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Stratigraphic-Paleogeographic Interpretation of the Results of Magnetic Susceptibility Investigations of Loesses at Nieledew (SE Poland)

Interpretacja stratygraficzno-paleogeograficzna wyników badań podatności magnetycznej lessów w Nieledwi (Polska SE)

ABSTRACT

Magnetic susceptibility of loesses from the well-known section at Nieledew was analysed. It was found that it is considerably lower in upper horizons of interglacial soils and in interstadial soils of gley type than in non-weathered layers of younger loesses containing the largest amount of carbonates (Fig. 1). Loesses from other Polish sections also show similar regularities. Therefore, the magnetic susceptibility of our loesses depends on climatic conditions of their accumulation and pedogenetic transformation. However, this dependance is diverse than in Chinese loesses (J. Kukla et al. 1988) because the soils occurring among them have an increased magnetic susceptibility. The diverse course of the susceptibility curves of Polish and Chinese loesses corresponds to different conditions of accumulation and epigenetic transformation of these deposits in middle Europe (periglacial loesses) and in SE Asia (peridesertic loesses).

In the last years attempts could be made to correlate the results of stratigraphic-paleogeographic investigations of Polish loesses with those of detailed analyses of their paleomagnetic properties. This was possible owing to the fact that scientists from the Department of Geophysics of PIG in Warsaw had undertaken paleomagnetic investigations of loesses using more recent techniques. These investigations, realized partially at the charge of the Department of Physical Geography of UMCS, were carried out by the method of detailed, practically continuous sampling in the loess sections at Łopatki and Nieledew, and by vertical microprofiling with a probe introduced into the drillholes in the sections at Obrowiec, Orzechowce, Sandomierz and Kazimierz-Kwaskowa Góra.

The first results of a comparison, on the example of the loess section at Łopatki, have already been published (H. Maruszczak, M. Tkacz 1987). The obtained methological conclusions and general progress in these investigations resulted in noticing also other paleomagnetic properties of loesses, not considered in the first paper. This observation has induced the authors to compare the results of stratigraphic-paleogeographic investigations of loesses at Nieledew carried out for many years with those of their continuous paleomagnetic sampling.

STRATIGRAPHIC AND PALEOGEOGRAPHIC INVESTIGATIONS OF LOESSES AT NIELEDEW

The loess section at Nieledew near Hrubieszów, discovered by J. Trembaczowski in 1949 y. (vide A. Jahn 1952, p. 425), was examined in detail for the first time by J. Mojski (1956, 1965). Many other authors and different experts dealt with it in the following years (K. Konecka-Betley 1968, J. Jersak 1969, 1973, R. Racinowski 1969, H. Maruszczak 1972, 1976, 1985, P. Tuchołka 1976, 1977, H. Maruszczak and M. Wilgat 1978). Datings of 27 samples from this section were carried out by the thermoluminescence (TL) method in 1982 y. (J. Butrym and H. Maruszczak 1983). Now it is one of the best known sections of the Quaternary deposits in Poland, which is of fundamental importance for the stratigraphy of loesses, especially of older ones. Therefore, it was presented many times at different international meetings, including two international loess symposiums (1961, 1985). So, the results of studies of this section were the basis for working out the loess stratigraphy in Poland (H. Maruszczak 1987, 1990b).

The description of the exposure is presented on the basis of the author's own studies (H. Maruszczak) carried out mainly in the years 1971-1975, and completed in 1985-1990. In the 70's the younger loesses were exposed best near the brickkiln of the still running brickyard then (exposure E — according to H. Maruszczak denotations), and the older loesses in the pit dug by J.E. Mojski at the beginning of the 60's, situated north of the brickyard (exposure A — after H. Maruszczak); the distance between these exposures is about 100 m. The parts of both exposures were presented jointly in the preceding descriptions. As a result the depths of the occurrence of older loess layers did not fit those published by J. E. Mojski (1972).

