STUDIA GEOMORPHOLOGICA CARPATHO-BALCANICA
VOL. XXXI KRAKÓW 1997 PL ISSN 0081-6434

ARTICLES

(ARTYKUŁY)

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PROFILE OF THE QUATERNARY DEPOSITS AT SIEDLISKA (FORELAND OF THE PRZEMYŚL CARPATHIANS, SOUTH-EASTERN POLAND) AND ITS PALEOGEOGRAPHIC ASPECT

INTRODUCTION

The presented profile of the Quaternary deposits at Siedliska is situated in the Chyrów Plateau, in the SE part of the Sandomierz Basin, 10 km eastwards of the Przemyśl Carpathian margin. The exposed here sediments are thick (over 20 m) and represented by different lithofacies with glacial, fluvial and eolian deposits, and also by paleosols.

We can found only few papers mentioning the Quaternary in the Siedliska environs. Łomnicki (1900) noticed so-called mixed gravels, which often occur in this region. They are composed of Scandinavian and flysch material, and are usually covered by a loam of loessy type. Klimaszewski (1948) mentioned a thin (2 m) layer of the Kraków moraine overlying fluvial gravels derived from flysch only; bottom of the till occurs 64 m above the San river level, and bottom of the gravel layer — 45–60 m. More informations about these undermoraine gravels were published by Laskowska-Wysoczańska (1980). She considered them to be probably a preglacial series, i.e. corresponding to the preglacial part of the Pleistocene — named pre-/proto-Pleistocene (Różycki 1980, Baraniecka 1990). After the latter author these gravels were deposited as alluvia of the pra-San river belonging to the Black Sea basin in the early Pleistocene.

The Siedliska profile is one of few sites with deposits of the South Polish Glaciations in SE Poland. In the 70's and 80's a stratigraphic position of the single till layer in the southern part of the Sandomierz Basin and in the Carpathian margin was defined more closely. This till is residuum of the maximum extent of the Scandinavian ice sheet distinguished by Różycki (1978) as the San Glaciation (Elster 2 or Mindel III), and by Lindner (1984, 1988) as the San 2 — the youngest of three glaciations, i.e. Nida, San 1 and San 2 belonging to the South Polish Megaglacial. However, stratigraphic position of the undermoraine gravels is not clear. Data presented in this paper, including also the results of TL age datings, give possibility of stratigraphic interpretation of these deposits other than the previous one. Moreover, in the Siedliska environs the oldest loesses occur, which have not been found in SE Poland up till now.

In the light of the above remarks the profile presented here seems to be important, both for the regional stratigraphy and paleogeography of the south-eastern part of the Sandomierz Basin and for solving problems of wider spatial range.

GEOLOGIC AND GEOMORPHOLOGIC SITUATION OF THE PROFILE

The Chyrów Plateau is the farthest SE subregion of the Sandomierz Basin. It belongs to the peri-Carpathian Plateaux which form a platform lying at the foot of the Polish Western Carpathian margin. Only small part of this region is in Polish territory. Undulating surface of the Plateau reaching 300–340 m a.s.l. is strongly dissected to a depth more than 80 m in valleys of the San and Wiar rivers (Starkel 1972b). The sub-Quaternary basement is built of the Sarmatian deposits: grey calcareous clays, mudstones and sandstones of the Przeworsk strata belonging to the autochthonous Miocene of the outer part of the Carpathian Foredeep. Near the outcrop (about 1 km) there is a limit of gently thrust of the folded Older Miocene of Stebnik unit occurring at the Przemyśl Carpathian margin. The Pleistocene is represented by: loesses and slope deposits forming usually a continuous cover on glacial deposits, glaciofluvial and other periglacial deposits, fluvial deposits of older terraces (Łanczont 1986, Starkel 1972b, Teisseyre 1938). In places pure Carpathian gravels are exposed at 280 m a.s.l., and at 250–235 m a.s.l. — sands and mixed gravels (Fig. 1A).

DESCRIPTION OF DEPOSITS

The Siedliska outcrop is situated within the extensive clay-pit which cuts a branch of flat hill rising up to 300 m a.s.l. The highest part of the exposure reaches 285 m a.s.l. and is 97 m over the mean level of the San river, which is incised about 7–9 m in the vast valley bottom.

The preliminary results of studies of the Siedliska outcrop were published in materials of conferences (Łanczont 1995b, 1996), and partially in the paper by Dolecki et al. (1996). A detailed lithological description of the loessy part

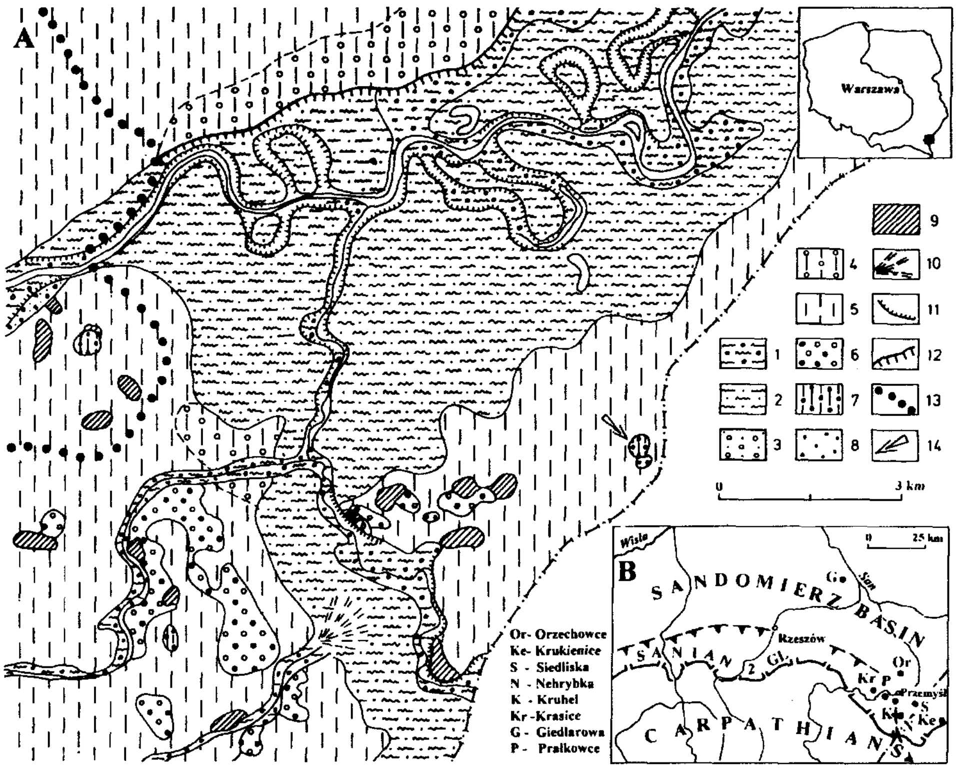

Fig. 1. Geological-geomorphological sketch of the Siedliska environs — A and maximum extent of the Scandinavian ice sheet in SE Poland and situation of the main profiles — B (A — partially after Gucik and Wójcik 1980, Geological Map of Poland 1: 200,000, Przemyśl-Kalników sheet; B — after Butrym et al. 1988). 1 — loams, sands and gravels of flood terraces 1–3 m high, 2 — *madas*, fluvial sands and gravels of "rendzina" terrace 7–10 m high, 3 — fluvial loams, sands and gravels of the Pleistocene low terrace 12–17 m high, 4 — fluvial sands and gravels of the Pleistocene middle terrace 20–25 m high, covered by loess, 5 — loesses and loess-like deposits, 6 — mixed gravels, 7 — till, 8 — "undermoraine" fluvial flysch gravels, 9 — outcropping of the under-Quaternary deposits, 10 — alluvial fans; edges of river terraces: 11 — low, 12 — high, 13 — Carpathian margin, 14 — situation of the Siedliska profile

Ryc. 1. Szkic geologiczno-geomorfologiczny okolicy Siedlisk — A oraz maksymalny zasięg lądolodu skandynawskiego w Polsce SE i lokalizacja profili reperowych — B (A — częściowo wg Gucik, Wójcik 1980, Mapa geologiczna Polski 1: 200 000, ark. Przemyśl-Kalników, B — wg Butrym i in. 1988). 1 — gliny, piaski i żwiry teras zalewowych o wysokości 1–3 m, 2 — mady, piaski i żwiry rzeczne terasy rędzinnej o wysokości 7–10 m, 3 — gliny, piaski i żwiry rzeczne terasy nadzalewowej niskiej o wysokości 12–17 m, 4 — piaski i żwiry rzeczne terasy nadzalewowej średniej pod pokrywą lessową: wysokość względna terasy 20–25 m, 5 — lessy i utwory lessopodobne, 6 — żwiry mieszane, 7 — glina zwałowa, 8 — „podmorenowe" rzeczne żwiry fliszowe, 9 — wychodnie utworów podczwartorzędowych, 10 — stożki napływowe; krawędzie teras rzecznych: 11 — niskie, 12 — wysokie, 13 — granica nasunięcia karpackiego, 14 — lokalizacja profilu Siedliska of the profile together with the results of analyses is presented in a paper by Łanczont and Alexandrowicz (in press). Letter indices of layers used in the present text and in Fig. 2 are identical as in the mentioned above paper.

