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The Accumulation Conditions of Neopleistocene Loess Deposits in the Northern Periphery of their Distribution in East Poland: an Instance from the Łęczna Environs

Warunki akumulacji neoplejstoceńskich utworów lessowych w strefie północnej peryferii ich występowania: przykład z okolic Łęcznej (Polska SE)

ABSTRACT

In deposits recognized as loess-like, the differentiation of granulation and thickness as well as their distribution were analyzed. The mentioned features of the cover formed by these deposits were the basis for the reconstruction of the dynamic conditions of eolian accumulation of silt in plain areas belonging to the Middle Polish Lowlands. Attention was paid to great differentiation of granulation characteristic for the deposits examined in these areas. Typical is a considerable increase of their thickness in the areas where orographic obstacles occur, i.e. low morphological near-edge ridges. From that the following conclusions cam be drawn supporting: a) the finding of the predominating role of eolian transport at a short distance (two kinds of such transport were distinguished); b) the reconstruction of the direction of the prevailing transporting winds (mainly from east and west).

INTRODUCTION

The first detailed information about the occurrence of loesses in the environs of Łęczna was presented by T. Mieczyński on a soil map 1 : 300 000 of the Lublin district in 1932, on which "deep loesses" (over 2–3 m thick) and "sandy loesses" were distinguished. The range of these loesses was accepted with small corrections in 1946 by S.Z. Różycki, when preparing the "Lublin"

sheet of the General Geological Map of Poland 1 : 300 000. This range was repeated in recent years without significant changes on the Geological Map of Poland 1 : 500 000 made by E. Rühle and published in 1986. In the more limited range loesses and loess-like deposits were shown on the "Łęczna" sheet of the Detailed Geological Map of Poland 1 : 50 000 published in 1980 (M. Harasimiuk and A. Henkiel 1980a, b).

The loess deposits of the Łęczna environs are developed untypically, not because of their lithological features but also of their relatively small thickness. Therefore, on the review maps in scales smaller than 1 : 1 000 000, they were omitted, also due to generalization. They were especially omitted on maps of distribution of loesses in Poland, which illustrated the papers of H. Maruszczak published in the years 1972–1987. On these maps only loesses thicker than 2–3 m were taken into consideration (e.g., H. Maruszczak 1987).

The purpose of this paper was not so much a more detailed presentation of the lithological features as to determine the peculiarities of the accumulation conditions of the deposits in the northern periphery of the range of loesses in Poland. It may be considered that the lithological features and distribution regularities correspond to an extremal variety of the accumulation conditions of loesses. The basic material for this work consisted of the results of the author's field studies of the superficial layers of the Quaternary deposits, carried out in the 70's at 450 points in an area of about 45 km^2. Beside the author's own actual data, also those have been taken into consideration which were obtained by Doc. M. Harasimiuk from 250 points in an area of 25 km^2, for which I am very thankful. Due to that an area of about 65 km^2 is involved in this paper.

GENERAL GEOLOGIC-MORPHOLOGICAL CHARACTERISTICS OF THE AREA STUDIED

The Łęczna environs are situated in the border zone of the Lublin Upland and the Western Polesiye Lowland. Carbonate rocks of the upper Maestrichtian of several hundred meters in thickness largely occur in the bedrock of the Quaternary deposits. Regardless of a considerable lithological differentiation of these rocks (gaizes, marlaceous gaizes, marls, marly limestones and soft limestones of the chalk type), composed arrangement and very small dips of the layers determine the general, plane character of the relief.

The rocks of the upper Maestrichtian as well as thin layers of Paleocene rocks (gaizes with interbeddings of limestones and marls) covering them in the western part of the area were subjected to a strong denudation in the Neogene. This was followed by extensive surface planations. The lower of them, truncutting the upper Maestrichtian, takes up the largest part of the area, and at present it rises 170–180 m a.s.l. It was formed on the turn of Pliocene and Pleistocene. The older and higher surface planation, however, rising 190-200 m a.s.l. and occurring only in the western part, cuts away largely Paleocene rocks. The extensive, lower surface planation was dissected by the wide and 70 m deep pra-Wieprz river valley in Protopleistocene and in the older and middle Pleistocene, and then by up to 100 m deep and narrow erosion gully (M. Harasimiuk and A. Henkiel 1980a, b, J. Butrym et al. 1991). These valleys were gradually filled up as early as in the older Pleistocene, particularly in the middle during Odranian glaciation (=Saalian I), when the whole area discussed was within the reach of the inland ice. As a result of this filling up, a polygenetic plain was formed which comprises preserved fragments of the lower Pliocene-Pleistocene surface planation, as well as areas of middle Pleistocene accumulation. In its southern part the plain rises 175–180 m a.s.l. and descends slightly northwards to 170–175 m a.s.l. (Fig 1). Where upper Cretaceous marly limestones and soft limestones are exposed on the surface or they occur at depths up to several meters, the plain is variegated by numerous karst dolinas (chalk karst type). In its southern, more elevated part they are mostly small dry forms (without water on the bottom). In the northern part situated more lower, with shallow ground waters, dolinas combine into larger forms of uvala types. The bottoms of these forms are usually planated by Holocene deposits of boggy type, among which small lakes occur here and there.

