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Vistulian loess deposits of the Dalków Hills

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A new site of loess deposits of the Dalków Hills at Cisów, and spatial relations between loess deposits and glacial deposits are presented in order to determine potential sources for alimentation of loess material. Based on detailed lithologic investigations, including textural, structural and lithofacial analysis, massive and crypto-laminated loess deposits were identified. Genesis of loess deposits at Cisów suggests that these are of the Vistulian age, formed under periglacial conditions in this area after a retreat of the ice sheet of the Leszno Phase (20 ka BP).

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Key words: Dalków Hills, Vistulian loess deposits, periglacial conditions.

INTRODUCTION

In Poland investigations of loess deposits were mainly conducted in uplands and piedmonts in a southern part of the country. A. Jahn (1950) and A. Malicki (1967) claimed that loess deposits were found only sporadically within glacial deposits of the Middle Polish Glaciation in northern Poland. This is the case in the Małopolska Upland and the Lublin Upland, whereas in western Poland loess commonly covers deposits of the Odranian Stage and, in the vicinity of Trzebnica, deposits of the Wartanian Stage (J. Jersak, 1973; J. Rokicki, 1952; Z. Jary, 1996).

STUDY AREA

The Dalków Hills form the northwestern range of the Trzebnica Ridge. Next to the view that this ridge is of a glaciotectonic origin connected with the Wartanian Stage (S. Dyjor, 1991; B. Krygowski, 1972; K. Rotnicki, 1960, 1966), there is a hypothesis on subglacial genesis of glaciotectonic dislocation of the Trzebnica Ridge (K. Brodzikowski, 1987; S. Szczepankiewicz, 1989). According to the latter, the Trzebnica Ridge was formed any later than during the Odranian Stage of the Middle Polish Glaciation. The study part of the Dalków Hills is named the Kożuchów Hills by W. Walczak (1971). The hills are an end moraine (B. Krygowski *et al.*, 1953), from 80–100 m a.s.l. in the north up to 180–200 m a.s.l. in the south (Fig. 1).

The study sites Cisów 1, 2 and 3 are located in small erosive valleys south of Kożuchów, within the northern slope of the Dalków Hills (Fig. 2). Loess deposits of the Dalków Hills cover hill slopes, composed of glacial and fluvioglacial deposits (Fig. 4). They are usually 2–3 m thick.

LITHOLOGY

Loess deposits of the Dalków Hills were first described by J. Rokicki (1952) who considered them the product of washing and water accumulation, and termed them the clayey sands. A. Kowalkowski (1966) referred origin of silt deposits on the Dalków Hills to aeolian processes, occurring in a periglacial climatic conditions of the Leszno Phase of the Vistulian.

The loess series is from 0.5 (Cisów 2) to 2.9 m (Cisów 1) thick (Fig. 5) and its lithology is as follows:

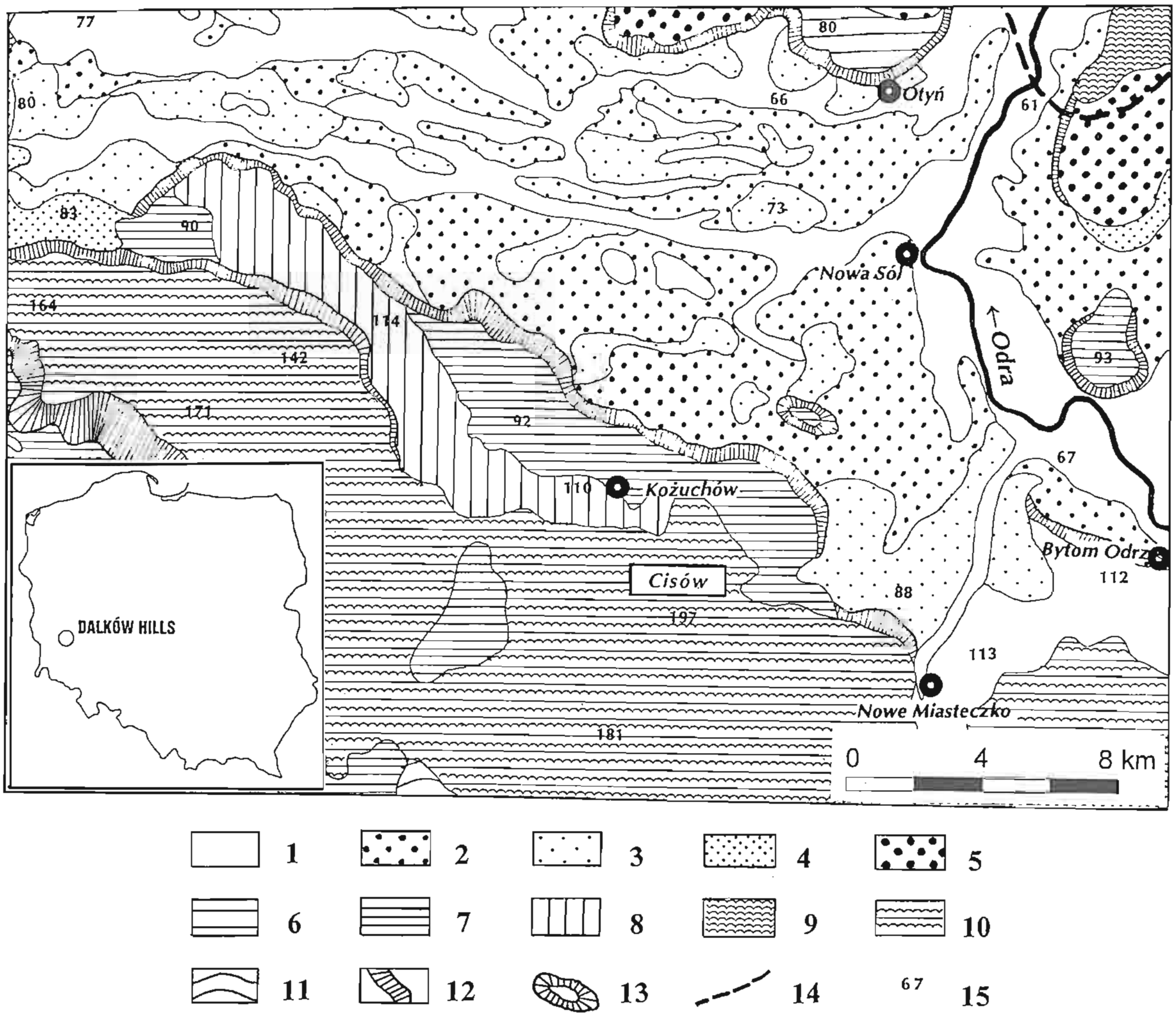


Fig. 1. Fragment of the *Geomorphological Map of Poland* 1:100 000, sheet Szprotawa, after B. Krygowski *et al.* (1953)

1 — flood and bottom terrace, bottoms of basins and tunnel valleys, 2 — middle terrace, 3 — high lower terrace, 4 — high higher terrace, 5 — outwash plain, 6 — flat morainic plateau, 7 — undulated morainic plateau, 8 — hummocky morainic plateau of accumulation origin, 9 — hummocky end moraine with lower relief, 10 — hummocky end moraine with higher relief, 11 — strongly hummocky morainic plateau of earlier glaciation, 12 — scarps, edges and valley slopes, 13 — residual hill, 14 — limit of the Vistulian Glaciation; Cisów — study site

CISÓW 1 (165.0 m a.s.l.)

0.0–0.1	Humus horizon.
0.1–1.4	Structure-less loess deposits, at 0.7 and 1.0 m levels with fissures are identified.
1.4–3.0	Fine (crypto-)laminated loess deposit.
> 3.0	Medium- and coarse-grained sands with single pebbles and single inserts of light grey muds.

CISÓW 2 (162.5 m a.s.l.)

0.0–0.1	Humus horizon.
0.1–0.6	Structure-less loess deposits.
0.6–0.7	Very fine-grained sand.
> 0.7	Brown till, many pebbles in the top.

CISÓW 3 (175.0 m a.s.l.)

0.0–0.45	Humus horizon.
0.45–2.10	Structure-less loess deposits, in the bottom single inserts of very fine-grained sand, at 2.05 m — decalcification horizon.
2.10–2.25	Dark grey very clayey till.
> 2.25	Coarse-grained sand with gravel, clay cement.