The outcrop profile has been obtained from examination of five exposures deepened by pits, in which different lithostratigraphic units of the Pleistocene deposits occur (Fig. 2). The synthetized profile (Fig. 3) was compiled mainly on the basis of facts recorded in the exposures 1–3.

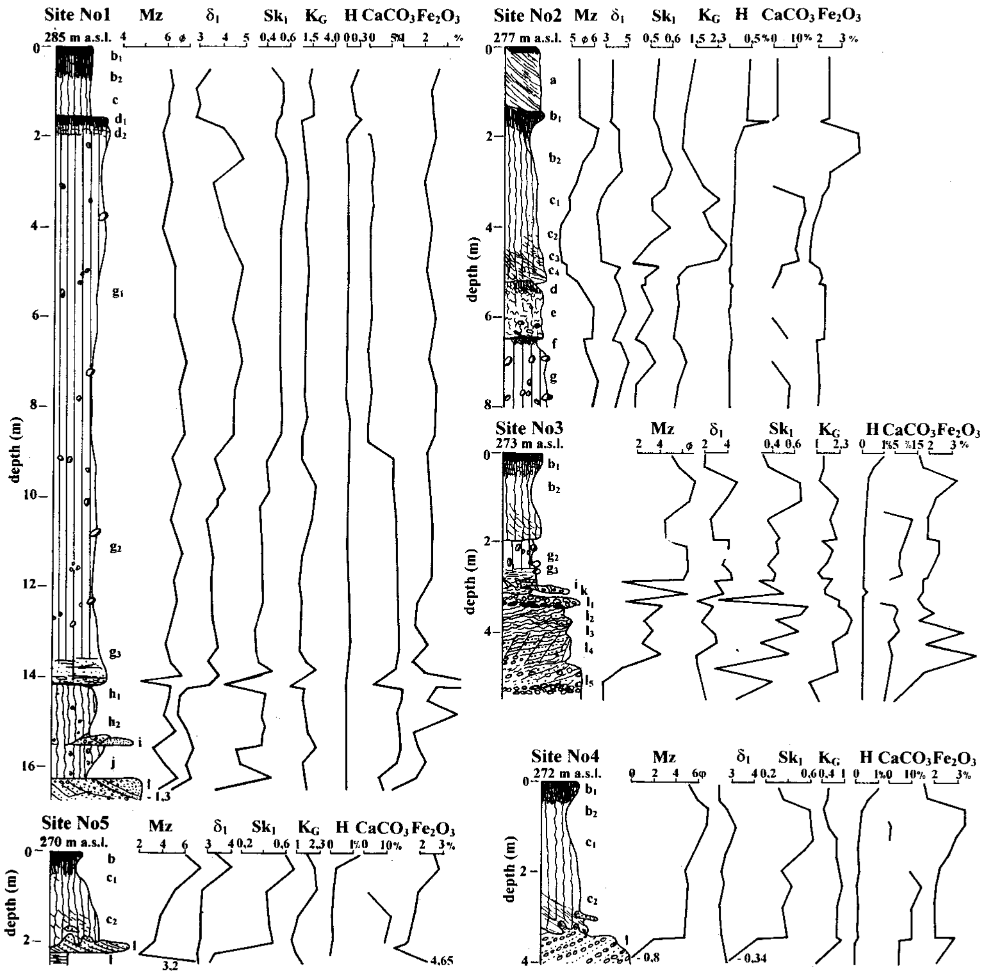

Fig. 2. Lithological profiles of the Pleistocene deposits at Siedliska: sites 1–5. Grain-size parameters: Mz — mean grain diameter (in phi scale), σ_I — standard deviation, Sk_I — skewness index, K_G — kurtosis index, $CaCO_3$ — carbonate content, H — humus content, Fe_2O_3 — free iron oxides content

Ryc. 2. Profile litologiczne osadów plejstoceńskich w Siedliskach: stanowiska 1–5. Parametry granulometryczne: Mz — średnia średnica ziarna (w skali phi), σ_I — wskaźnik wysortowania, Sk_I — wskaźnik skośności rozkładu uziarnienia, K_G — wskaźnik kurtozy, $CaCO_3$ — zawartość węglanów, H — zawartość humusu, Fe_2O_3 — zawartość tlenków żelaza

Site No 1

Description is compiled from studies of the pits: main (1) and accessory (1a) ones (Fig. 4B). The top part of such compiled profile contains the younger loesses and till which was examined in core taken from 10.9 to 14.25 m using hand drill. The bottom part of the profile, from 14.25 to 16.75 m, is built of the submoraine loesses overlying fluvial series. It was described from examination of pit 1a:

b_1–b_2	0.00–0.90 m	Holocene brown soil.
c	0.90–1.65 m	Decalcified loess, greyish-yellowish. Sharp denudational border.
d_1–d_2	1.65–2.30 m	Humus and browned horizons of interstadial subarctic soil developed on till. Distinct border.
g_1–g_3	2.30–14.25 m	Brown-greyish till, decalcified to a depth of 8.35 m; in the bottom part elongated sandy bodies with fine gravels. Distinct erosional border. Till samples were dated twice: from 10.8 m at over than 262 ka (Lub 2,850) and from 8.2–8.3 m at 506 ± 114 ka (Lub 3,201)
h_1–j	14.25–16.30 m	Carbonate loess, silty and silty-clayey, yellowish-greyish, laminated in places, in the middle part of layer disturbed by tongue structure with sandy-gravelly and loess deposits secondarily displaced. Below 15.55 m clayey compact loess with gravels; it contains numerous shells of molluscs. Sharp border. Sample from 15.95 m was TL dated at 538 ± 121 ka (Lub 3,202).
l	16.30–16.75 m	Loose medium- and coarse-grained sand with gravels. Sample from 16.5 m was TL dated at 555 ± 119 ka (Lub 3,203).

Site No 2

The younger loesses were found here, which cover loess-like deposits overlying till:

a	0.00–1.70 m	Deluvia of Holocene soil, turf horizon at the top.
b_1–b_2	1.70–3.00 m	Brown Holocene soil. Gradual transition.
c_1–c_2	3.00–5.15 m	Massive silty loess, and below a depth of 4 m — silty and fine sandy, stratified and laminated, solifluctionally disturbed in places. Distinct border. Sample from 4.0 m was TL dated at 22 ± 4 ka (Lub 3,199).
d–e	5.15–6.50 m	Horizon of interstadial pedogenesis (pseudogley soil) developed on the loamy-clayey, grey, loess-like deposit, with sporadically occurring redeposited gravels of Scandinavian and local rocks, and with big clayey-carbonate concretions. Distinct erosional-denudational border. Sample from 6.15 m was TL dated at 350 ± 79 ka (Lub 3,200).