The principal plane urface is dissected by recent valleys of the river Wieprz and its tributaries. The Wieprz river valley is divided into two different segments. In its south-east part it is an up to 2 km wide form and 15-20 m deep, which was formed as a result of exhumation old valleys (the lower section from Łańcuchów to Zakrzów — Fig. 1) — after Odra inland ice regressed. However, the middle and north-west part is constituted by a gorge with steep sides, 20–30 m deep and only 0.5 km wide. Among the tributaries of the Wieprz river the biggest is Świnka, the valley of which in the east cuts into the plain only up to 10 m, and up to 20 m in the west at the estuary.

To make the image of the principal relief elements more complete, it should be added that in the south-east part there occur fragments of a more

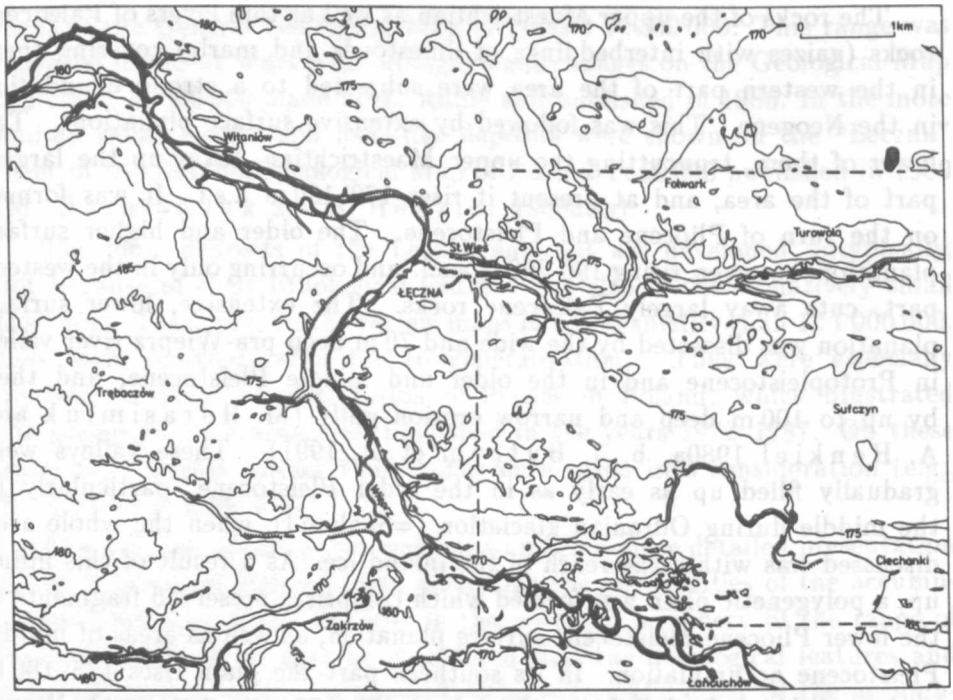

Fig. 1. A sketch-map of the Łęczna environs; isohypses drawn every 5 m. The range of the area presented in Fig. 4 is denoted by a dashed line

extensive, polygenetical terrace plain stretching in large areas along the river Wieprz above Łańcuchów. It rises 10–15 m over today's valley bottom of this river. It is built of river and lake-overflow sediments of the Wartanian (=Saalian II) age, generally overlain by thin covers of subaqual or subaerial sediments of the Vistulian (=Weichselian) age. Proper terraces from the period of the latter glaciation are preserved only in small fragments in the Wieprz river valley, which do not deserve attention from the point of view of the problems discussed in this paper.

The differentiated geological structure of the Łęczna environs is similar to that of the neighbouring ones from the south-west areas belonging to the Lublin Plateau. This differentiation had no significant effect on loess accumulation. As in the upland mentioned loesses were generally accumulated on different bedrocks and clastic deposits in Poland's territory.