The present description of the Nieledew section is done for exposure A because only there the paleomagnetic analyses were carried out. The top of this exposure reaches a height of 200 m a.s.l. in the zone of a rather steep slope of the Białka river valley, exposed to WSW. Although a considerable part of the exposure is covered with vegetation at present, all described elements of the section are accessible for investigations. The description of the distinguished layers has been compiled on the basis of the investigations of the deepened pits.

The text of the description corresponds to the earlier versions comprising exposure E (for younger loesses) and exposure A (for older loesses); identical letter denotations for the layers and the depth of their occurrence in metres were used. It differs from the description from 1985 by taking into account the results of the microstructural analyses of loesses carried out by S. Licznarowa in 1973 (information about it in: H. Maruszczak 1990).

a_1 0.00 — 0.60 Deluvial products of anthropogenic denudation of humus horizon of the present soil with turf horizon in top.

a_2 0.60 — 0.80 Humus horizon, dark grey; HCl+ (weakly). Clay with admixture of organic matter, grey-silvery in colour; silasepic and skellattisepic plasmic fabric, typical for the chernozem soil-forming process.

a_3 0.80 — 1.00 Transitional horizon, grey and grey-yellowish; HCl+ (weakly). Gradual transition.

b_1 1.00 — 1.70 Silty deposit, light grey-yellowish, homogenous, at the top structureless, and at the bottom with traces of lamination and with scattered carbonate concretions; HCl+. Gradual transition. Filamentous pseudomycelia visible on a rather homogenous background. Clay with admixture of carbonates, silvery-golden in colour; crystic plasma.

b_{2-3} 1.70 — 1.90 Weakly distinguishable horizon, somewhat darker, with yellowish and yellowish-rusty spots; HCl+. Gradual transition. Weakly visible traces of lamination and better visible filamentous pseudomycelia.

c 1.90 — 2.30 Silty deposit, light grey-yellowish with weakly marked brownish tint; HCl+. Gradual transition. Small, scattered carbonate concretions occur at the top, and filamentous pseudomycelia — in the whole layer. Clay with admixture of organic matter and carbonates, grey-brown coloured; silasepic and skellattisepic plasma, similar as in layer a_2; small concentric concretions of iron compounds.

d 2.30 — 2.80 Silty deposit, greyish-yellowish; yellowish tint more distinct than in b_1; HCl+. Gradual transition.

e_1 2.80 — 3.75 Silty deposit, greyish-yellowish, laminated and layered, with dense net of filamentous pseudomycelia and with carbonate incrustation in fissures; HCl+. Border readable. At the top, from 2.8 to 2.9/3.0, rather a distinctly distinguishable horizon with yellowish and yellowish-rusty spots.

f_1–h_3 3.75 — 3.95 Distinctly layered denudation products of paleosol, with grey-yellowish, brownish and grey layer-streaks; HCl-. Border readable.

h_3 3.95 — 4.40 Bottom part of illuvial horizon, yellowish-brownish, with darker and lighter streaks; HCl-. Gradual transition.

i_1 4.40 — 4.50 Silty deposit, yellowish, structureless; HCl-. Border readable (decalcification border).

i_2 4.50 — 5.00 Silty deposit, light grey-yellowish, homogenous; HCl+. Border readable — at the bottom in places thin inserts of the underlying deposit. Clay with admixture of carbonates and iron compounds, silvery-golden in colour; crystic and skellattisepic plasma with features similar as in black pararendzinas.

j 5.00 — 5.55 Humus horizon, grey and dark grey with dunnish tint; in the middle and lower parts weakly marked filamentous carbonate pseudomycelia; matrix HCl-. Transition typically gradual. Clay as in i_2; crystic plasma, which probably is connected with the occurrence of numerous forms of secondary carbonates.

k 5.55 — 6.20 Transitional horizon, and brown horizon (of forest brown soil?). At the top grey, lighter and lighter, downward with lighter grey-yellowish and brown-yellowish spots and with filamentous carbonate pseudomycelia, downward more and more numerous, in places passing into concretion agglomerates; matrix HCl-. Gradual transition. The horizon is cut by irregular pseudomorphs of cracks, filled with the material from the overlying humus horizon, reaching down to 6.50.