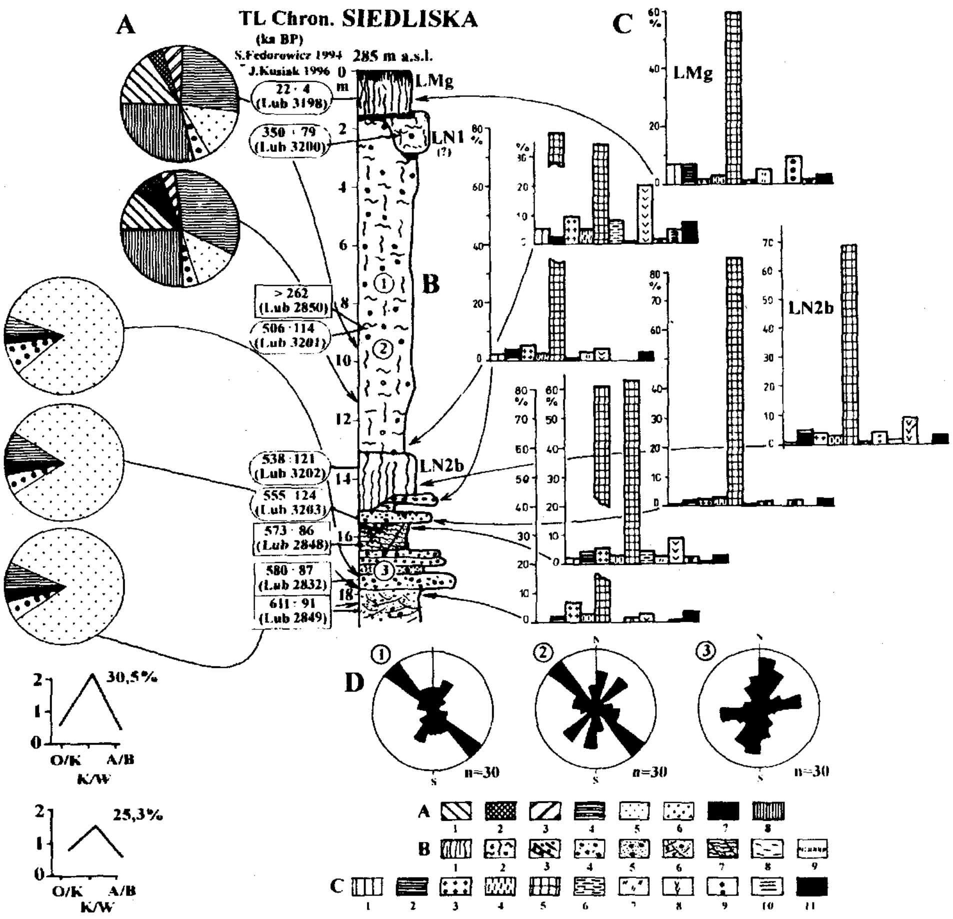

Fig. 3. Synthetized lithological profile of the Pleistocene deposits at Siedliska. A — Petrography of gravels in the fraction 5–10 mm (analysed by J. Nowak, UMCS Lublin). Scandinavian rocks: 1 — crystalline, 2 — limestones, 3 — Paleozoic sandstones + Paleozoic quartz; local rocks: 4 — limestones, 5 — sandstones, 6 — quartz, 7 — cherts, 8 — others. Petrographic indices: O/K — relation of sedimentary rocks to crystalline rocks, K/W — relation of crystalline rocks to limestones, A/B — relation of resistant rocks to non-resistant rocks. B — Lithology: 1 — silts (loesses and loess-like deposits), 2 — till, 3 — fluvial loamy sands with gravels, 4 — gravels, 5 — varigrained sands with gravels, 6 — medium sands with rare gravels, 7 — fine sands of fluidal structure, 8 — clayey muds, 9 — soils (Holocene one at surface, paleosols deep into the profile). C — Heavy transparent minerals in the fraction 0.25–0.1 mm (analysed by M. Wilgat, UMCS Lublin): 1 — zircon, 2 — rutile, 3 — tourmaline, 4 — staurolite, 5 — garnet, 6 — epidote, 7 — apatite, 8 — amphibole and pyroxene, 9 — biotite and chlorite, 10 — others (topaz, sillimanite, titanite), 11 — weathered and undefined minerals. D — Diagrams of orientation of longer axes of clasts (n — number of measurements). TL chronology: datings carried out by S. Fedorowicz in square frames, by J. Kusiak— in round frames. All TL datings were carried out in the TL Laboratory of the Department of Physical Geography and Paleogeography UMCs in Lublin

f	6.50–7.20 m	Horizon with signs of pedogenesis (of interglacial rank?) developed on till; probably bottom part of an undefined soil with bluish spots (bottom part of Btg horizon?).
g	7.20–7.80 m	Dark grey till.

Site No 3

Series of fluvial deposits with differentiated lithology is main sedimentation unit; it is the oldest Quaternary unit in the described outcrop:

b_1–b_2	0.00–1.35 m	Genetic horizons of Holocene lessivé soil. Distinct change of colour and decalcification border.
c	1.35–1.95 m	Silty-fine sandy deposit, brown-greyish. Distinct lithological border.
g_2–g_3	1.95–2.85 m	Greyish till, in the bottom part stratified and streaky, with intrusions of clay material. Sharp erosional border.
i	2.85–3.10 m	Loamy-sandy deposit interbedded with strongly weathered gravels. Distinct border.
k	3.10–3.15 m	Clayey-silty deposit, non-calcareous, grey. Distinct lithological border.
l_1	3.15–3.40 m	Medium and coarse sand with fine gravels. At the bottom of the layer flat carbonate cementation concretions occur. Sample from 3.25 m was TL dated at 573 ± 86 ka (Lub 2,848).
l_2	3.40–4.40 m	Silty sand, fine- and medium-grained, with very fine gravels, flow structure, laminae 2–5 cm thick. Below 4.10 m coarse sand with poorly visible structure.
l_3–l_6	4.40–6.15 m	Sands and sands with gravels; weathered gravels with manganese envelopes. Sample from 4.5 m was TL dated at 611 ± 91 ka (Lub 2,849).

Ryc. 3. Syntetyczny profil litologiczny osadów plejstoceńskich w Siedliskach. A — Petrografia żwirów frakcji 5–10 mm (opracował J. Nowak, UMCS Lublin): skały skandynawskie: 1 — krystaliczne, 2 — wapienne, 3 — piaskowce paleozoiczne + kwarce paleozoiczne, skały lokalne: 4 — wapienie, 5 — piaskowce, 6 — kwarce, 7 — rogowce, 8 — inne. Wskaźniki petrograficzne: O/K — stosunek skał osadowych do skał krystalicznych, K/W — stosunek skał krystalicznych do wapieni, A/B — stosunek skał odpornych do skał nieodpornych. B — Litologia: 1 — pyły (lessy i utwory lessopodobne), 2 — glina lodowcowa, 3 — fluwialne piaski gliniaste ze żwirami, 4 — żwiry, 5 — piaski różnoziarniste ze żwirami, 6 — piaski średnie z rzadkimi żwirami, 7 — piaski drobne o strukturze fluidalnej, 8 — mułki ilaste, 9 — gleby (holoceńska przy powierzchni, kopalne wewnątrz profilu). C — Minerały ciężkie przezroczyste we frakcji 0,25–0,1 mm (oznaczyła M. Wilgat, UMCS Lublin): 1 — cyrkon, 2 — rutyl, 3 — turmalin, 4 — staurolit, 5 — granat, 6 — epidot, 7 — apatyt, 8 — amfibole i pirokseny, 9 — biotyt i chloryt, 10 — inne (topaz, sylimanit, tytanit), 11 — minerały zwietrzałe i nieoznaczone. D — Diagramy orientacji dłuższych osi klastów (n — ilość pomiarów). Oznaczenia wieku TL: w ramkach prostokątnych wykonał S. Fedorowicz, w ramkach owalnych wykonał J. Kusiak. Wszystkie analizy termoluminescencyjne wykonane zostały w Laboratorium TL Zakładu Geografii Fizycznej i Paleogeografii UMCS w Lublinie