However, relief was of important significance. As regards Poland, typical loesses have been found to occur in thicker covers only in areas with a marked relief (upland and foothills), largely on the hypsometric

level 200–350 m (H. Maruszczak 1985). They are found rather exceptionally in peripheral zones of uplands, at heights down to 180 m a.s.l. (M. Harasimiuk 1987). They occur rarely above the upper limit mentioned, but this is irrelevant in the present study.

In the environs of Łęczna the deposits discussed occur on areas beneath the lower limit of the "loess level" in Poland. Hypsometrically this region belongs to the belt of mid-Polish lowlands, and not to the south-Polish uplands. However, the deposits discussed are connected with areas adjacent to the Wieprz river valley, the relief of which is a little rougher. It can be stressed that along the typically lowland section of this river valley, stretching further north-westwards from the area discussed loess deposits do not occur any more. They are not even distinguished where the relative relief is similar to that in the Łęczna environs, or even bigger.

LITHOLOGICAL AND STRATIGRAPHIC CHARACTERISTICS OF LOESSES

The deposits discussed are characterized by a considerable admixture of sand grain. Thus on the map by T. Mieczyński (1932) largely "sandy loesses" were reasonably distinguished. Also the deposits, which were determined as "deep loesses" on the above map and which occupy the east part between the rivers Wieprz and Świnka —situated east of the line joining the localities Łańcuchów in the south and Folwark in the north (Fig. 1) — are distinguished by a considerable content of sand fractions.

The admixture of sand grains occurs in two forms: 1) regularly mixed up with silt fractions, 2) as more or less distinct interbedding of silty and fine sands. The former practically occurs in the whole profile of the deposits discussed. The latter, however, plays the biggest role in their lower parts.

A high content of sand grains makes it difficult to distinguish unequivocally the deposits still corresponding to the term "loess" from those which have already become sandy. This is significant not only in analysing the differentiation and horizontal ranges indicated on maps, but also in determining the lower boundary of deposits in vertical profiles. Thin loess covers cause particularly great difficulties. They can be distinguished most easily when Upper Cretaceous or Paleocene rocks occur in the substratum. However, when they occur on Pleistocene silt-sandy deposits the difficulties are very great. They become greater when data are available only from drillings made with manual soil augers (most actual data for the present paper). Therefore, only covers of over 2 m in thickness were taken into account when preparing a distribution map of the deposits discussed. A smaller thickness

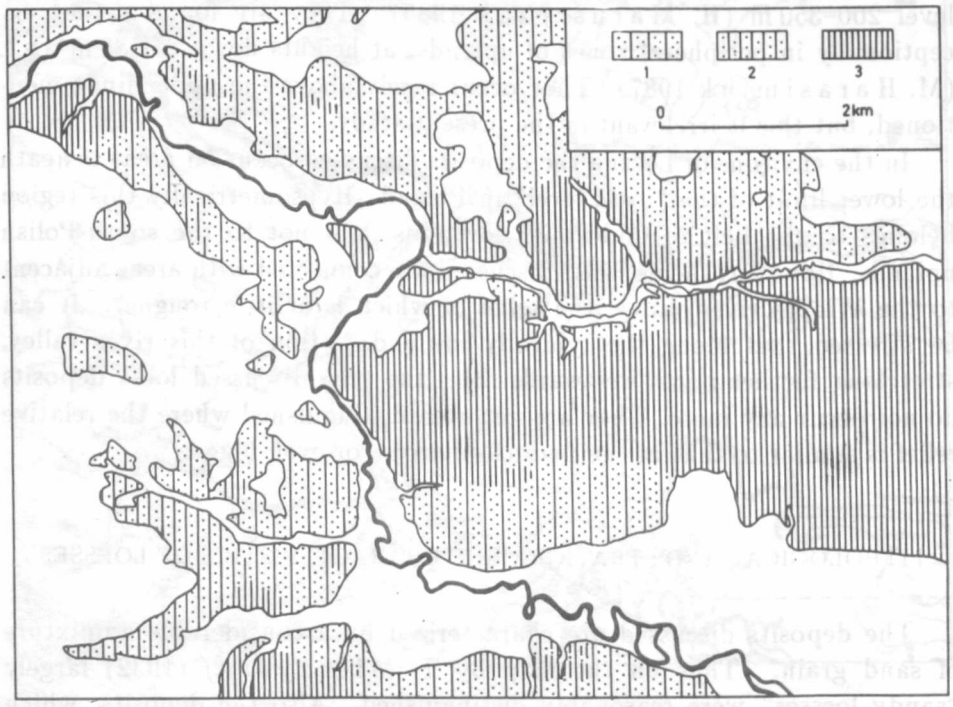

Fig. 2. Lithological varieties of loess deposits in the Łęczna environs; by H. Maruszczak 1988

