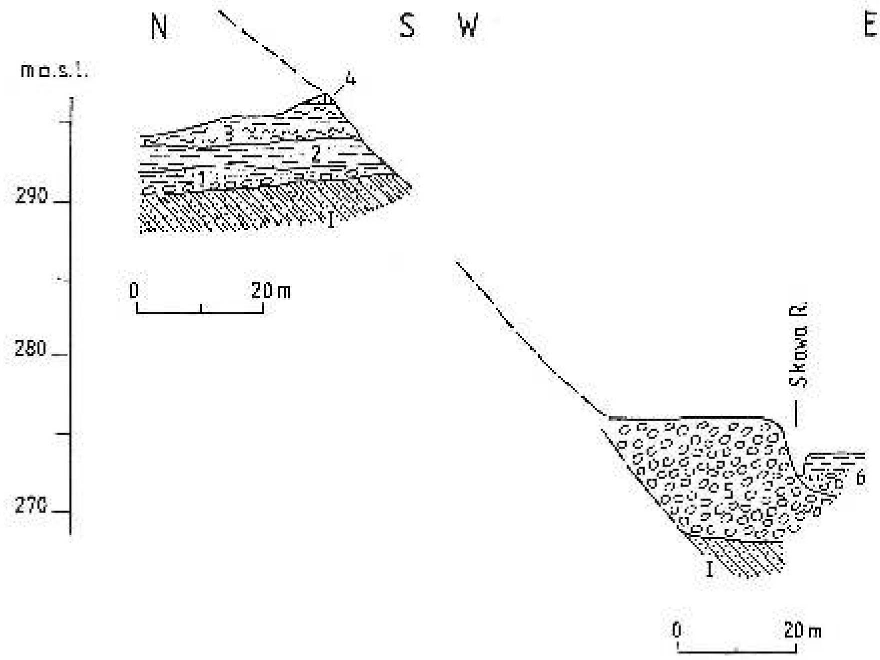


Fig. 2. Simplified geological cross-section of the Skawa River valley left slope and floor at Świnna Poręba

I — sandstones, mudstones and shale of the Lower Istebna beds (Cretaceous), 1 — alluvial gravels, sands and silts (Early Vistulian), 2 — silts, peaty silts and sands of an oxbow lake (Brörup Interstadial), 3 — solifluctional and deluvial loams and silts (Plenivistulian), 4 — loess-like silts (Younger Pleniglacial), 5 — alluvial gravels (Younger Pleniglacial, Late Glacial, Holocene), 6 — alluvial gravels, sands and silts (Holocene)

revealed a low content of garnets and biotite as well as a lack of amphiboles (Table 1). These features of the complex B deposits are unequivocal evidence for minor transport of local, disintegrated material, most probably by solifluction; with the increasing intensity of frost disintegration, this coarser debris was transported.

These soliflucted loams are overlaid by the deposits of complex C, comprising a 10 cm-thick sandy loam layer (sample 7) and a 50 cm-thick clayey silt layer (sample 8). The mean grain diameter is 3.7 ϕ in the loam, 60 ϕ in the silt, with standard deviations of 2.9 and 3.4, and loess indices of 0.8 and 0.2 respectively. In sample 8, the proportion of garnets (21%) is the largest in the entire profile; as in sample 4, biotite is not abundant and amphiboles are absent.

Both the loam and the silt are deluvial deposits. The loam was deposited by initial intense washout acting on nearby vari-grained solifluction covers. The overlying silt material gives evidence of less intense washout; it comes most probably from garnet-rich rocks (Upper Istebna of the Middle Godula beds, *cf.* Krysowska-Iwaszkiewicz and Unrug, 1967) located in a higher part of the valley slope.

These deluvial deposits are overlaid by two loam layers of complex D containing local debris, altogether 50 cm thick. A complete grain-size analysis was made only of the lower layer (sample 9: $Mz = 4.5$ ϕ, $\delta_I = 3.8$, $L = 0.4$), but the upper layer includes more debris (even more than in sample 6). Therefore complex D, like complex B, is coarsening upwards succession. Similarly, garnets are not abundant in the lower layer of complex D (Fig. 3, sample 9) which also contains neither biotite nor amphiboles. These similarities suggest that deposits of complex D are also solifluctional.