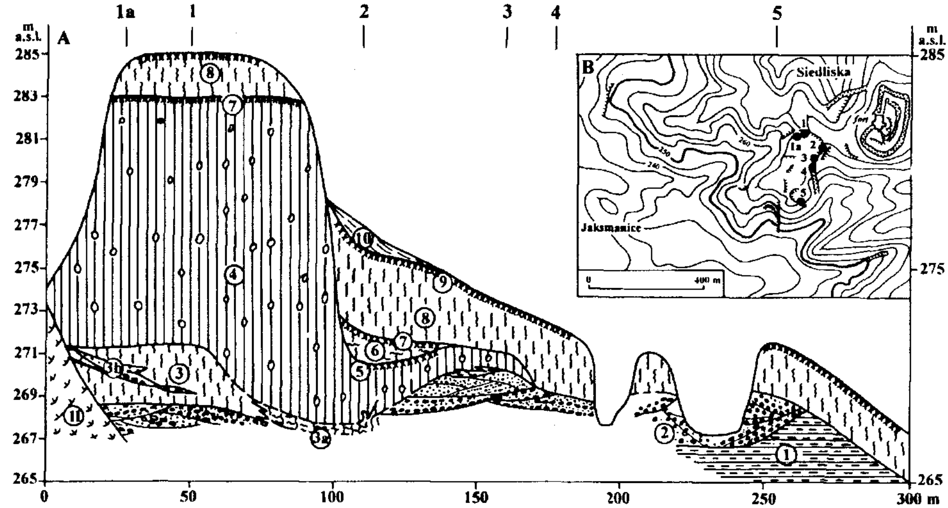

Fig. 4. Geological cross-section (A) and hypsometrical sketch (B) of the Siedliska outcrop environs. Tertiary, Miocene: 1 — clays; San 1 Glaciation: 2 — sandy-gravelly fluvial sediments; San 2 Glaciation, ascending phase: 3 — the second oldest loess (LN2b), 3a — loess-like varved silts, 3b — intraloess tongue structure; San 2 Glaciation, maximum phase: 4 — till; Mazovian Interglacial: 5 — bottom horizons of the degraded paleosol GJ3b (?); Liwiec Glaciation: 6 — loess-like deposits (LN1) of solifluction facies; Wisła Glaciation, Interpleniglacial: 7 — paleosol of interstadial rank; Wisła Glaciation, Upper Pleniglacial: 8 — upper younger loess (LMg); Holocene: 9 — soil, 10 — soil deluvia, 11 — heap

Ryc. 4. Przekrój geologiczny (A) oraz szkic hipsometryczny (B) rejonu odkrywki w Siedliskach. Trzeciorzęd, miocen: 1 — iły; zlodowacenie sanu 1: 2 — piaszczysto-żwirowe sedymenty rzeczne; zlodowacenie sanu 2, faza wstępująca: 3 — less najstarszy drugi (LN2b), 3a — lessopodobne mułki zastoiskowe, 3b — śródlessowa struktura jęzorowa; zlodowacenie san 2, faza maksymalna: 4 — glina zwałowa; interglacjał mazowiecki: 5 — dolne podpoziomy zdegradowanej gleby GJ3b (?); zlodowacenie liwca: 6 — utwory lessopodobne (LN1?) facji soliflukcyjnej; zlodowacenie wisły, interpleniglacjał: 7 — gleba kopalna rangi interstadialnej; zlodowacenie wisły, górny pleniglacjał: 8 — less młodszy górny (LMg); holocen: 9 — gleba, 10 — deluwia glebowe, 11 — hałda

Sites Nos 4 and 5

Sites 4 and 5 are situated in the lower part of the slope, rather steep here (Fig. 4B). In the pits there are exposed from top: Holocene soil developed on loess underlain by sands with gravels:

a) Site No 4: carbonate sandy loess of deluvial facies (layer c) is 3.45 m thick and is underlain by poorly calcareous (5%) sands with gravels (layer l). Top surface of sands is of denudation nature.

b) Site No 5: sequence and lithology of deposits are similar. Fine-laminated loess with admixture of redeposited fine gravels in the lower part is 2 m thick (layer c) and overlies thin layer of sandy-gravelly deposits (layer l), which cut rocks of the Tertiary basement. Sample taken from the sandy layer was TL dated at 580 ± 87 ka (Lub 2,832).

PROPERTIES OF QUATERNARY DEPOSITS

BOTTOM FLUVIAL DEPOSITS

This gravelly-sandy series (layers l_{1-5}) overlies an erosional socle built of little resistant calcareous Sarmatian clays weathered to a depth of 0.5 m (layer ł). Found in the site No 5 the bottom of the series is at 268 m a.s.l. and its top — in the site No 1 — reaches 271 m a.s.l., i.e. about 80 m over the mean level of the San river. These deposits are poorly and very poorly sorted, with grain-size distribution usually positively and very positively skew, and with kurtosis from mesokurtic to extremely leptokurtic, which suggests genetic homogeneity of source material (Fig. 2). The bottom part of series is built of sands and gravels with horizontal and cross-stratification, and the top part — of sands with ripple marks and horizontal lamination. These sands are disturbed by reverse faults of throw from 3 to 10–15 cm caused probably by subsidence of basement (deposition on flood plain icing? compare Drozdowski 1979). Facies association seems to be accumulated by a braided river system (Zieliński 1993). Erosion traces are visible at top of this series.

Gravels are strongly weathered, in a considerable part ferruginized, without Scandinavian material (Fig. 3A). They are composed mainly of Carpathian sandstones of different lithology and resistance (87.6–91.6% in the fraction over 10 cm, and 82.4–83.8% in the fraction 5–10 cm), with dominance of carbonate-free ones. Some of them have characteristic carbonate and siliceous crusts and sinters on the surfaces. Limestone gravels (5.7–8.0%) are mainly decalcified; Jurrasic limestones of Štramberk type forming about half of them occur as exotics within the margin flysch units in the region situated W and SW of Przemyśl. Within cherts and lydites the most numerous are lithological varieties typical for the Tertiary menilite series of the Carpathian flysch. Therefore, it seems that the described gravels derived entirely from the different flysch series of the Carpathians. Gravels originating probably from the eroded Miocene basement occur in very small amount. Measurements of orientation of longer gravel axes indicate domination of transport from the SSW direction (Fig. 3D–3).

Among heavy minerals of the fluvial series the opaque minerals prevail (usually over 50%). Transparent minerals assemblage (Fig. 3C) is rather monotonous, dominated by garnet (62.2–85%), with admixture of amphibole>tourmaline>rutile>staurolite>epidote>apatite; accessory minerals occur in rather constant ratios. Amount of zircon is small because it accumulates in finer fractions than the examined one. Qualitative and quantitative stability of heavy minerals composition in all examined samples allows us to suppose that the fluvial sediments were alimented from the one common source of material — the Carpathian flysch layers rich in garnets (Szczurowska [in:] Wdowiarz et al. 1974, Tokarski 1947). These rocks, and especially *Inoceramus* layers, Carpathian exotics, Miocene conglomerates, and their wastes,

Table 1 — Tabela 1

Composition of transparent heavy minerals (in the fraction 0.1–0.25 mm) in carbonate cementation concretions at contact of layers l_1 and l_2

Skład minerałów ciężkich przezroczystych (we frakcji 0,1–0,25 mm) w węglanowych konkrecjach cementacyjnych na pograniczu warstw l_1 i l_2

No of sample	zircon	rutile	tourmaline	disthene	staurolite	andalusite	topaz	sillimanite	titanite	epidote	apatite	garnet	amphibole	pyroxene	biotite	chlorite	weathered, undefined
1	3.4	5.0	5.0	0.7	3.1	—	—	—	0.2	5.0	0.2	63.5	8.6	—	—	0.9	4.1
2	0.5	3.6	7.2	0.8	2.6	0.5	0.3	0.3	—	3.4	4.4	60.8	7.7	0.3	1.0	3.4	3.4

contain also some amount of amphibole in heavy minerals assemblage (Szczurowska [in:] Wdowiarz et al. 1974, Racinowski 1976, 1995, Turnau-Morawska 1947) (Table 1).

Amounts of amphiboles and garnets are antagonistic in the vertical section of alluvia; relatively increased amount of amphiboles corresponds with decreased amount of garnets. As amphibole is little resistant for chemical weathering, such a situation indirectly gives information about cold, wet climate and greater alimentation of alluvia with denudation products transported transversely from the weathered covers (Mycielska-Dowgiałło 1995). Then, increasing amount of garnet, which is resistant for mechanical abrasion, seems to indicate that river reworked older alluvia mainly. As is well known, a high content of garnet is typical for sediments washed many times (Mycielska-Dowgiałło 1980, Kociszewska-Musiał et al. 1972).

In the exposure 3, in the upper part of the fluvial series, between coarse sands with fine gravels and silty sands (contact of layers l_1 and l_2) many flat carbonate concretions occur. They are discoidal, ellipsoidal and spherical, and contain from 28.4 to 39.8% of $CaCO_3$ (Fig. 2). Such forms were defined by Książkiewicz (1968) as cementation concretions. Traces of primary sand layering occurring inside them indicate that sands were material subjected to diagenesis. It is also confirmed by similar composition of heavy minerals in these sands (Fig. 3C) and in concretions (Table 1).