The loess series at Cisów is a massive, non-carbonate deposit at the top which forms a lithofacies of massive loess. At Cisów 1, depth 0.7 and 1.1 m, there are fissures which form in plan irregular hexagonal polygons, 10–40 cm in diameter. The massive loess lithofacies at this site passes directly into a laminated loess lithofacies, being a crypto-laminated loess

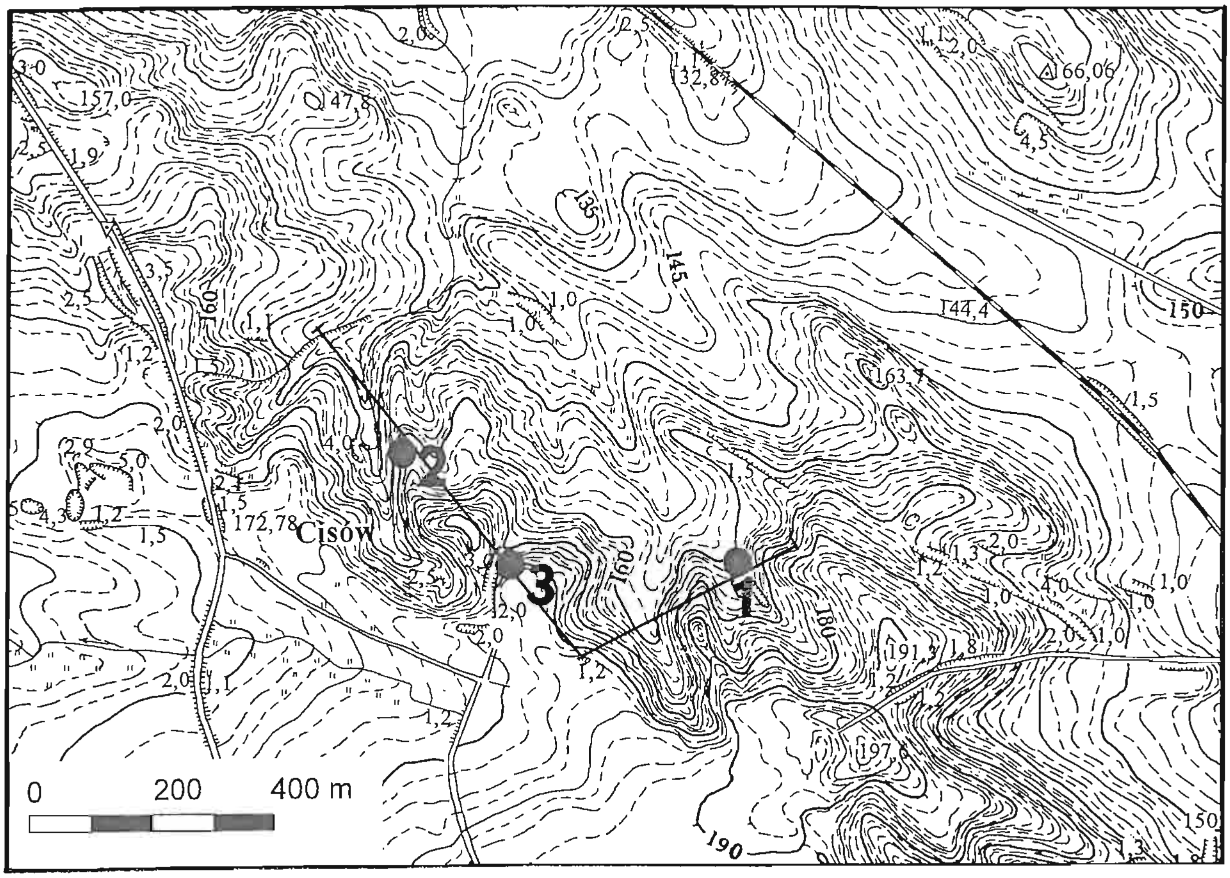


Fig. 2.Fragment of a topographic map with study sites (1–3) and a morphologic profile

sublithofacies. Individual laminae are 1–2 cm thick, from dark yellow to brown. The contact between loess deposits and underlying deposits is very clear. At all investigated sites there is more sandy material in the bottom of the loess series, i.e. when it comes in contact with fluvioglacial deposits. The glacial deposits are tills, sands and fluvioglacial gravels, and the ice sheet was also responsible for glaciotectonic pushing of the patchy Pliocene clays (Fig. 3).