The uppermost complex E of this section comprises a sandy-clayey silt, 75 cm thick. The mean grain diameter of this silt (sample 10: 6.9 ϕ) is slightly smaller than in the deluvial silt of sample 8, because of a smaller sand fraction content (9.5% — the lowest in the entire section). The standard deviation of 3.1 is similar to that of samples 4 and 7. This silt differs from the deposits below mainly by its relatively high loess index (Fig. 3) of $L = 1.7$. Moreover, among its heavy minerals (Fig. 3, sample 10), the garnet content is low (as in sample 9), while the biotite content is nearly ten times higher than in samples 4 and 8, and the amphiboles (lacking in the lower complexes) make up 2.1% of the heavy minerals content.

The location of the studied section, not far from the southern limit of the foreland (Fig. 1) suggests that, as in the foreland, the amphiboles and the increased biotite content in the complex E are evidence of aeolian transport from exposed glaciofluvial deposits containing Scandinavian material. There is striking correspondence of grain-size and mineralogical properties: sample 10, the only one in the studied section bearing amphiboles and a markedly higher biotite amount, is also the only one with a loess index higher than 1. In the weathered flysch rocks sampled in the vicinity of the profile described (Table 1, samples 11–13) amphiboles are entirely absent and the biotite content constitutes only 0.9–1.6% of the heavy minerals. A silt from complex E in the Świnna Poręba section might therefore be a typical aeolian loess or a slope deposit. There are no arguments in favour of the second explanation (i.e. no traces of a primary deposit), but it is difficult to reject completely; for this reason, deposits of this kind have been called loess-like silts in this paper and not simply loesses.

Table 1

**Quantitative percentages of heavy minerals in the Quaternary deposits of the Beskid Mały and Beskid Makowski Mts. (analyses of the 0.063–0.1 mm fraction, conducted by B. Bagiński)**

| Sample number and location (*cf.* Fig. 1) | Garnet | Tourmaline | Zircon | Monacite | Biotite | Amphibole | Epidote | Titanite | Staurolite | Rutile* | Non-transparent |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Świnna Poręba section: | | | | | | | | | | | |
| 1 | – | 3.2 | 4.4** | – | 2.4 | – | – | – | – | 51.0 | 39.0 |
| 2 | 19.9 | 1.8 | 6.6 | 2.7 | 0.6 | – | – | – | – | 48.0 | 20.4 |
| 4 | 1.8 | 8.4 | 1.9 | – | 1.9 | – | – | – | – | 66.9 | 19.1 |
| 8 | 21.0 | 11.6 | 6.3 | 3.2 | 2.1 | – | – | – | – | 45.6 | 10.2 |
| 9 | 5.2 | 4.1 | 9.0 | 3.7 | – | – | – | – | – | 70.9 | 7.1 |
| 10 | 3.5 | 4.0 | 7.2** | – | 18.5 | 2.1 | – | – | – | 25.7 | 39.0 |
| Sites between Świnna Poręba and Baczyn sections: | | | | | | | | | | | |
| 11. Świnna Poręba (P) | 29.5 | 6.0 | 3.4 | – | 0.9 | – | – | – | – | 48.3 | 10.0 |
| 12. Dąbrówka (D) | 2.8 | 4.5 | 4.1** | – | 1.3 | – | – | – | – | 63.0 | 24.3 |
| 13. Sosnówka (S) | 0.7 | 5.5 | 4.2** | – | 1.6 | – | – | – | – | 71.0 | 16.0 |
| 14. Jaszczurówka (J) | 7.0 | 4.3 | 9.6** | – | 6.1 | – | – | – | – | 14.0 | 59.0 |
| 15. Jaszczurówka (J) | 7.1 | 9.5 | 2.7** | – | 16.7 | 4.8 | 2.2 | – | – | 17.0 | 40.0 |
| 16. Świnna Poręba (P) | 6.8 | 4.2 | 11.3 | 4.3 | 8.9 | 1.3 | 0.7 | – | – | 15.5 | 47.0 |
| 17. Zagórze (Z) | 18.7 | 5.8 | 7.1** | – | 3.9 | – | – | – | 0.5 | 9.0 | 55.0 |
| 18. Marcówka (M) | 1.0 | 5.6 | 2.1 | 0.8 | 2.7 | 1.8 | – | 1.0 | – | 69.2 | 15.8 |
| Baczyn section: | | | | | | | | | | | |
| 19 | 14.9 | 9.0 | 6.0** | – | 9.6 | – | – | – | – | 26.0 | 34.5 |
| 22 | 3.8 | 7.0 | 8.2** | – | 16.0 | 2.5 | 1.5 | – | – | 19.0 | 42.0 |
| 23 | 16.2 | 3.6 | 6.3** | – | 13.0 | 0.8 | 1.7 | – | – | 16.0 | 40.0 |
| 26 | – | 2.4 | 3.6** | – | 23.5 | 4.3 | 3.2 | – | – | 15.0 | 48.0 |