UNDERMORAINE LOESSES

In the exposure 1, over gravels and under till, the layers "h_1–j" of silty deposit occur which thickness is about 2 m. (Fig. 2). One can well define it as eolian loess, which was accumulated in continental conditions at low altitude (on terrace).

The deposit contains 15% of fine sand fraction, 52% of loess fraction and 19% of clay fraction. Its grain-size parameters are typical for subaerial loess: Mz = 6.51 φ, δ_I = 2.60, Sk_I = 0.44, K_G = 1.16. Opaque minerals constitute 21.6% of heavy minerals assemblage. Among transparent minerals garnet is dominant (68.7%). Successive places are occupied by chlorite > rutile > apatite > tourmaline > > biotite > staurolite (Fig. 3C). Contents of zircon and amphiboles are low (1%). Such a composition shows a direct connection between this loess and source deposits in the basement. High content of garnets (68.6%) proves that the loess was alimented mainly from the fluvio-periglacial deposits built of Carpathian alluvia. Considerable amount of micas (22.6%) in heavy minerals composition seems to indicate flood water deposition of source material.

Malacofauna found in the bottom loess layers forms an assemblage of very numerous specimens but specifically uniform (Łanczont and Alexandrowicz in press). It is represented only by *Succinea oblonga elongata*. This fauna typical for loess indicates an open, quite humid habitat, and cold, subpolar climate, i.e. an environment of tundra type. This extremely poor assemblage suggests that the molluscs lived in unfavourable conditions (Alexandrowicz et al. 1989).

During dust blowing this deposit was periodically transformed by gravitational flow factors. In the bottom part the loess is developed in the eolian and eolian--colluvial facies what is indicate by scattered gravels derived from the closest vicinity. In the middle part of loess bed a periglacial structure occurs (Fig. 4A). It is a tongue of sediments redeposited and inclined 5° to N. Sandy-gravelly bodies and detached loess blocks with features of parent material are randomly distributed within this tongue (Fig. 5). Angular loess blocks have straight, intact edges, so they were frozen getting inside the cover (probably they fell off). This secondarily displaced material remained compact and was not sorted so it could evidence fast movement and burial of frozen bodies (Dylik 1953). The upper part of the loess bed has usually a massive structure but interbeddings with laminated loess, in places disturbed by sheet solifluction, also occur. Lamination in loesses indirectly indicate that eolian dust was depositid on wet ground (Cegła 1972, Jary 1996).

Laskowska-Wysoczańska (1980) described the undermoraine limno--periglacial silts occurring at Siedliska, which are unseen at present. They probably correlate with our loess. These silts were glacitectonically disturbed. Silt diapiric microstructures are extruded within the overlying till. These silts seem to correspond with silty-clayey deposit (layer k) from the exposure 3, which overlies the fluvial series (layer l). This deposit is characterized by the following grain-size parameters: Mz = 6.44 φ, δ_I = 3.67, Sk_I = 0.51, K_G = 0.51. It can be considered as a subaquatic loess facies formed by material blown into small, shallow water pools. This deposit was cut by solifluction flows, which left a thin sandy cover (layer i) with gravel bodies. Connection of this cover with the underlying fluvial series is unquestionable; they have almost identical composition of heavy minerals assemblage (Fig. 3C).

TILL

The main layer in the profile is till (layer g) of differentiated thickness, which was caused by younger denudation processes. Its greatest thickness is 12.5 m in the exposure 1 (Fig. 2, 4A). Due to drying, the till exposed in the pit is very hard and cracked along almost vertical joint faces; it looks like a lithified rock. It contains 20–26% of clay, 40–55% of silt and 25–35% of sand. Till is characterized by the following grain-size indices: Mz = 5.89–6.78 φ, δ_I = 4.45–5.04, Sk_I = 0.41–0.57, K_G = 1.12–1.75. To a depth of 9.2 m it is decalcified or contains trace amounts of $CaCO_3$, and below 9.2 m carbonates make up to 6.9%. Content of humus is low (less than 0.1%), and of iron oxides about 2%.

In the gravel fraction of till the local component prevails (Fig. 3A). In the fraction 5–10 cm among the rocks transported from a small distance the limestones dominate (34.6–35.9%), and different sandstones of Carpathian origin are the next (12.3–13.1%). Carbonate and limonite concretions are also numerous (17–23.5%). Among debris of Scandinavian origin the crystalline rocks (grey, pink and red granitoid rocks, rarely grey gneisses and biotite schists) are most abundant than the Palaeozoic, mainly organogenic, limestones. Scandinavian gravels are surely impoverished with components less resistant to weathering; Palaeozoic dolomites and shales are absent, proportion of sandstones is low.

Transparent minerals prevail in the heavy fraction; content of opaque minerals is 38.9% (Fig. 3C). Glauconite is abundant, while content of micas is low. Among the transparent minerals garnets (34.1%) and amphiboles (18.8%) constitute a half, and the following are: tourmaline, zircon, rutile, apatite, staurolite and pyroxene. It is the association which, similarly as petrographic composition of gravel fraction, points to high participation of local rocks, i.e. pre-Quaternary basement of the Carpathian Foredeep and older Quaternary deposits, in alimentation of the till deposited over them (Butrym and Racinowski 1983, Racinowski 1995).

In the bottom part of the till layer (about 1 m thick) the streaks of silty-clayey material occur, which was incorporated from the direct basement, and also sandy bodies of thickness from few to 10 cm, inclined 7–13° to SE (site No 3). Such structures are considered to be connected with very active process of taking material from the direct basement by moving ice sheet (Różycki 1970). Higher lying zone (about 3 m thick) has rather distinct stratification which can be linked with deposition of mineral material from the bottom ice sheet parts (Kasprzak 1988, Nalewajko 1982, Olszewski 1974). The upper part of the till layer has rather monotonous structure with slightly visible division into more silty bottom part and upper — more sandy. Such till structure is typical for subglacial basal till (Stankowska and Stankowski 1984, Stankowski 1996). Arrangement of longer axes of clasts shows a tendency to assembling and existing of one prevailing orientation (NW–SE), which suggests the supposed direction of local ice sheet transport (Fig. 3D — 1 and 2).

Till surface forms a buried, denuded slope. In top part of till traces of pedogenesis were found in few places. In the exposure 2 (Fig. 2) a loamy horizon (layer f) occurs, rusty-brown, with gleying stains, and with surface of discontinuity in the top. It is probably a part of paleosol profile, which upper genetic horizons were denuded. Therefore, it is difficult to define it (cut illuvium?). However, in the exposure 1 it is an interstadial soil of brown subarctic type, rather rich in humus (0.26%) in the accumulation horizon (d_1). Stratigraphic position of these two paleosols developed on till seems to be different.

OVERMORAINE LOESS-LIKE DEPOSITS

In the exposure 2 (Fig. 2), over the mentioned residuum of paleosol developed on till, a small loam patch occurs which has features of loess-like deposit of solifluction facies (layer e). In this deposit the eolian component was less important due to more active supply of till denudation products. Lithological features of this deposit are the following: Mz = 6.53 φ, δ_I = 4.26, Sk_I = 0.43, K_G = 1.08. The upper part of this deposit is decalcified, and in the bottom part a horizon of illuviated carbonates occurs. They form agglomeration of many crusted carbonate hollow concretions. This concretion type is connected with swamp processes (Siuta and Florkiewicz 1965). In the top of this loam traces of pedogenesis of interstadial rank are visible. It is about 0.75 m thick layer of swampy soil of gley type, with poorly developed morphological features. Low content of organic substance in the accumulation horizon of this soil resulted probably from their hydromorphic character.

YOUNGER LOESSES

The buried slope cut in till is wholly covered by subaerial stratified loess of deluvial facies (layers c_{2-4}) and by massive loess (layer c_1). Garnet is dominant (59.2%) in the heavy minerals assemblage of the loess, and the following are: chlorite, zircon, rutile and apatite (Fig. 3C). Such a composition is qualitatively and quantitatively different from that of the underlying till. However, it is similar to that of the submoraine loess suggesting similar character of material source.