1 — fine sands with silty carbonate deposits and silty-loamy interbeddings; 2 — silty carbonate deposits with distinct interbeddings of fine sands; 3 — mostly sandy loesses with frequent interbeddings of silty sands, particularly in the lower part of the cover

applies to deposits transformed by weathering and soil-forming processes. The vertical range of such processes corresponding to the thickness of the recent soils (Holocene) is usually about 1.5 m.

Among the covers of thicknesses exceeding 2 m there were distinguished: 1) silty sands, often without carbonates, with distinct interbeddings of silty and silty-loamy carbonate deposits; 2) silty-sandy and silty-loamy deposits with distinct interbeddings of fine sands; 3) silty and silty-sandy carbonate deposits, usually with interbeddings of fine sands in the lower part. The most "loessy" among the three varieties mentioned, i.e. in point 3, distinctly predominates in the central-eastern part of the area studied between the rivers Wieprz and Świnka (Fig. 2). In the north-west direction this variety decreases distinctly in favour of the most sandy variety.

Even the most silty and silty-sandy "loess" deposits are characterized

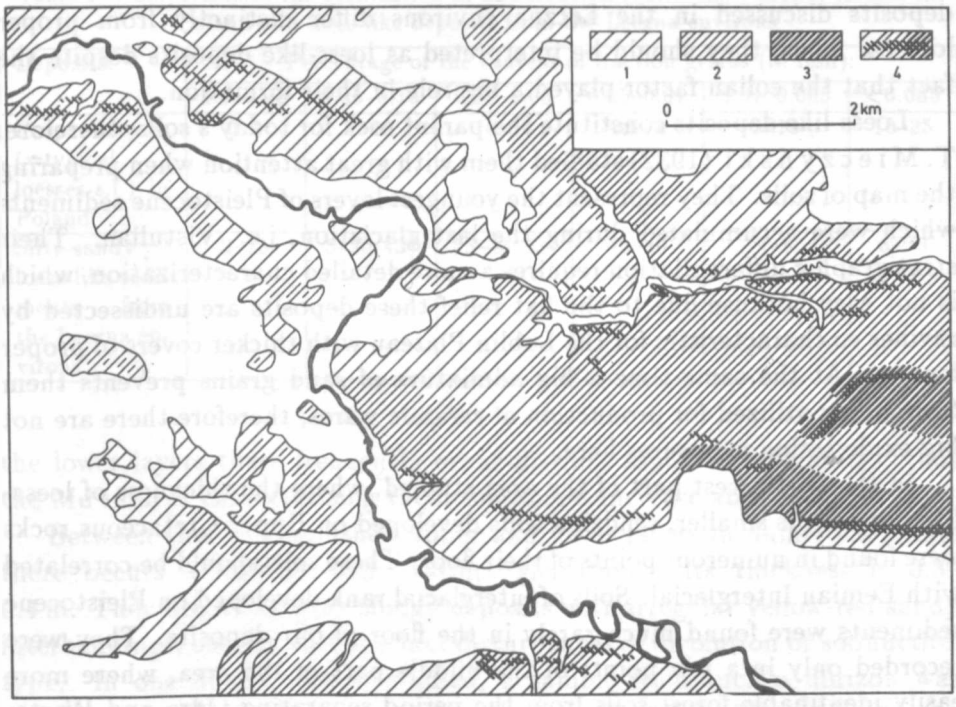

Fig. 3. Thickness of loess deposits in the Łęczna environs; by H. Maruszczak 1988
1 — 2 to 4 m; 2 — 4 to 6 m; 3 — over 6 m; 4 – thickness swellings in the form near-edge ridges

by distinctly coarser granulation than proper loesses (= typical loesses s.l.) in Poland. This is illustrated by Table I. It appears from it that coarse silt fraction (0.10–0.05 mm) predominates more frequently in the deposits of the Łęczna environs than that of medium silt (0.05–0.01 mm) the most representative for loesses. In some beds with numerous sandy interbeddings, fine sand fraction (0.25–0.10 mm) appears to predominate. As a result the size of medium grains (Md), even in the most loessy variety of the deposits discussed, ranges from 35 to 130 μm, whereas proper loesses are in the interval of 15–40 μm. However, the Mz index for our deposits is 3.1–5.4 ϕ, and 5.0–6.5 ϕ for proper loesses. The indices of standard deviation σ are in the interval 1.4–2.0, whereas for proper loesses 0.9–1.7. As regards the grain selection rate the deposits discussed are then sorted out distinctly weaker, and proper loesses moderately weakly. However, the differences of sorting out are rather relatively small.