Geological position of the sampled deposits: 1 — Lower Istebna beds weathering cover, 2 — alluvial sand, 4 — lower solifluctional loam, 8 — deluvial loam, 9 — upper solifluctional loam, 10 — loess-like silt; 11 — Middle Godula beds weathering cover, 12 — Ropianka beds weathering cover, 13 — Magura beds weathering cover, 14 — alluvial silt, 15 — loess-like silt, 16 — Skawa River 6 m terrace sands, 17 — Skawa River 6 m terrace sands, 18 — loess-like silt; 19 — alluvial silt, 22 — lower loess-like silt, 23 — solifluctional loam, 26 — upper loess-like silt; * — rutile together with spinnels and semi-transparent oxides; ** — zircon together with monacite; the mineralogy of the samples 3, 5, 6 and 7 at Świnna Poręba (Fig. 3) and 20, 21, 24 and 25 at Baczyn (Fig. 5) was not analysed

In the case described there is no doubt that the former deposits containing Scandinavian material lay north of the loess-like silts site. Thus the loess-forming winds blew from the north. Because of the submeridional orientation of the Skawa River valley between Świnna Poręba and Wadowice (Fig. 1), those winds did not meet any major orographic obstacles.

Thus the earlier interpretation, relating all the deposits younger than the oxbow silts (B–E) to solifluction (Grzybowski and Śniadek, 1997) needs some modifications: the profile also comprises deluvial and loess-like deposits. The new data presented in this paper, indicate that the lower solifluctional loams (B) can be referred to the older Pleniglacial, the deluvial loams and silts (C) to the Interpleniglacial and the upper solifluctional loams (D) and the loess-like silts (E) to the younger Pleniglacial[1]. Alternatively, all these slope deposits might be connected only with the (younger?) Pleniglacial. However, traces of illuvial processes found in the lower solifluctional loams seem to justify the first explanation.

[1]The loess occurring at the mouth of the Ponikiewka stream, mentioned by Klimaszewski (1948), cf. supra, could have a similar stratigraphical position.

Roughly 2 km southward of the Świnna Poręba profile, in the silts interbedded with the gravels of the alluvial cone of the Jaszczurówka Stream (tributary to the Skawa River) described by Grzybowski and Śniadek (1999), amphiboles are lacking while biotite constitutes 6% of the heavy minerals (Table 1, sample 14). At the same site, in the loess-like silts overlying the gravels (sample 15), the amphibole content reaches 5% and the biotite content 17% of heavy minerals; the appearance of epidotes here is significant.

In the 6 m terrace deposits at Świnna Poręba (Table 1, sample 16 collected roughly 500 m south of the profile described) amphiboles that constitute 2% of the heavy minerals might come from erosion of loess-like deposits. A lack of amphiboles in the lowest terrace deposits (Table 1, sample 17) might have been caused by rapid disintegration of these unstable minerals.

## LOESS-LIKE SILTS IN THE PALECZKA RIVER VALLEY

Loess-like silts have also been recognised in the Beskid Makowski Mts., in the Paleczka River valley (Figs. 1 and 4) at Baczyn. The location of the Baczyn site resembles that of the site at Świnna Poręba, only 2.5 km south from the Wielickie