STRATIGRAPHIC POSITION OF THE DEPOSITS FROM SIEDLISKA AND THEIR SIGNIFICANCE FOR RECONSTRUCTION OF PALEOGEOGRAPHICAL DEVELOPMENT OF THE DIRECT FORELAND OF THE PRZEMYŚL CARPATHIANS

Record of the Pleistocene events begins from a series of fluvial accumulation, which bottom lies on a terrace about 80 m over the present San river channel. This series was deposited in cold climate by a braided river transporting a considerable amount of gravelly and sandy material from its Carpathian catchment northwards. These sediments have features similar to the preglacial deposits, because the Scandinavian crystalline material is absent among gravels (compare Dżułyński et al. 1968). Therefore, Laskowska-Wysoczańska (1971) related them to the Older Quaternary. On the other hand, as opposed to the typical preglacial (compare Kucia-Lubelska 1965), in these sediments the indices of maturity of heavy minerals assemblage (showing the relation of the resistant minerals to the others) are very low (0.05–0.14) indicating week selection of detritic material.

The 80 m terrace is about 10 m below the lowest of four terraces built of the Carpathian gravels and situated on the watershed between the San and Dniester rivers (Teisseyre 1938). These gravels were deposited by waters flowing from the Carpathians to the Dniester river during the Older Quaternary. High altitude of the preglacial terrace steps (275–310 m a.s.l.) was connected with neotectonic activity of the interfluve area (Teisseyre 1938, Starkel 1984). Progressing lift movements caused changes of drainage network and capture of the San river downstream of Przemyśl to the hydrographic system of the Sandomierz Basin. Time of this valley formation was defined variously: after Teisseyre (1938) it was before glaciation of this area, and after Romer (1907) and Klimaszewski (1948) — after glaciation. Later hypotheses ascribed this time to the Günz Glaciation (Starkel 1984), Malopolanian Interglacial (Mindel I/Mindel II) (Pożaryski et al. 1994) or to the period after retreat of the Odra (Saale 1+2, Riss 1) ice sheet from the Middle Polish Glaciation (Laskowska-Wysoczańska 1993, 1995).

In the light of the presented materials one can suppose that the bottom fluvial sediments from the Siedliska profile belong to the accumulation series lining the mentioned, surely shallow valley cut in the pre-Quaternary rocks. Thermoluminescence age of these deposits determined at 611–555 ka BP connects their accumulation time with the period of the San 1 Glaciation (Elster 1 or Mindel II), the second from among the Middle Polish Glaciations, correlated with the oxygen isotope stage 16 (after Shackleton and Opdyke 1973; compare Lindner 1988). Therefore, age of the erosional surface, on which the fluvial sediments were accumulated, could be related to the Małopolanian Interglacial; it is also evidenced by strong weathering of the Miocene clays occurring under the alluvial cover. Such stratigraphic interpretation of geological data is in agreement with the recently published opinion of Pożaryski et al. (1994) about the Pleistocene evolution of the part of the San river valley beyond the Carpathians.

According to the latest studies the San 1 ice sheet reached the northern part of the Sandomierz Basin (Lindner et al. 1995, Lindner and Wojtanowicz 1997) depositing a till dated by the TL method at 595±89 ka (Kwapisz and Szajn 1987). Glacial and extraglacial waters from the Carpathians joined before ice-sheet front and flowed to the east (along zone of the present Lubaczówka, Szkło and Wereszyca river valleys?) to the Dniester river (Lindner and Marks 1995).

Fluvial sediments at Siedliska seem to be connected with the 70–80 m terrace of the San river, the fourth over the Holocene bottom, in the Carpathian part of this river valley (Starkel 1972a). In the nearby villages Kruhel and Krasice (Fig. 1B) patches of till occur on flattening remnants corresponding to this terrace. The till was deposited by the ice sheet of the San 2 Glaciation (Butrym et al. 1988, Łanczont et al. 1988). According to the hitherto existing opinions the 70–80 m terrace of the San river was connected with the Narew Glaciation (Menap or Günz) (compare Starkel 1965, 1972a, Zuchiewicz 1995).

Top surface of the fluvioperiglacial deposits at Siedliska should be linked with a stratigraphic hiatus covering probably the Ferdynandów Interglacial (Mindel II/Mindel III). During this period the fluvial series was dissected, the valley deepened, and its previous bottom was transformed into a high terrace. Near-surface parts of the fluvial sediments weathered and were decalcified in subaerial conditions; however, deposits with traces of interglacial pedogenetic processes are absent.

In the ascending phase of the San 2 Glaciation this terrace was covered by subaerial loess. Thus defined stratigraphic position of loess seems to be unquestionable though in its bottom there is no interglacial soil. However, paleogeomorphological situation, succession of strata, consistent sequence of TL datings obtained for the overlying and underlying deposits, and also TL age of the loess (538 ka) confirm stratigraphic position of this loess. Its occurrence at the Carpathian margin is the evidence of intensive eolian accumulation in the extraglacial zone of the ice sheet.

Dust deposition occurred in very cold and rather wet environment of subarctic tundra. According to nature of different processes accompanying eolian deposition, together with the massive loess (eolian loess s.s.) the following genetic-facial varieties occur: colluvial, deluvial (laminated loess) and solifluctional (compare Łanczont 1995a, Maruszczak 1990). Dust sedimentation was sometimes disturbed by gravitation processes of complicated nature, which could be interpreted as congelifluction mass movement ("cold" solifluction) with participation of colluvial transport over permafrost (Dylik 1952, Jahn 1956, Klatkowa 1965, Klimaszewski 1978, Olchowik-Kolasińska 1962). Periglacial tongue structure deforming the middle part of loess was produced by these processes. Thus formed loess cover was almost completely destructed due to activity of the advancing ice sheet, and probably also later — in result of intensive erosion during deglaciation (compare Maruszczak 1995).

As the loess was formed in the ascending phase of the San 2 glacial cycle, it can be correlated with the unit LN2b, according to the detailed classification of the oldest loesses in Grzęda Horodelska published by Dolecki (1991, 1995). In the stratigraphic scheme of the Polish loesses worked out by Maruszczak (1991, 1994, 1995) the loess LN2 is correlated with the oxygen isotope stage 12. It corresponds to the Tiligulian Loess in Ukraine, which is considered to be formed in the periglacial zone of the Oka Glaciation (Gozhik et al. 1995,