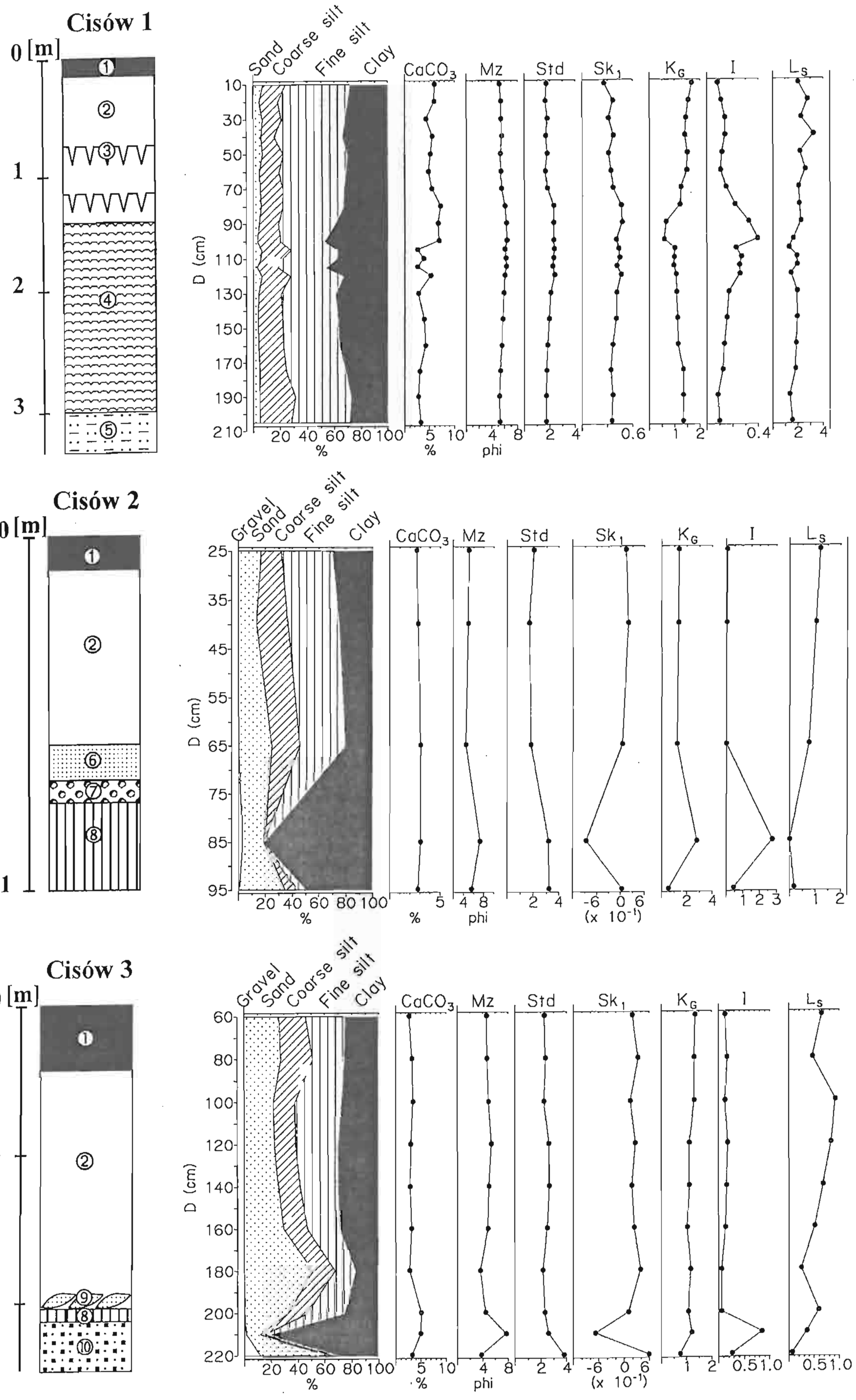
At all the sites throughout the section, there is large content of fine silt (0.05–0.02 mm), i.e. loess fraction — from 22.7 (Cisów 3) to 43.0% (Cisów 1), and clay (< 0.02 mm) — from 20.1 (Cisów 1) to 40.7% (Cisów 2). The percentage of colloidal clay (< 0.002 mm) ranges from 4.4 (Cisów 2) to 15.3% (Cisów 3). At Cisów 2 and 3 there is much sand (1–0.1 mm), from 20.9 to 30.0%. Graphic grain size indices (*cf.* R. L. Folk, W. C. Ward, 1957) are: mean grain diameter Mz from 3.61 to 7.66 phi, standard deviation Std from 1.64 to 3.81, skewness Sk_I from –0.87 to 0.58 and curtosis K_G from 0.56 to 2.76. Clayey index I (A. Karczewski, 1963) ranges from 0.02 to 2.75 and loess index L_s (J. Nowak, 1981) from 0 to 3.23 (Fig. 3).