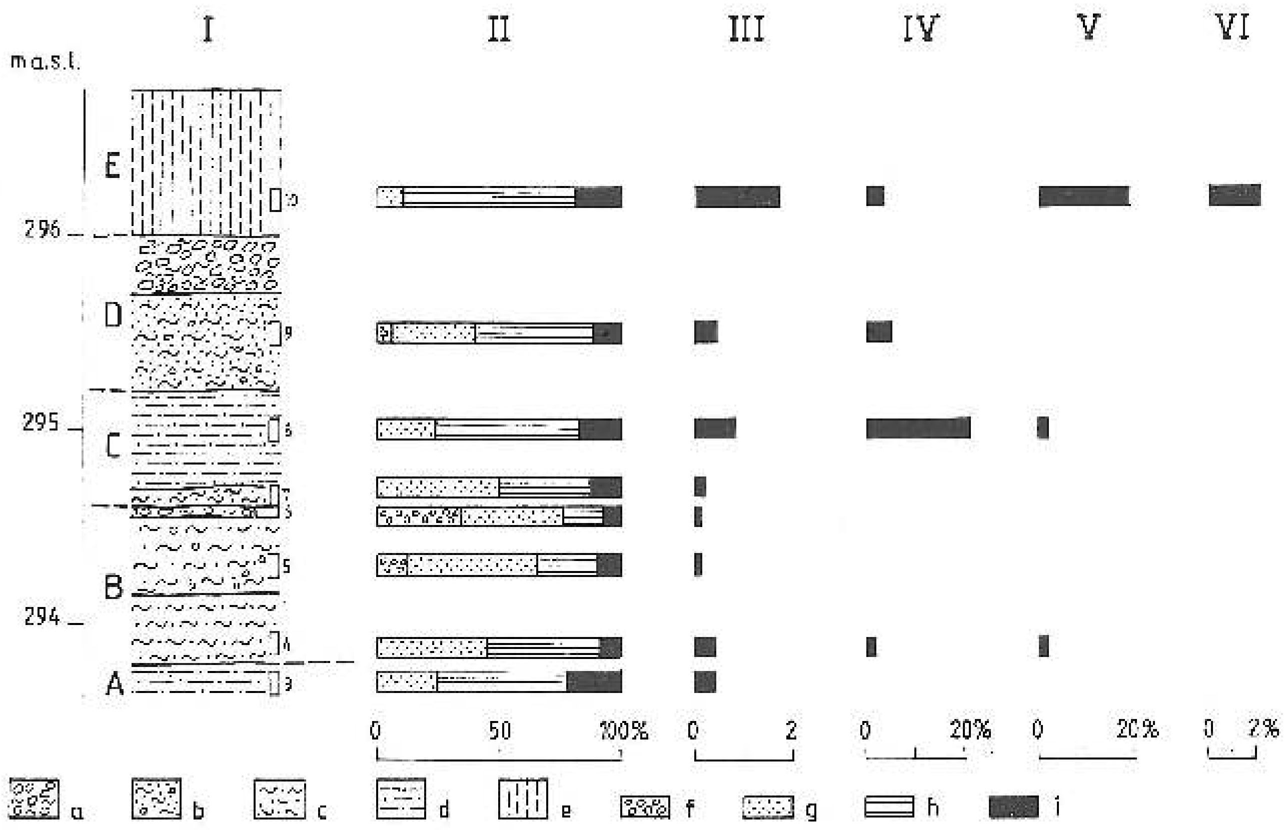


Fig. 3. Grain-size parameters and heavy minerals in the Quaternary slope deposits at Świnna Poręba

I — simplified geological section: A — oxbow silt, B— lower solifluctional loams, C — deluvial loams, D — upper solifluctional loams, E — loess-like silt, a — loam with abundant debris, b — sandy loam with scattered debris, c — sandy loam, d — sandy loam with clayey fraction, e — clayey silt with sandy fraction, 3–10 — sample numbers corresponding to Table 1 (samples 1 and 2 were collected in the deposits underlying the complex A); II — grain-size distribution: f — gravel fraction (> 2 mm), g — sandy fraction (0.0625–2 mm), h — silty fraction (0.002–0.0625 mm), i — clayey fraction (< 0.002 mm); III — loess index values (Nowak, 1981); IV — garnets; V — biotite; VI — amphiboles

Foreland. However, the Paleczka River valley is divided from the foreland by ridges of the Chełm Range, about 100 m high.