All granulation indices indicate relatively unambiguously that the

deposits discussed in the Łęczna environs differ distinctly from proper loesses. Thus, they should be interpreted as loess-like deposits despite the fact that the eolian factor played a big role in their formation.

Loess-like deposits constitute the parent rock for today's soils; therefore, T. Mieczyński (1932) studied them with great attention when preparing the map of soils. They represent the youngest layers of Pleistocene sediments which were accumulated during the last glaciation, i.e. Vistulian. Their stratigraphic differentiation requires a more detailed characterization, which is not easy because due to the flat relief these deposits are undissected by ravines so characteristic for the Lublin Plateau with thicker covers of proper loesses. At the same time a big admixture of sand grains prevents them from being utilized for production of ceramic wares; therefore there are not big exploitation exposures here.

In the north-west part of the area studied, where the thickness of loess-like deposits is smaller, rendzina soils developed on Upper Cretaceous rocks were found in numerous points of their floor. These soils should be correlated with Eemian Interglacial. Soils of interglacial rank developed on Pleistocene sediments were found much rarely in the floor of our deposits. They were recorded only in a few points of the middle part of the area, where more easily identifiable forest soils from the period separating Odra and Warta, i.e. Saalian glaciations occur more frequently (J. Butrym et al. 1991). In this part of the area, horizons of the "pavement" type connected with erosion surfaces, can be of a better use more frequently than soils in distinguishing the covers of the deposits studied. Pavements are formed by gravels of Scandinavian rocks originating from fluvioglacial sediments occurring in numerous places below the erosion surface. It is most difficult to determine the lower boundary of loess-like deposits in the eastern part of the area between the rivers Wieprz and Świnka. Their thickness exceeds here 6 m (Fig. 3), and in extremal cases it reaches 10–11 m. Thus they were examined down to the floor only in a few places, and only by means of drillings. The examinations did not result in finding interglacial soils. Therefore, it cannot be excluded that in this part of the area pre-Vistulian loess-like deposits can occur.

Stratigraphic differentiation is thus determined from the data concerning these areas in which the thickness of the deposits studied does not exceed 6 m. In such areas the differentiation is distinct in the vertical profile. The upper layers, down to a depth exceptionally exceeding 2–3 m, are more "loessy". They are distinguished by a smaller admixture of sand grains and by rarely occurring sandy interbeddings. The size indices of medium grains (Md) for these layers are in the interval 40–60 μm. However, among

Table 1. Comparison of the granulation of unweathered (carbonate) proper loesses in Poland and loess-like deposits from the Łęczna environs

Deposits:	Percentage of the content of fraction grains (in mm):					
	1.0–0.25	0.25–0.10	0.10–0.05	0.05–0.01	0.01–0.005	<0.005
Proper loesses (=typical loesses s.l.) in Poland	0–1	1–10	10–20	40–70	5–15	10–25
Silty-sandy loess-like sediments from the Łęczna environs	2–15	5–20(43)	25–45(53)	10–40	1–6	5–20

the lower layers there frequently occur distinct sandy interbeddings; thus the Md indices characterizing them sometimes increase above 100 μm.

Between thus distinguished upper and lower layers in numerous points there occurs a horizon with distinct gleization. Its thickness is 0.3–0.4 m. They are ashen grey sludgy deposits with irregular yellow-red sandy interbeddings, usually with distinct disturbances of involution or solifluction type. In one of the section studied, a sample from such a horizon was dated by the thermoluminescence method to 83±12 ka BP (J. Butrym et al. 1991). It should be stressed that with the dating technique used "residual thermoluminescence" is not taken into consideration, i.e. TL reserves which the grains analyzed have received from the previous bed of their occurrence. Because before being deposited in the place of today's occurrence these grains may have been transported for a short time, their residual thermoluminescence must have been considerable*. Therefore, the given TL age is surely increased. Accordingly, the gleization horizon may be connected with one of the Interplenivistulian periods of interstadial warming up.