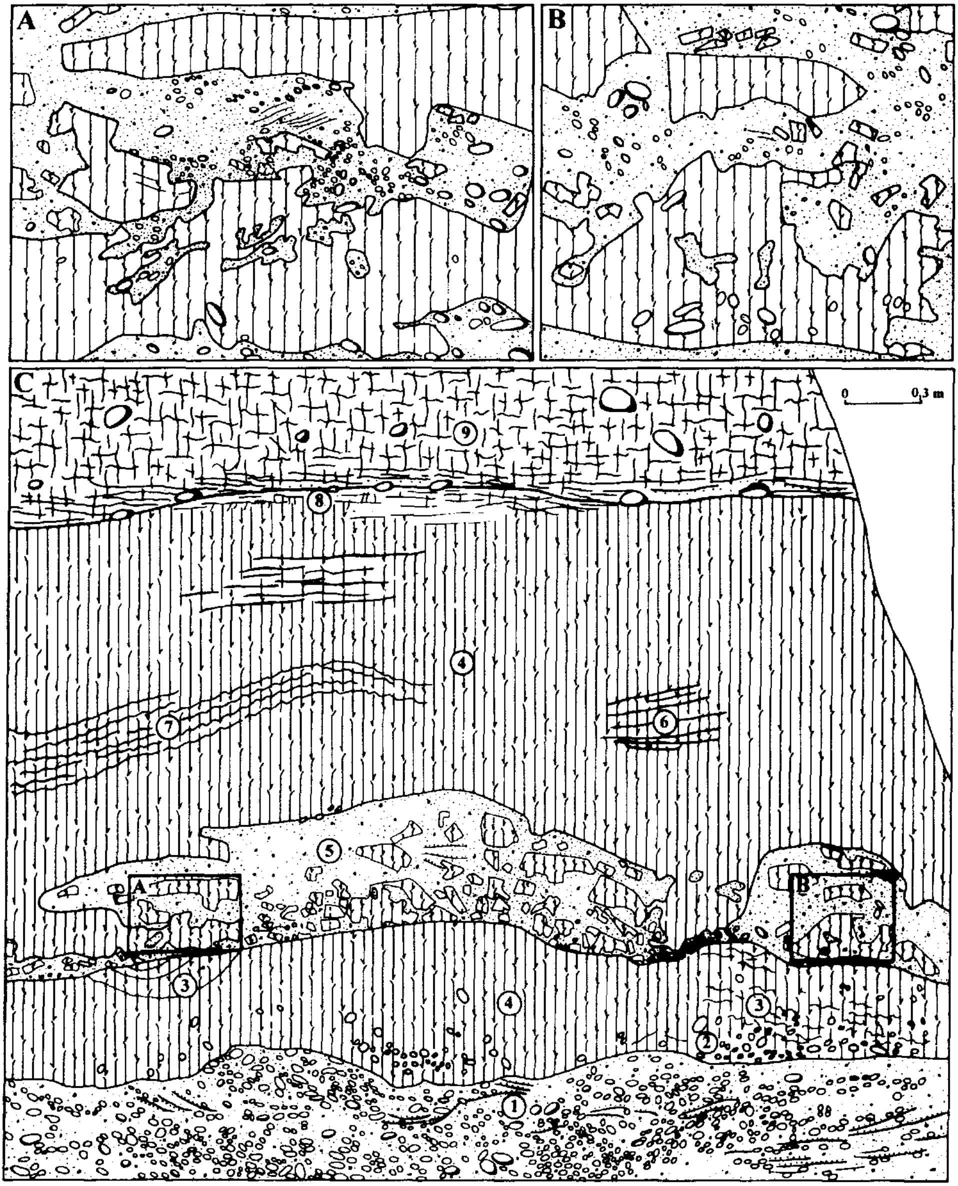

Fig. 5. Part of the exposure 1a at Siedliska. 1 — fluvial sands and gravels, 2 — loess with admixture of gravels, 3 — structures of ferruginous streaks, 4 — massive loess, 5 — tongue structure with loess bodies and sandy-gravelly material, 6 — laminated loess, 7 — solifluction structures in loess, 8 — foliated textures in loess, 9 — till

Ryc. 5. Fragment odsłonięcia 1a w Siedliskach. 1 — piaski i żwiry rzeczne, 2 — less z domieszką żwirów, 3 — struktury smug żelazistych, 4 — less masywny, 5 — struktura jęzorowa z pakietami lessu i materiałem piaszczysto-żwirowym, 6 — less laminowany, 7 — struktury soliflukcyjne w lessie, 8 — struktury listkowe w lessie, 9 — glina zwałowa

Maruszczak 1995), and to the "bottom loess horizon of the Older Pleistocene" in the Volhynia and Podolia (Bogucki 1987). In the central part of the Sandomierz Basin the age counterpart of our loess are undermoraine loess-like varved silts of proglacial lake, TL dated at 539 ± 81 ka. They are underlain by lacustrine deposits, probably from the Ferdynandów Interglacial (Wojtanowicz 1985).

Till is the main stratigraphic horizon in the Siedliska profile. The result of TL dating of this till (506 ka) well fit into the limits of the maximum extent of the Pleistocene ice sheet in Poland, which were defined at 520–500 ka BP (Wojtanowicz 1985, Lindner and Wojtanowicz 1997) or at 530–510 ka BP (Butrym et al. 1988, Łanczont et al. 1988). Butrym dated by the TL method the till from Przemyśl at 528 ± 79 ka (Buraczyński 1988), from Krasice at 484 ± 72 ka and 495 ± 74 ka (Butrym et al. 1988), from Giedlarowa at 508± 80 ka (Wojtanowicz 1982), from Dubanowice and Krukienice in Ukraine at 529 ± 79 ka and 521 ± 78 ka, respectively (Butrym et al. 1988). The till from the San 2 Glaciation at the Carpathian margin has similar petrographic features as the same age till in the Western Wolhynia Upland and in the Sandomierz Basin. However, it is more weathered and contains greater amount of the local material derived from the direct basement (Dolecki et al. 1996). Petrographic features of this till correspond to the stratigraphic lithotype P_2 according to the scheme published by Rzechowski (1974, 1986). In this scheme the lithotype P_2 is connected with the Kock stadial, which was the maximum one during the Middle Polish glaciations, but it is correlated with the older stadial of the San Glaciation and with the oxygen isotope stage 16.

During the deglaciation of the San 2 ice sheet in the Przemyśl environs thick series of glaciofluvial deposits were formed. They were redeposited many times in the descending phases of the San 2 Glaciation and in the Mazovian Interglacial (Łanczont et al. 1988, Łanczont and Nowak 1992, Łanczont and Racinowski 1994). According to the other opinion the formation of these deposits was an intensive but short event occurring during the ice sheet recession (Laskowska-Wysoczańska and Wysoczański-Minkowicz 1992, Laskowska-Wysoczańska 1993).

In the Carpathian Foreland the Great Interglacial s.l. was the period of strong erosion in valleys and denudation in extra-valley areas, the most intensive during its oldest phase (Laskowska-Wysoczańska 1971). At Siedliska these processes considerably reduced thickness of the till and cut a fossil slope.

There are preserved the lowest, hydromorphous subhorizons of a paleosol developed on this till (site No 2). An attempt is possible to correlate development of soil-forming processes with the interglacial soil denoted as GJ3b from the Mazovian Interglacial (Maruszczak 1991). Poligenic, strongly gleyed forest soil representing this warm period was developed on the weathering products of till from the San 2 Glaciation. This paleosol was found at Orzechowce in the Kańczuga Upland (Maruszczak 1985b, Maruszczak et al. 1972). The soil from the Mazovian Interglacial corresponds to the Zawada soil complex in the San and Dniester interfluve. This pedocomplex was developed on the Tiligulian Loess or on the moraine from the Oka Glaciation (Bojarskaja et al. 1973, Veklich and Sirenko 1976).

The subsequent unit of the sediments from Siedliska is represented by a loess-like deposit which was TL dated at about 350 ka, so it can be correlated with the Liwiec Glaciation (pre-Saalian) corresponding to the oxygen isotope stage 10 (Lindner 1988, 1991); loesses and loess-like deposits of such stratigraphical position are denoted as LN1. Deposit features indicate weak eolian accumulation, with participation of slope processes, in conditions of more wet cold climate.

It is difficult to interpret a stratigraphical position of an interstadial soil formed on the loess-like deposit LN1 (site No 2). It was probably a complicated situation. It it rather no reason to recognize this soil as a result of pedogenesis older then the middle part of the Vistula Glaciation, because signs of denudation processes (which could point to a longer hiatus) are absent in its top. Furthermore, the whole sequence of lithological features of the loesses overlying this soil, and also their TL age determined at 22 ka, univocally evidence that they represent the phase of the last climatic pessimum, i.e. Upper Pleniglacial of the Vistulian (Veichselian). However, it is not unlikely that the earlier weathering-pedogenic processes, of difficult to define age, formed a horizon of illuviated carbonates in the bottom part of the LN1 bed, which is marked by big concretions (compare Pécsi and Richter 1996). If so, then the stratigraphic hiatus of a greater time and morphogenetic significance was obliterated by the younger soil-forming processes.

The interstadial gley soil developed on the LN1 deposit probably corresponds to the subarctic brown soil at the top of till in the exposure 1, which is connected with the better drained part of the buried slope. Similar genetic differentiation, conditioned by relief, is shown by the Interplenivistulian soils developed on the middle younger loess in the mouth of the San river valley from the Carpathians (Łanczont 1995a).

The last geological event of the Pleistocene recorded at Siedliska was connected with sedimentation of loess deposits, which represent stratigraphic unit of the upper younger loess LMg in the scheme work out by Maruszczak (1991). Features of this loess evidence intensive eolian accumulation in severe continental climate of the Plenivistulian, at first with participation of the washing processes. The upper younger loess covers considerable areas in the Przemyśl environs, and its small patches extend into the foothills, where their southern limit is in line with the vertical extent at 280–320 m a.s.l. (Łanczont 1993). At this upper limit, in zone of the Carpathian margin (Winna Góra, 275 m a.s.l.) the LMg loess overlying flysch schists reaches thickness of 8 m.

FINAL REMARKS

1. On the basis of the presented geological data and results of TL datings it can be supposed that the old-Quaternary water outflow from the Carpathian margin to the Dniester river catchment was stopped in the Malopolanian Interglacial, and the San river valley was formed downstream of Przemyśl. This fact could be connected with the so-called Kujawy phase — the middle one from the Quaternary phases of intensified tectonic activity in the Polish territory distinguished by Baraniecka (1983). TL datings of sands and gravels of Carpathian origin deposited on the erosional surface show that they were accumulated between about 611 to 555 ka BP. This valley aggradation should be related to advance of the San 1 ice sheet in the northern part of the Sandomierz Basin.