At Baczyn, the Paleczka River valley is incised in the Oligocene Magura sandstones (Fig. 4); the lowermost part of the Quaternary deposits comprises alluvial gravels (complex A on Fig. 5, *cf*. Grzybowski, 1999) containing some silt intercalations, presumably laid down during the younger Pleniglacial of the Vistulian. In a sample collected from such an intercalation (Table 1, sample 19), the silt fraction comprises 52%, the mean grain diameter is 6.6 ϕ, the standard deviation is 3.1 and loess index is 1.1. In this sample garnets constitute roughly 15% and biotite 10%, while amphiboles are lacking (Table 1).

The alluvial complex A is overlaid by a silt with some humus patches, 50 cm thick (B). Samples of this silt (21 and 22) differ from the alluvial silt (19) mainly by their higher content of silt (roughly 76 and 83%) and by their much higher loess indices (2.5 and 3.1). Nevertheless their mean grain diameters (6.9 and 6.2 ϕ) are similar to that of the alluvial silt sample; the standard deviation of the lower part of the silt (sample 20: 2.9) is comparable with the standard deviation of the alluvial silt but in the upper part (sample 21: 2.0) it is considerably lower (i.e. the sorting is better). In sample 21, garnets are also less abundant than in the alluvial silt (Table 1, Fig. 5), while the amount of biotite is higher; this sample notably, contains amphiboles and epidote.

Based on the grain-size and mineralogical features listed above, the silt B as represented by samples 20 and 21 might be recognised as a loess. It is quite possible that the material brought by winds has been deposed during relatively less severe climatic conditions. Then, steppe or tundra vegetation (though the poorly preserved pollen grains, could not be identified) favoured aeolian sedimentation on the valley floor.

Just above this loess-like silt, a layer of Magura sandstone debris is embedded is in a sandy loam (C). The thickness of this layer locally exceeds 100 cm, but it decreases considerably towards the present valley thalweg; many of the fragments are inclined in the same direction. In the heavy minerals of this loam (Table 1, sample 23, Fig. 5) garnets are more abundant, while the proportion of amphiboles and epidote decreases. These observations indicate that material came from the valley slope, via denudation of either the Magura sandstone debris or the loess-like silts (B). Most probably this slope movement included solifluction, which led to mixing and not to sorting of the slope cover material.

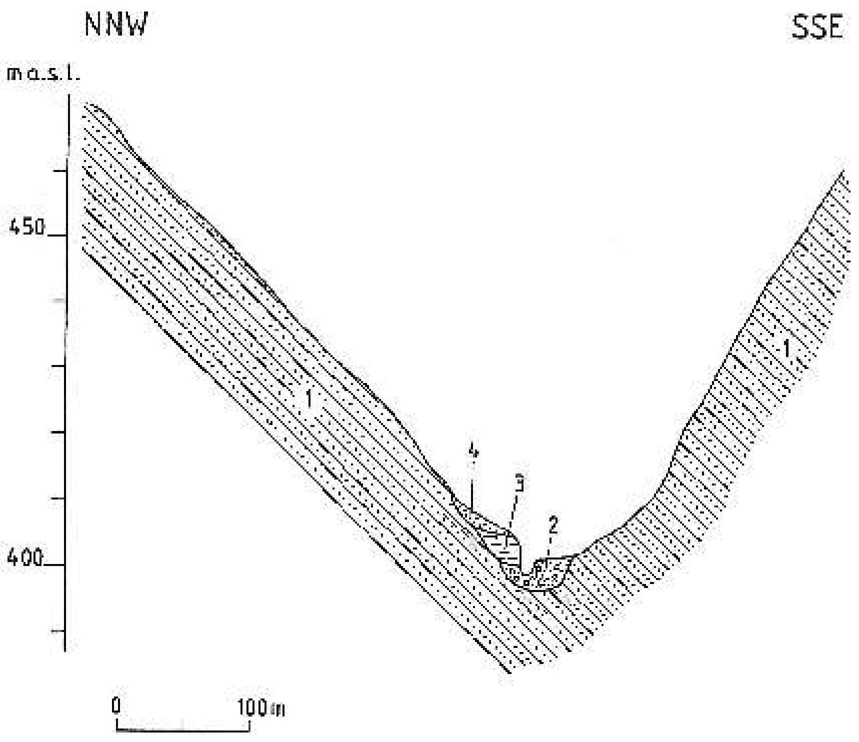


Fig. 4. Simplified geological cross-section of the Paleczka River valley at Baczyn