l 6.20 — 6.70 Silty deposit, yellowish-grey, structureless, with filamentous carbonate pseudomycelia, scarce at the top and very abudant at the bottom; matrix at the top HCl-. Gradual transition. Clay with admixture of carbonates, golden-silvery in colour; crystic plasma; small concretions of iron compounds.

l 6.70 — 7.10 Humus horizon, light grey with yellow-dunnish tint; weakly developed filamentous carbonate pseudomycelia, less and less numerous downward; matrix HCl-. Gradual transition. Clay with admixture of carbonates, golden-silvery in colour; crystic plasma.

m 7.10 — 7.90 Transitional horizon similar as in k, but lighter coloured, with a great number of small carbonate concretions at a depth of 7.50–7.60; there are also iron-manganese concretional agglomerates; matrix HCl-. Gradual transition.

n 7.90 — 9.10 Silty deposit, structureless, at the top light grey-yellowish with a dunnish tint and with yellow-rusty spots, from 8.55 downward more and more bluish-greenish spots (gleyification) qualifying a general tint of colouring; down to 8.35 concretional iron-manganese agglomerates occur, smaller and smaller downward; matrix HCl- to 8.35, and lower HCl+ weakly. Microstructural features similar as in l. At the top, distinct fissure carbonate pseudomycelia occur, and lower — more and more numerous filamentous pseudomycelia; from 8.65 big carbonate concretions occur. Bottom layers of this deposit show the reverse magnetic polarity (Chegan event?).

o_1 9.10 — 9.15 Humus horizon, light grey with a dunnish tint; HCl-. The horizon is not clearly distinguishable in places, or it is strongly deformed by solifluction, or eroded.

o_2 9.15 — 9.30 Leaching horizon, greyish with rusty spots at the bottom; HCl-. In places strongly deformed by solifluction together with the overlying horizon. Gradual transition. Clay with admixture of carbonates and iron compounds, silvery-grey in colour; crystic plasma; underdeveloped concretions of iron compounds and traces of organogenic carbon occur.

p_1 9.30 — 9.60 Illuvial horizon, uppermost part; brownish with numerous spots and bluish and rusty tongues; HCl-.

p_2 9.60 — 10.25 Illuvial horizon, upper and middle parts; brown and yellow-brown, at the top — a little more spotty, and downward coloured homogeneously enough; HCl-. Clay as in o_2; crystic, skellattisepic and vosepic plasma (i.e. testifying to transport of colloids from higher lying soil horizons); underdeveloped concretions of iron compounds occur.

p_3 10.25 — 11.40 Illuvial horizon, lower part; lighter coloured yellow-brown with bluish spots; HCl-. Gradual transition.

r 11.40 — 11.80 Silty-loamy deposit, light grey-olive with spots and streaks yellowish, with enough numerous iron-manganese concretions, and scarce, dispersed carbonate concretions; matrix HCl-.

The litho- and pedostratigraphic interpretation of the described layers, taking into account the results of TL datings, is presented on Fig. 1A. It can be seen that the particular stratigraphic horizons of loesses have a rather small thickness here. It is connected with the situation of the section on a rather steep slope with "warm" exposition. This situation also accounts for the occurrence of different stratigraphic gaps and breaks due to the development of erosion. The biggest and most distinct erosional break occurs betwen the younger loess (LM) and the older one (LS); it is marked by a bracket in Fig. 1A. The erosion processes caused then the removal of the upper and middle horizons of the pedocomplex from Eemian and the earliest Vistulian; after H. M a r u s z c z a k (1990b) the period of its formation should be correlated with oxygen-isotope substages 5.5 and 5.4. Only "root" part of the forest soil (layer h_3) remained in position; a comparison with the soil of the same age (wholly preserved in exposure E at Nieledew) shows that erosional degradation removed layers about 1.5 m thick. The final formation phases of this erosional break left in place, in exposure A, thin layers of denudation products of pedocomplex, distinguished in the description as layers $f_1 - h_3$.