* That the transport was shortlived and of course only partially of eolian type seems to be accounted for not only by the grain size of the deposit discussed. Its grains originate not only from older Pleistocene sediments but probably also from weathered Tertiary local rocks. This indirectly points to the occurrence of abundant redeposited pollen of various species of Tertiary plants among Intersaalian organogenic sediments occurring under the cover of loess-like deposits (opinion of Dr Z. Janczyk-Kopikowa, see J. Butrym et al. 1991).

DIFFERENTIATION OF THICKNESS AND RELIEF OF THE COVER OF LOESS DEPOSITS

The cover of the deposits is not continuous, and particularly in the western part of the area its occurrence is insular. It is most uniform and the thickest (over 6 m) in the area between the rivers Wieprz and Świnka. Outside this area a thickness of 2–4 m predominates, increasing locally to 4–6 m along higher river valley edges extending latitudinally, as well as in places with considerable relative relief (compare Fig. 1 and 3). Particularly characteristic for this cover is the occurrence of distinct "swellings" or ridges extending along latitudinally oriented edges (geomorphological escarps).

The ridges mentioned represent zones of intensified accumulation of silt deposits. They emerge to several meters above the basic topographic surface of loess patches. Similarly, though usually a little bigger, accumulation ridges also occur in regions with covers of proper loesses in Poland. They constitute one of the most characteristic, primary forms of loess accumulation and they are distinguished as "near-edge ridges" (H. Maruszczak 1972, 1985). They are equivalents to huge, also accumulation loess ridges reaching relative heights of several dozen meters, extending along the right bank of the lower Danube, which Bulgarian authors describe as "gyrbishta" (M. Minkov 1968).

The biggest near-edge ridges occur in the southern part of the area discussed, in the vicinity of Łańcuchów and Ciechanki. They are mainly connected with edges of plains of limnic-fluvial accumulation from the Saalian period. These plains rise to 10 m above river terraces of the Vistulian, and to 15–20 m above today's bottom of the Wieprz river valley. The ridges associated with the edges reach relative heights up to 2–3 m, their width is from 100 to 200 m and length of to several kilometers (Fig. 3). The ridges extending along the edges of the Świnka river are smaller as well as those of the section of the Wieprz valley west of Łęczna. The biggest ridges are partially readable on hypsometric maps with isohypses drawn every 5 m (Fig. 1). On detailed maps with isohypses drawn every 1.25 m, the outlines of not only big but small ridges as well are readable (Fig. 4).

Worthy of a particular attention are the ridges connected with edges situated at a more considerable distance from larger river valleys. An extremal example in this respect is the form occurring in the region of the village Sufczyn (Fig. 1), which is connected with a weakly distinguished edge, merely several meters high, separating the accumulation plain of the Saalian age from the accumulation-denudation plain situated lower.

Fig. 4. A detailed hypsometric map of the area between Łęczna and Ciechanki; isohypses drawn every 1.25 m

The occurrence of though small but numerous near-edge ridges in the Łęczna environs should be given close attention. It seems that in areas with thicker covers of proper loesses the occurrence of such forms should also be numerous. Thicker loess covers however, are connected with higher elevated land areas with a more intensive relief. In the Lublin Plateau

these areas are of relative relief exceeding 30–50 m*. With such a relief and their corresponding mesoform it is much more difficult to find a possible occurrence of accumulative ridges having a relative height of only a few meters. Besides, such small forms play a secondary role in relation to a strongly developed erosion-denudational valleys dissecting the loess cover.

Small near-edge ridges can thus be treated as forms of loess relief particularly characteristic for plain areas with relative relief similar to those in the Łęczna environs, i.e. of the order of 10–30 m.

Beside these ridges in the range of the deposits discussed there occur numerous, small cavings without outflow which appear distinctly in the isohypsic pattern (Fig. 1,4). However, they are the main forms reproducing karst topography of the underlying upper Cretaceous rocks. Therefore, I am not discussing them here as connected with the pattern and properties of the loess cover.

NEAR-EDGE RIDGES AS AN EVIDENCE OF DYNAMIC ACCUMULATION CONDITIONS OF LOESS DEPOSITS

The morphological features of ridges, i.e. "swellings" of the loess cover in zones connected with low edges, point relatively unequivocally to their close relationship with eolian accumulation of loess silt. From the point of view of accumulation dynamics they can be compared to natural levees of alluvial plains. Similarly to the latter they are built in zones of a more rapid fall of the carrying force of transporting currents. In plain areas, all ridges, even several meters high, constitute obstacles for winds transporting silt. These obstacles cause a decrease of the speed and turbulence of atmospheric currents, compelling in this way the transported silts to sediment (H. Maruszczak 1967).