There is a very small content of calcium carbonate, usually from 2.87 (Cisów 2) to 4.58% (Cisów 1) only. Such a low content, even at considerable depths (2.9 m at Cisów 1), is connected with decalcification of deposits within periglacial erosive valleys. W. J. Vreeken and H. J. Mücher (1981) found that within dry periglacial valleys in the Netherlands, where dewatering led to increased permeability, loess deposits have been more intensively decalcified than in the vicinity.

From a mineralogical-petrographic point of view, loess deposits of Cisów consist mainly of quartz, muscovite, feldspars (microcline, plagioclases) and clayey minerals. Next to this basic material there are also glauconite, biotite, fragments of rhyolite and heavy minerals. Mineralogic investigations could determine indirectly a potential supply source of silty material. Basing on mineralogic and granulometric investigations of loesses in the Małopolska Upland, R. Chlebowski and L. Lindner (1992) pointed out to a local character of loess accumulation during the Vistulian.

In microscale these deposits indicate an aggregate structure, with individual grains bonded by ferric compounds and clayey minerals. At depth up to 60 cm at Cisów 1, small quantities of organic matter (0.59–3.11%) including 0.34–1.80% of C were found in the bottom.

In microstructure, the predominant are microlaminae and periglacial silt droplets microstructures (J. J. M. van der Meer, 1987; H. Mücher, 1986), striotubule biomicrostructures, biopores and cutans microstructures (J. Biernacka, K. Issmer, 1996; R. Brewer, 1976).


Cisów 1
0 [m]
1
2
3
Sand
Coarse silt
Fine silt
Clay
CaCO3
Mz
Std
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Ls
D (cm)
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phi
Cisów 2
Gravel
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Cisów 3