Layers LM occurring over the described break are rather weakly differentiated. The horizons of pedogenetic transformation found among them have no features of interstadial rank soils; they can be interpreted only as soil sediments (sg). The occurrence of these sediments is the basis for distinguishing the second rank stratigraphic units (similar as in exposure E at Nieledew) among the layers LM (H. M a r u s z c z a k 1990a). However, the older loesses are distinctly divided into units of lower rank due to the occurrence of well developed soils among them. The upper soil, separating LSg from LSs layers, represents the pedocomplex correlated with the interval between Odra and Warta glaciation and with the earliest phases of this second glaciation (H. M a r u s z c z a k 1990b). It surely comprises a truncated (= partially degraded) soil of forest brown type (layer k) from the period between Odra (= Saalian I) and Warta (= Saalian II) glaciations, and the superimposed chenozem-type humus horizon (layer j) from the earliest Wartanian. The development period of this pedocomplex should be correlated with oxygen-isotope substages 7.3–7.1. The underlying soil separating LSs from LSd has features of the initial chernozem of interstadial rank (layers l–m); it most likely corresponds to oxygen-isotope substage 7.5. The lower part of loess layer n, underlying this soil, manifests signs of very strong gleyification. Thus, it can be interpreted as interstadial soil; in the stratigraphic scheme it is correlated with the lowest older loess (LSn — Fig. 1A).

Layers o–p, which underlie older loesses, represent forest soil of interglacial rank. It was developed on the oldest weathered loesses (LN), during the younger part of the "great" Mazovian (= Holsteinian) interglacial; therefore, it corresponds to oxygen-isotope stage 9.

RESULTS OF PALEOMAGNETIC STUDIES

The loesses at Nieledew were continuously sampled. From this section 512 samples were taken. The components of the natural remanent magnetization vector (NRM) was measured by means of JR-4 spinner magnetometer, and the magnetic susceptibility by means of x-bridge KLY-2. In order to remove secondary magnetization, each specimen underwent alternating field demagnetization experiments (its optimum value was equal 22 mT). After computing the measurement data, a series of paleomagnetic parameters was obtained, the diagrams of which are showed in Fig. 1B, C, D.

No sediments with negative inclination occur in the section investigated, but a very low value of inclination (4^o) appears in the point of the section, where the Chegan event was described by P. Tucholka (1977). This point occurs in the loess horizon that was dated on 290 ka. Thus, the occurrence of the paleomagnetic event exactly in this part of the section is confirmed. The lack of samples with negative inclination is probably connected with a very small thickness of the inversion horizon — smaller than the diameter of a paleomagnetic sample (25 mm). In the light of the recent paleomagnetic data (U. Bleil, G. Gard 1989; A.N. Tretyak 1983), the paleomagnetic event which is a little older than 300 ka can be identified with Biwa II event (called also Y-zona). However, the Chegan event occurred 200–260 ka ago. If the TL datings of Nieledew section are precise enough, we may then suggest that P. Tuchołka recorded another paleomagnetic episode in the interval between Biwa II and Chegan event.

The diagram of susceptibility (Fig. 1E) is a reflection of changes in the concentration of magnetic carriers in the sediments investigated. A differentiation of the magnetic susceptibility in loess sediments is connected with dissolution or accumulation of magnetite grains in soil horizons. Accumulation of magnetic carriers in soil horizons has been observed in Chinese loess (J. K u k l a et al. 1988). In the Nieledew section there occurs a different phenomenon; the magnetic carriers were probably dissolved in soils and gleyed horizons. This phenomenon has already been observed in gleyed soils from Great Britain (B. A. M a h e r 1986).