1 — Magura sandstones (Eocene-Oligocene), 2 — alluvial gravels (younger Pleniglacial), 3 — solifluctional loams with debris and loess-like silt (younger Pleniglacial, see Fig. 5), 4 — deluvial loam (Late Glacial-Holocene)

The sloping top surface of the solifluction debris described above is covered by a 200 cm thick clayey silt, lacking marked lamination but locally containing clayey patches (D). Grain-size analyses of samples from this silt (24–26) are plotted in Figure 5; their silt content reaches 77–80% and the mean grain diameter is 6.2–6.4 $\phi$; standard deviation values decrease slightly upwards (2.3–2.1), whereas the loess index increases from 2.4 to 2.9. In sample 26, garnets are lacking while the amounts of biotite (23.5%), amphiboles (4.3%) and epidote (3.2%) are the highest in this section.

This silt is very similar to the silt of complex B and it might also be considered as a loess-like silt. It does not contain humus, presumably because of climatic conditions more severe than during the previous aeolian accumulation episode.

The top surface of this upper loess-like silt, inclined towards the Paleczka River valley thalweg, reveals a denudational origin. This surface is covered by the uppermost loam, 100 cm thick, containing some sandstone debris (E). The top surface of this loam is present land surface, also inclined towards the Paleczka River valley. Based on its location at the outlet of a small denudational valley, its origin might be connected with deluvial processes; the landform is a deluvial cone.

The four sedimentary complexes described above (B–E) appear more or less similar to the deposits of the Świnna Poręba section but their succession is quite different. At Baczyn there is only one layer of solifluction deposits (C) separating two layers of loess-like silts (B and D). The youngest layer of this profile comprises denudational deluvial deposits, still forming today.

The loess-like silts of Baczyn show loess features more clearly: their loess indices are higher, and their amphibole and biotite contents are larger than at Świnna Poręba.

As at Świnna Poręba, the presence of amphiboles and the larger amount of biotite (with possible epidote as well) indicates aeolian transport from the north, connected with deflation of the foreland deposits. The loess material was blown over an orographic barrier. The lower proportion of clay at Baczyn relative to Świnna Poręba might reflect a higher altitude of aeolian transport.

In the Paleczka River valley, during the first loess-forming episode comprising the sedimentation of the lower loess-like silts (B) the climate was presumably less severe (and less humid) than immediately afterwards, during deposition of the solifluction loam (C). Subsequently, while the sedimentation of the upper loess-like silts (E) took place, the climate became more arid again. These slight climatic fluctuations presumably did not exceed the range of cold climate conditions of the younger Pleniglacial of the Vistulian. The deluvial loam (E) of the uppermost part of the Baczyn section was deposited in markedly less severe climatic conditions, allowing an increase in washout — presumably during the Late Glacial or at the beginning of the Holocene (*cf.* Starkel, 1984, 1995).

Silts similar to those of Baczyn were found about 7 km west of the described site, at the Marcówka locality, on the top surface of a small plateau built of Magura sandstone, roughly 100 m above the present Paleczka River valley floor (Majewska, pers. inf.). Those silts have a high loess index (2.6), low garnet and biotite contents but a noteworthy amount of am-