2. These data indicate that the preglacial series at Siedliska, correlated by Laskowska-Wysoczańska (1980) with the early Pleistocene, is younger. In this instance the petrographic analysis of gravels appeared to be insufficient criterion to interpret stratigraphic position of the deposits.

3. The moraine deposits from the Siedliska site were formed during the period of the maximum extent of the Scandinavian ice sheet and represent the transgressive phase of the San 2 Glaciation.

4. An important fact in paleogeographical development of the described area is occurrence of under- and over-moraine loess deposits corresponding to the oldest loesses which represent the San 2 (ascending part) and Liwiec Glaciations. Up till now, loess accumulation during the older glacial cycles has been recorded in the South Polish Uplands, mainly in borings (Dolecki 1991, Lindner 1988, Maruszczak 1985a). In the northern part of the Carpathians the following oldest stratigraphic loess units with paleosols of interglacial rank were evidenced: from the Wilga Glaciation (recession stadial of the San 2 Glaciation) and from the Liwiec Glaciation in the Załubińcze profile near Nowy Sącz (Nawrocki and Wójcik 1995), and from the Odra Glaciation in the Prałkowce profile near Przemyśl, where the loess deposits contain malacofauna typical for loesses (Łanczont 1991, 1994). It seems that westwards of Przemyśl the real chances are to find and evidence the oldest loess deposits, which can occur in higher slope parts of the San river valley, among other things under the preserved patches of the till from the San 2 Glaciation.

5. During the studies of the Siedliska profile the numerous erosional-denudational surfaces were found, which represent long hiatuses. There were evidenced the stratigraphical breaks falling on the interglacial periods of the Middle Pleistocene, and the long break comprising a considerable part of the Younger Pleistocene: from the Odra Glaciation to the Interpleniglacial of the last cold period. Therefore, univocally defined and full profiles of paleosols of higher stratigraphical rank were not found. Perhaps an exception is the preserved bottom part of paleosol developed on the till from the San 2 Glaciation, which probably represents the Mazovian Interglacial.

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to dr Maria Wilgat for the heavy minerals analysis and for preparing the English version of this paper, to dr Jerzy Nowak for the petrographical analysis of gravels and to mgr Sławomir Terpiłowski for discussing sedimentological problems of the examined deposits. Mgr Ewa Sadowska kindly helped with preparation of the figures. I tender my grateful thanks to mgr eng. Jan Błotnicki and to IV year students of geography at the Maria Curie-Skłodowska University for help during the field works in 1992.

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STRESZCZENIE

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PROFIL OSADÓW CZWARTORZĘDOWYCH W SIEDLISKACH NA PRZEDGÓRZU KARPAT PRZEMYSKICH (POLSKA SE) I JEGO PALEOGEOGRAFICZNE ZNACZENIE

Artykuł omawia profil osadów czwartorzędowych w Siedliskach na Płaskowyżu Chyrowskim, w bliskim sąsiedztwie brzegu Karpat przemyskich (ryc. 1). Profil ten charakteryzuje się znaczną miąższością oraz zróżnicowaniem genetycznym utworów z udziałem osadów fluwialnych, glacjalnych i eolicznych (ryc. 2, 4). W przewadze są to osady mezoplejstocenu (ryc. 3). Stwierdzono w badanym profilu kilka poziomów z oznakami rozwoju procesów glebotwórczych, o różnej randze stratygraficznej; są one jednak słabo zachowane ze względu na późniejsze procesy denudacyjne. Najwyższa część odsłonięcia wznosi się 285 m n.p.m. i 97 m nad średni poziom wody w korycie Sanu. Pełny profil osadów badanych w 5 odkrywkach obejmuje od góry (ryc. 3): 1. less (wiek TL — 22 ± 4 ka); 2. utwór lessopodobny (wiek TL — 350 ± 79 ka); 3. glina zwałowa (wiek TL określono na 506 ± 114 ka oraz więcej niż 262 ka); 4. less (wiek TL — 538 ± 121 ka); 5. seria rzeczna złożona z mułków, piasków i żwirów wyłącznie pochodzenia karpackiego (wiek TL w przedziale 555–611 ka), leżąca na 80 m wysokości cokole skalnym, zbudowanym z trzeciorzędowych iłów warstw przeworskich zapadliska przedkarpackiego.

Według Laskowskiej-Wysoczańskiej (1980) te aluwia są wieku wczesnoplejstoceńskiego i stanowią osady pra-Sanu, związanego wówczas z dorzeczem Dniestru. Czas, kiedy nastąpiła przebudowa systemu hydrograficznego Kotliny Sandomierskiej i przerwanie odpływu w strefie brzegu karpackiego ku SE (tłumaczone neotektoniczną mobilnością obszaru międzyrzecza sańsko-dniestrzańskiego), odnoszony jest do okresu przed nasunięciem lądolodu krakowskiego (Teisseyre 1938), tj. na zlodowacenie günz (Starkel 1984) lub interglacjał malopolanian (Pożaryski i in. 1994) ewentualnie do okresu po jego recesji (Romer 1907), a nawet po ustąpieniu lądolodu odrzańskiego (Laskowska-Wysoczańska 1993). Prezentowane materiały geologiczne oraz fakty natury geomorfologicznej dają podstawę do przypuszczenia, że omawiane osady rzeczne

związane były z sedymentacją o charakterze roztokowym oraz zostały złożone przez wody Sanu odprowadzane z jego karpackiej zlewni ku północy, podczas środkowego ze zlodowaceń południowopolskich — san 1. Powstanie tej doliny można by więc wiązać z interglacjałem malopolanian, co odpowiada koncepcji Pożaryskiego i in. (1994).

Podmorenowa seria lessu węglanowego powstała w fazie wstępującej zlodowacenia sanu 2 i korelowana jest z LN2 (less najstarszy drugi) w schemacie stratygraficznym lessów polskich Maruszczaka (1991) oraz LN2b według schematu lessów najstarszych skonstruowanego przez Doleckiego (1991, 1995). Jest to jedyne stanowisko lessów tego wieku w strefie bezpośredniego przedpola wschodniego odcinka Karpat. Cechy litofacjalne tego utworu (ryc. 5) oraz zespół typowo lessowej malakofauny, licznej pod względem dobrze zachowanych okazów, ale wyłącznie jednego gatunku *Succinea oblonga elongata* (Łanczont i Alexandrowicz w druku), wskazują na sedymentację w warunkach zimnej i względnie wilgotnej tundry subarktycznej.

Przewodnim poziomem stratygraficznym w Siedliskach jest glina zwałowa, reprezentująca zlodowacenie południowopolskie san 2 w maksymalnym zasięgu. W składzie petrograficznym tej gliny przeważają skały lokalne; żwiry skał skandynawskich stanowią 25,3–30,5% i brak wśród nich dolomitów i łupków paleozoicznych. W tym względzie wykazuje ona duże podobieństwo z gliną zwałową tego wieku na Wyżynie Zachodniowołyńskiej i w Kotlinie Sandomierskiej (Dolecki i in. 1996). Zachowały się najniższe "korzeniowe" podpoziomy gleby kopalnej rozwiniętej na tej glinie (stanowisko 2). Zapewne można ją korelować z interglacjalną glebą oznaczaną symbolem GJ3b, przypadającą na interglacjał mazowiecki (Maruszczak 1991).

Kolejny cykl glacjalny sedymentacji eolicznej reprezentuje — zachowany tylko w niewielkim płacie (stanowisko 2) — utwór lessopodobny, paralelizowany ze zlodowaceniem liwca i oznaczony symbolem LN1 (less najstarszy pierwszy). Ten less jest zwietrzały i zawiera tylko wtórne węglany. Górny odcinek profilu o miąższości 2–4 m obejmuje osady lessowe, których akumulacja miała miejsce podczas pełni zlodowacenia wisły; mogą one być korelowane z jednostką stratygraficzną określaną jako less młodszy górny (LMg). W spągu tego lessu jest gleba interstadialna, paralelizowana z interpleniglacjalnym ociepleniem.

W profilu występują liczne luki stratygraficzne, zarejestrowane w kopalnych powierzchniach erozyjno-denudacyjnych; najpoważniejsza przerwa obejmuje znaczną część neoplejstocenu, od zlodowacenia odry do młodszej części zlodowacenia wisły.