The graphs of the magnetic susceptibility in Chinese loess were correlated on the basis of simple geometric relation with oxygen-isotope curve (J. K u k l a et al. 1988). This type of correlation has been applied for the Nieledew section (Fig. 1E, F). If we assumed only the geometrical character of this correlation, the existing stratigraphic interpretation of the upper part of this section (H. M a r u s z c z a k 1985, 1987) should be changed. However, it is very difficult to define the degree of this correlation because of the presence of considerable erosion gaps in the Nieledew section (in contrast to Chinese loess). The degree of this reliability will of course be determined more exactly on investigating the magnetic susceptibility in other Polish loess sections.

The shape of the magnetic susceptibility curves can be determined by the presence of considerable stratigraphic gaps and a large accumulation of iron hydroxides in illuvial horizons. The convergence of this curve shape with that of the remanent magnetic intensity shows that the influence of iron hydroxides on magnetic susceptibility is very small. In the Eemian soil horizon (sensu H. M a r u s z c z a k 1985) of Nieledew A section there occurs a large stratigraphic gap. Its presence can be the cause of the divergence in the stratigraphic interpretation of this part of the section studied. The occurrence of this gap was taken into account when working out the first version of the correlation of our magnetic susceptibility curve with oxygen-isotope curve (Fig. 1E, F). Similar asymmetry of the shape both of the magnetic susceptibility curve and the oxygen-isotope one can be seen. The course of the latter curve is connected with asymmetric development of the glacial cycle, which characteristic feature is a relatively slow development of cooling and fast warming. On the magnetic susceptibility curve also a gradual decrease of the oscillation amplitude can be seen, which is probably connected with a decrease of the magnetic susceptibility as a time function,