The occurrence of numerous ridges of this type seems to indicate unambiguously that loess silt was transported largely in low layers of the atmosphere thus at not long distances. The fact that the distances constituted the "first" kilometers in the region of Łęczna is also accounted for by the granulation of the deposits studied, which is much coarser than in the case of proper loesses. Similar conclusions concerning the distances of eolian transport were drawn from the analysis of the Vistulian proper loesses occurring in much thicker covers of the Lublin environs, 23 km WSW of Łęczna. Such conclusions were documented by the results of detailed studies of the granulation, composition of heavy minerals and sedimentological

* The relative relief indices given here were calculated for measurement fields of 10 km^2.

analysis of loesses (H. Maruszczak and R. Racinowski 1976, M. Harasimiuk 1987).

What silt sources played the main role at such a kind of transport? There is no doubt that in Pleniglacial, i.e. with permafrost, silt was "produced" relatively commonly as a result of frost disintegration within a plain, on which accumulation of loess deposits followed. It seems that like in other loess regions of southern Poland, a considerable role must have been played by silts washed away by melt waters and deposited on the bottom of valleys and depressions during floods. This has been pointed out for a long time in synthetizing papers concerning Polish loesses (A. Jahn 1956, H. Maruszczak 1967, 1972, 1985, J. Jersak 1976). The example from Łęczna environs confirms such interpretations in relation to loess-like deposits. They reach their greatest thickness in the area discussed in the region of Ciechanki and Sufczyn, i.e. in the neighbourhood of the extensive alimentation area on the bottom of the Wieprz river valley, the width of which is great here. Their thickness along the narrow Świnka river valley is considerably smaller (Fig. 3).

All ridges appearing in the environs of Łęczna are connected with edges extending in directions approximate to latitudinal. They are absent along the meridional, water gap section of the Wieprz river valley between Zakrzów and Łęczna. These facts are the basis for attempts to determine the predominating directions of loess bearing winds. To avoid misunderstandings it should be stressed that the absence of near-edge ridges along the meridional section of the Wieprz river valley can not be connected with its small width, because west of Łęczna, where the latitudinal section of this river's breach valley is also narrow, there occur near-edge ridges.

The occurrence of ridges on either side of the latitudinal sections of the narrow valleys seems to indicate that their formation should not be connected with winds perpendicular to the edge. Such winds, after passing the bottom of the narrow valley, would not be sufficiently "loaded" with silt. Thus it seems that in the environs discussed largely winds from the east and west sectors were loess-forming during the Vistulian. Therefore, only a discontinuous loess cover of a small thickness was formed along the meridional section of the Wieprz river breach. It can be added that also at present winds predominate from the west sector in the Łęczna environs (the rate of SW – NW winds is about 42%), and from the east one (NE – SE winds about 30%).

For comparison it may be stressed that in the formation of "gyrbishta" along the Danube largely W or NW winds also participated, which were almost parallel or oblique to the bank of the Danube valley in the section of

the occurrence of these big ridges (H. Maruszczak 1964, S.Z. Różycki 1964, M. Minkov 1968). The predominating winds perpendicular to "gvrbishta", i.e. north ones were considered by D. Jaranoff (1956) as loess-forming. The basic argument for this author was the fact of a rapid decrease of the thickness of Bulgarian loesses with the distance from the Danube. Such a motivation omitted, however, the fact of the occurrence of loesses and their distribution regularities on the north, Rumanian side of the Danube (H. Maruszczak 1964).

An analysis of near-edge ridges of the Łęczna environs does not warrant a more accurate determination of the direction of latitudinal winds. A relatively small thickness of the loess cover and its weak stratigraphic differentiation do not facilitate drawing conclusions in this respect. They must have been both W and E winds, perhaps the latter predominated more in the Pleniglacial, and the former in the late Glacial (see H. Maruszczak 1985).

FINAL REMARKS

1. The geological structure of the Łęczna environs indicates that the loess deposits were accumulated here during Vistulian. This facilitates interpretation of the cover features of these deposits from the point of view of the conditions of their accumulation. The situation of the considered deposits below 180 m a.s.l., i.e. below the lower limit of the loess distribution in Poland, as well as the plain character of the relief determined various features of their individuality.