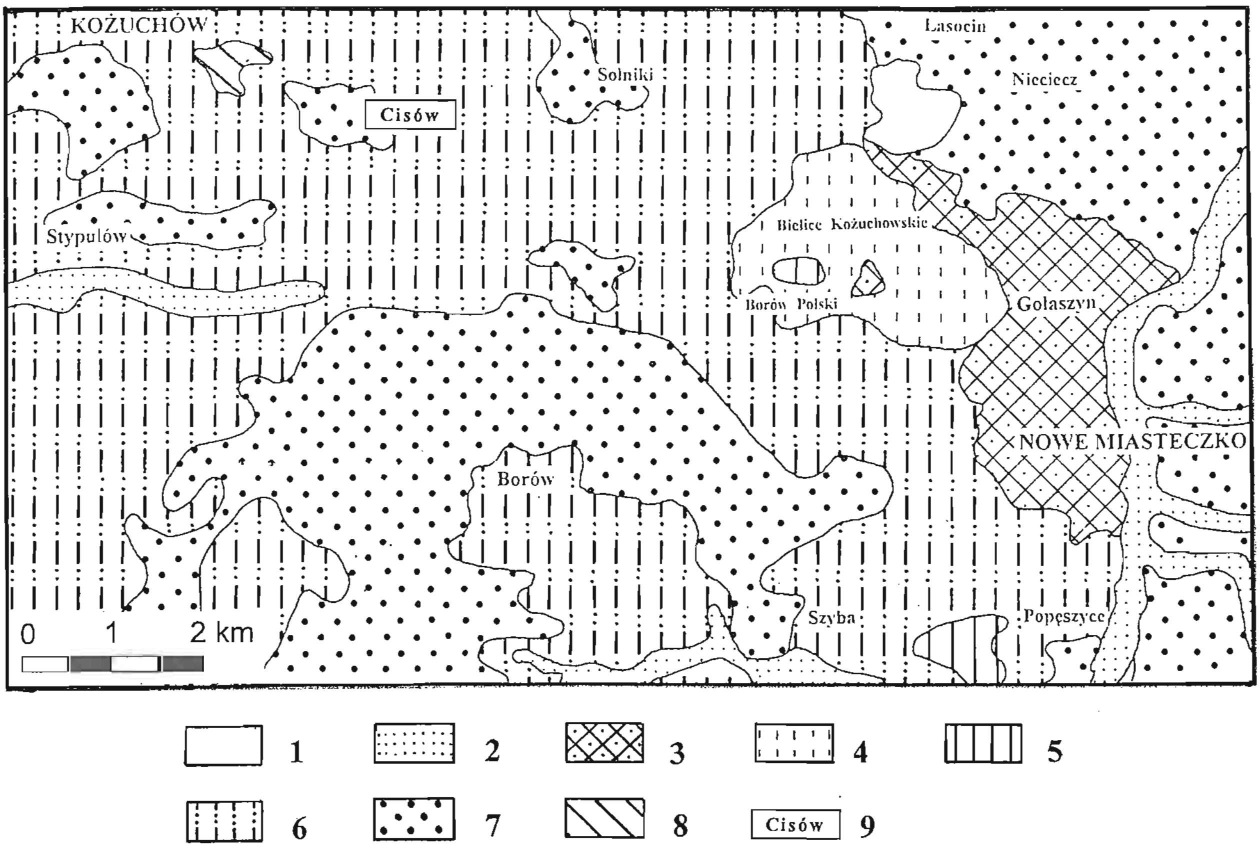

Fig. 4. Fragment of the *Geological Map of Poland* 1:200 000, sheet Zielona Góra, after J. E. Mojski, A. Kawecka (1976)

Holocene: 1 — organic muds, 2 — alluvial muds, sands and gravels, 3 — deluvial sands and clays; **Vistulian**: 4 — loesses; **Middle Polish Glaciation — Wartanian Stage**: 5 — glacial sands, gravels and blocks, 6 — till and its residues, 7 — fluvioglacial sands and gravels; **Neogene**: 8 — clays, muds and sands; 9 — study sites

RECONSTRUCTION OF PERIGLACIAL CONDITIONS

Loess deposits at Cisów (Dalków Hills), found within a limit of periglacial processes and phenomena during the Vistulian, were accumulated on end moraines of the Wartanian Stage. Based on litho- and morphostratigraphic data, the origin of loess series at Cisów should be referred to the Leszno Phase of the Vistulian Glaciation (20 ka BP). The same conclusion was drawn by J. E. Mojski (1977) with reference to loess deposits at Bielice Kożuchowskie (Fig. 4).

Relations between Vistulian loess deposits and glacial deposits and forms are not only morphologic but also genetic ones. This is confirmed by investigations of loess deposits in western Pomerania (J. Cegła, S. Kozarski, 1976; K. Issmer *et al.*, 1990; S. Kozarski, B. Nowaczyk, 1991, 1992). Fluvioglacial deposits and forms are an intermediary link of silty material between a glacier and accumulates, i.e. loess covers. Deposits of fluvioglacial and glacial features are a potential source for alimentation of silty material.

Giving theoretical principles of loess formation and its relation to a glacial environment, J. J. Smalley (1966) distinguished six phases of loess history. The first phase is formation of quartz grains due to glacial processes, the second is glacial crushing of quartz grains and other rock components, the third — glacial transport of detritus, the fourth — deposition of mixed melt-out detritus, the fifth — wind transport, and the sixth deposition of silty material. H. Maruszczak (1990) suggests to use the term periglacial loess rather than glacial loess as the former is more suitable to the origin of loesses in most area of Europe.