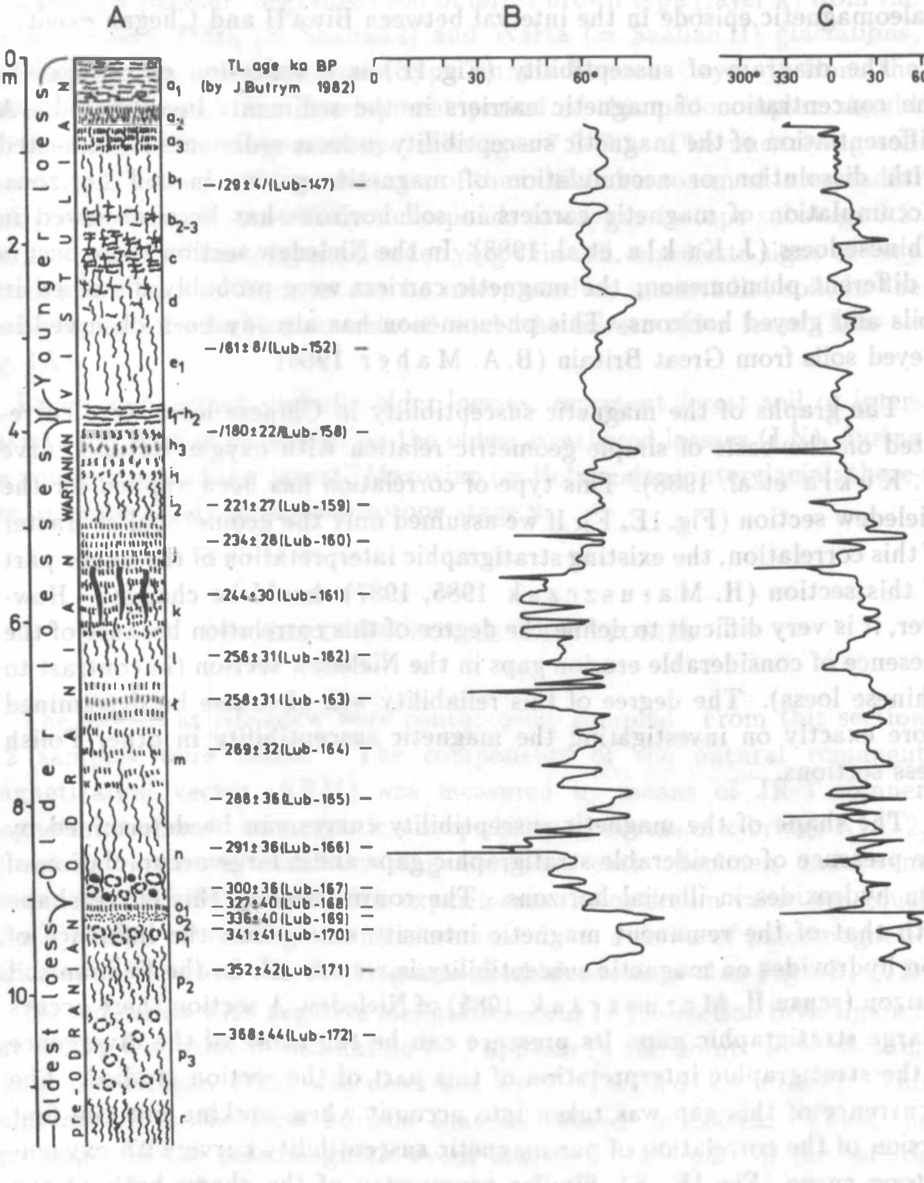
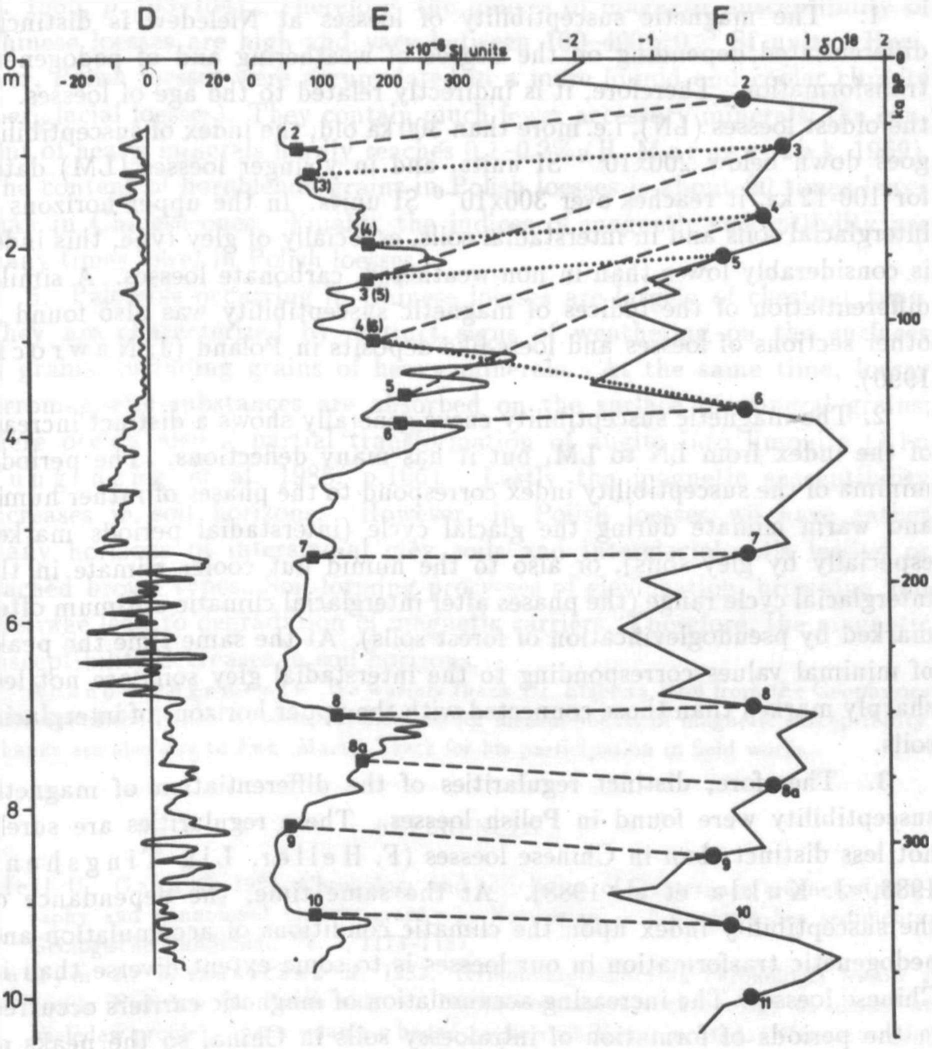