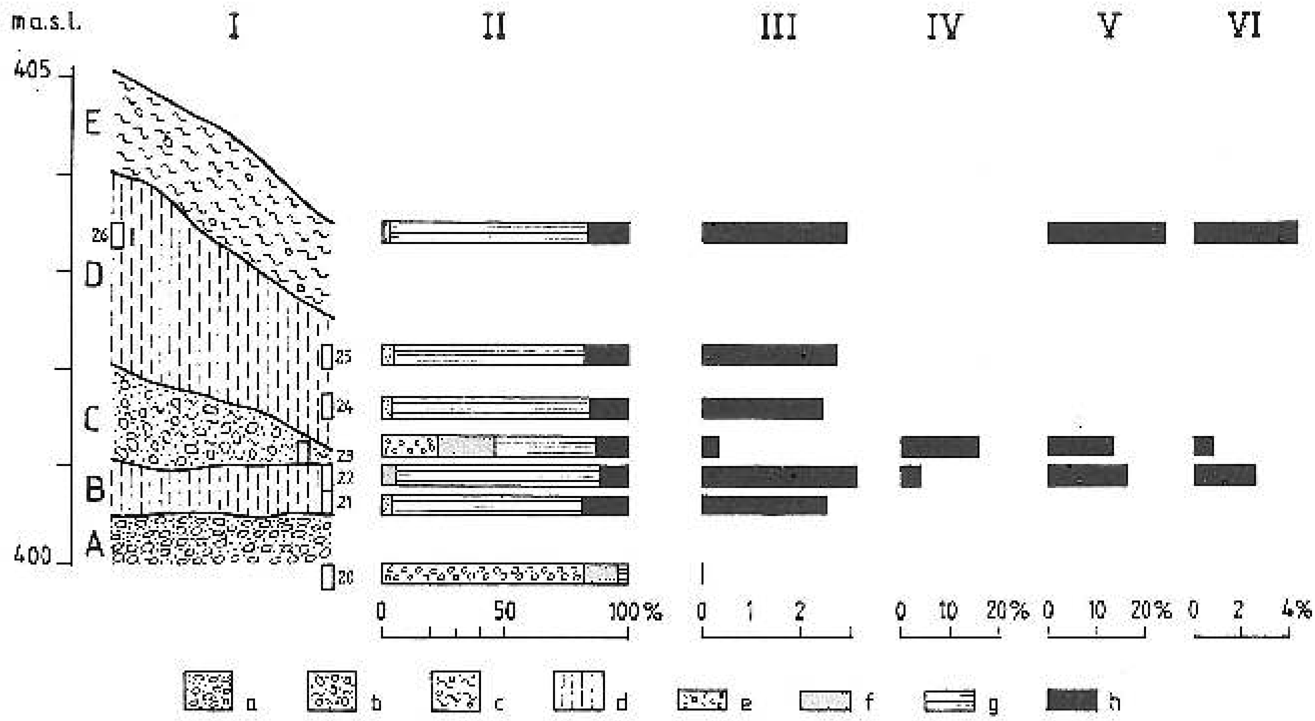


Fig. 5. Grain-size parameters and heavy minerals in the Quaternary deposits at Baczyn

I — simplified geological section: A — upper part of the alluvial gravels (silt intercalations occur below), B — lower loess-like silt, C — solifluctional loam with debris, D — upper loess-like silts, E — deluvial loam, a — sandy gravels, b — loam with abundant debris, c — loam with scattered debris, d — clayey silt, 20–26 — sample numbers corresponding to Table 1 (sample 19 was collected in a silt intercalation below the sample 20); II — grain-size distribution: e — gravelly fraction (> 2 mm), f — sandy fraction (0.0625–2 mm), g — silty fraction (0.002–0.0625 mm), h — clayey fraction (< 0.002 mm); III — loess index values (Nowak, 1981); IV — garnets; V — biotite; VI — amphiboles

phiboles (Table 1, sample 18); they most probably also belong to the loess-like deposits.

## CONCLUSIONS

Grain-size analysis and heavy minerals indicate the occurrence of Vistulian loess-like deposits in the northern outskirts of the Beskid Mały Mts. (in the Skawa River valley) and of the Beskid Makowski Mts. (in the Paleczka River valley).

Among the indices obtained from the grain-size analysis, the loess index (Nowak, 1981) give the clearest evidence. As in the foreland sections, these are higher in the loess-like silts than in other slope (deluvial or solifluctional) deposits occurring in the same or adjacent sites.

The presence of amphiboles and the elevated biotite content might be considered as diagnostic features of the local loess-like deposits (a similar interpretation might account for presence of epidote). It should be stressed that these mineralogical features appear together with high loess index values.

Variations in the garnet content might be useful mainly to pinpoint the local derivation of the Quaternary clastic material, from particular units of the flysch succession. Amounts of resistant tourmaline and zircon in the studied sections are too small (Table 1) to deliver any useful information on the material supply or on the sedimentary environment. The rutile content may prove of value to future investigations.

A substantial part of the loess-like silt material described came from deflation of deposits covering the Carpathian forelands and Fore-Carpathian basins, presumably thicker and more extensive than now. Therefore this material was brought by northern winds.

Most probably the aeolian sedimentation of the described loess-like silts took place during the younger Pleniglacial of the Vistulian; therefore the silts correspond to the Upper Younger Loess (*sensu* Maruszczak, 1991).

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