D. Goossens (1988) postulates that silty deposits, mean grain diameter 30 μm, are mainly accumulated in front of orographic obstacles or directly on the obstacles, depending

Fig. 3. Grain size distributions and calcium carbonate content in deposits at the study sites Cisów 1–3

1 — humus horizon, 2 — massive loess, 3 — fissures, 4 — crypto-laminated loess, 5 — muds and clayey inserts within fluvioglacial deposits, 6 — structure-less fluvioglacial sands, 7 — stones, 8 — till, 9 — sandy inserts, 10 — structure-less fluvioglacial sands and gravels; graphic grain size indices: Mz — mean grain diameter, Std — standard deviation, Sk_I — skewness, K_G — curtosis, I — clayey index, L_s — loess index; gravel (> 1mm), sand (1–0.1 mm), coarse silt (0.1 –0.05 mm), fine silt (0.05 –0.02 mm), clay (< 0.02 mm)

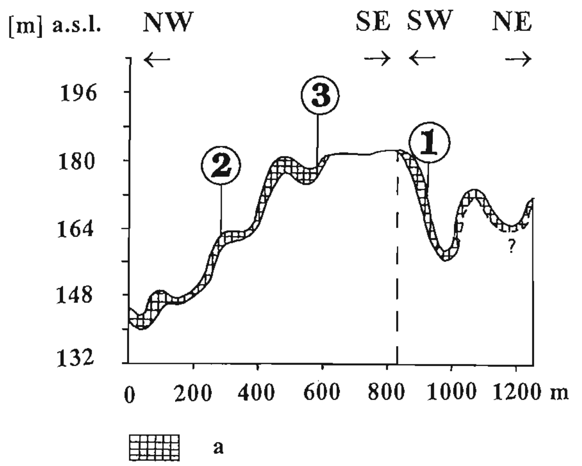

Fig. 5. Morphological profile through the end moraine with loess cover and the study sites at Cisów
1 — Cisów 1, 2 — Cisów 2, 3 — Cisów 3; a — loess deposits

on a predominant wind direction. Orographic obstacles themselves strengthen turbulence of winds but do not weaken the accumulation processes.

Loess deposits at Cisów, occurring in the top parts of end moraines of the Wartanian Stage, confirm the views of D. Goossens (1988) that loess deposits can be also accumulated in areas of increased turbulence, that is at highest points of orographic obstacles (Fig. 5). Likewise, the view of J. J. Smalley (1966) is also confirmed, concerning development phases of loess covers and their indirect relation to a glacial environment.

Basing on lithologic and sedimentologic analyses, the loess deposits at Cisów should be treated as the periglacial short transport loess deposits. The present investigations helped also to identify lithofacies of massive loess and sublithofacies of crypto-laminated loess, the latter being a variant of the laminated loess lithofacies. In lithofacial analysis a subdivision applied for loess deposits in western Pomerania has been adopted (K. Issmer, 1998).

However, a significant role in development of the Vistulian loessy covers in western Poland was played by climatic conditions, connected with the past periglacial zone in this area.

CONCLUSIONS

Preliminary lithostratigraphic investigations lead to conclusion that the beginning of the accumulation of loess deposits of Dalków Hills was at the Pleni-Vistulian. The genesis of subareal loess series is connected directly to the presence of periglacial zone. Consequently, these deposits should be termed Vistulian periglacial loess deposits.

The lithologic variability of loess deposits of the Dalków Hills, manifested in the lithofacial variability, indicates both the lithologic differentiation of the areas of alimentation and different climatic conditions during the last deglaciation between 20 and 16.2 ka BP (S. Kozarski, 1995).

Apart from the lithologic and climatic factors the morphologic factor should also be considered as it conditions the origin of covers of loess deposits at certain places. Non-continuous covers of loess deposits in the top parts of end moraines of the Dalków Hills (Fig. 3) point to the fact that is mainly the aeolian transport in all its variations that is responsible for the delivery of silty materials to these places.

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VISTULIAŃSKIE OSADY LESSOWE WZGÓRZ DALKOWSKICH

Streszczenie

Zaprezentowano nowe stanowiska osadów lessowych na Wzgórzach Dalkowskich dla ustalenia relacji przestrzennych między osadami lessowymi a glacjalnymi w celu określenia potencjalnych źródeł alimentacji materiału lessowego (fig. 1, 2, 5). Na podstawie szczegółowych badań litologicznych, w tym analiz teksturalnych i strukturalnych oraz analizy litofacjalnej, wydzielono osady lessowe masywne i skrytolaminowane (fig. 3, 5). Geneza osadów lessowych z Cisowa pozwala wnosić, że są to vistuliańskie osady lessowe powstałe w warunkach peryglacjalnych panujących na tym obszarze po ustąpieniu lądolodu fazy leszczyńskiej (20 ka BP).