2. This plain relief, specific rather for plains of central Poland than uplands, corresponded to a relatively small accumulation intensity of loess silt. This was determined by higher wind velocities and smaller atmospheric turbulences than in uplands with a more marked relief. A higher velocity of winds is indicated by coarser grains of the deposits discussed and the admixture of sand fractions much higher than that in the covers of proper loesses in upland areas.

3. A considerable size of average grains and frequent occurrence of sand interbeddings correspond to a relatively small content of carbonates. Because of a small content of colloidal fraction our deposits have a weakly developed aggregate structure. Due to that their porosity is small and they do not show the capacity for additional collapse. Other features distinguishing them may also comprise a weakly developed ability to form vertical bluffs, which is partially connected with the physical features

mentioned, and also with a relatively small thickness. Therefore, they should be included to loess-like deposits.

4. The differentiated thickness and relief of the cover of our deposits — virtually distributed beyond the range of the Vistulian proper loesses — indicate that they were formed with a high involvement of eolian transport. This is particularly indicated by the occurrence of "swellings" of the loess cover thickness in zones adhering to edges (near-edge ridges). The relatively numerous sand interbeddings occurring in it can be connected with modified saltation transport, and silty ones with suspended eolian transport. The average size of grains indicates that the eolian transport must have taken place in low atmosphere layers and at small distances, of the order of "first" kilometers.

5. A short distance of eolian transport and the loess cover distribution itself indicate that the main areas of silt alimentation were on the bottoms of river valleys. These bottoms in the Pleniglacial were systematically overbuilt during spring floods which left fresh sediments susceptible to winnowing. The relationship with such alimentation areas is indicated by: a) location of the thickest and most extensive loess patch between the rivers Wieprz and Świnka, b) the occurrence of near edge ridges largely along valley banks.

6. Among near-edge ridges those extending in latitudinal direction predominate distinctly. As those forms occur at the same time on the north and south side of valleys, it may be implied that they were "heaped up" largely by winds from eastern and western sectors. In the area studied no facts have been found which would allow a more accurate determination of the role of winds from these two sectors.

7. Small, near-edge loess ridges of up to 2–3 m in relative heights, up to 100–200 m wide and up to several kilometers in length, occurring so numerously in the Łęczna environs, can be considered as the most characteristic relief element of the cover of the deposits discussed. In this respect these deposits differ distinctly from the upland covers of proper loesses, in the range of which near-edge ridges occur much more rarely, or they play quite an subordinate role in the rich complex of forms of loess relief.

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STRESZCZENIE

Analizowano zróżnicowanie uziarnienia i miąższości, a także rozmieszczenie utworów lessowych w terenie równinnym położonym 170–180 m n.p.m. (ryc. 1). Stwierdzono, że w okolicy Łęcznej były one akumulowane w okresie ostatniego zlodowacenia. Dzięki temu można było podjąć próbę rekonstrukcji warunków dynamicznych akumulacji pyłu w ciągu jednego cyklu glacjalnego. Stwierdzono duże zróżnicowanie uziarnienia badanych utworów; zaliczono je do utworów lessopodobnych i określono różnice w stosunku do lessów właściwych (tab. 1). Wyróżniono następujące ich odmiany: 1) piaski drobnoziarniste z przewarstwieniami pylastymi i pylasto-gliniastymi; 2) pyły z przewarstwieniami piasków drobnych; 3) lessy przeważnie z domieszką piasków drobnych (ryc. 2). Charakterystyczne jest duże zróżnicowanie miąższości, a szczególnie występowanie „nabrzmień" w strefie występowania przeszkód orograficznych w postaci niskich krawędzi morfologicznych (ryc. 3,4). Te „nabrzmienia" stanowią analogi wielkich wałów lessowych, występujących w strefie wysokich brzegów dużych dolin rzecznych. Takie wały nad dolnym Dunajem stanowią istotny element krajobrazu; autorzy bułgarscy wyodrębniają je jako „gyrbiszta".

Duże zróżnicowanie uziarnienia oraz osobliwości ukształtowania pokrywy badanych utworów świadczą, że powstawały one przy istotnym udziale transportu eolicznego. Warstwy pylaste należałoby wiązać przy tym z transportem zawiesinowym, który odbywał się w niskich warstwach atmosfery, a więc na małe odległości. Przewarstwienia piaszczyste natomiast wiązały się głównie z eolicznym unoszeniem turbulencyjnym. Małe odległości transportu eolicznego dają podstawę do określania kierunku przeważającego wiatrów transportujących; były to głównie wiatry z sektorów wschodnich i zachodnich.