Fig. 1. Loesses from the Nieledew section and their paleomagnetic features
A — litho- and pedostratigraphic scheme worked out by H. Maruszczak (1990); the presented results of TL datings are largely related to samples from exposure "A", and only three (in brackets) are extrapolated from exposure "E"; B — magnetic inclination; C — magnetic declination; D — differential magnetic inclination; E — magnetic susceptibility; F — oxygen-isotope curve after J. Imbrie et al. 1986. Letter symbols of stratigraphic units of loesses: L — loess; M — younger; S — older; N — oldest, g — upper, s — middle, d — lower, n — lowest. Letter symbols of soil units: G — soil; H — present (Holocene) soil;



J — fossil interglacial soil, i — fossil interstadial soil, sg — soil sediments, g — symptoms of pedogenesis development, dg — soil deluvia. Squares on diagram E denote junction points arbitrarily established in relation to the TL age of loesses. Points with numbers without brackets are correlated with the junction points on oxygen-isotope curve (circlets on curve F) and linked by dashed lines. The alternative variant of correlation for younger loesses — taking into consideration only the geometry of the magnetic susceptibility curve — is marked by dotted lines (and by numbers in brackets on curve E)

DISCUSSION AND FINAL REMARKS

1. The magnetic susceptibility of loesses at Nieledew is distinctly differentiated depending on the degree of weathering and of pedogenetic transformation. Therefore, it is indirectly related to the age of loesses. In the oldest loesses (LN), i.e. more than 300 ka old, the index of susceptibility goes down below 200×10^{-6} SI units, and in younger loesses (LM) dated for 100-12 ka, it reaches over 300×10^{-6} SI units. In the upper horizons of interglacial soils and in interstadial soils, especially of gley type, this index is considerably lower than in non-weathered, carbonate loesses. A similar differentiation of the indices of magnetic susceptibility was also found in other sections of loesses and loess-like deposits in Poland (J. Nawrocki 1990).

2. The magnetic susceptibility curve generally shows a distinct increase of the index from LN to LM, but it has many deflections. The periodic minima of the susceptibility index correspond to the phases of rather humid and warm climate during the glacial cycle (interstadial periods marked especially by gley soils), or also to the humid but cooler climate in the interglacial cycle range (the phases after interglacial climatic optimum often marked by pseudogleyification of forest soils). At the same time the peaks of minimal values corresponding to the interstadial gley soils are not less sharply marked than those connected with the upper horizons of interglacial soils.

3. Therefore, distinct regularities of the differentiation of magnetic susceptibility were found in Polish loesses. These regularities are surely not less distinct than in Chinese loesses (F. Heller, Liu Tingsheng 1986, J. Kukla et al. 1988). At the same time, the dependance of the susceptibility index upon the climatic conditions of accumulation and pedogenetic trasformation in our loesses is to some extent diverse than in Chinese loesses. The increasing accumulation of magnetic carriers occurred in the periods of formation of intraloessy soils in China, so the peaks of maximal values of magnetic susceptibility are connected with soils. This "inversion" of the shapes of susceptibility curves of Chinese and Polish loesses corresponds to different climatic conditions of accumulation and epigenetic transformation of loesses in middle Europe and in SE Asia.

4. Loesses in China were accumulated in rather dry and warm continental climate (peridesertic loesses). So, they are rich in accessory minerals; among other things they contain as much as 1-2% of heavy minerals (A.S. Kes 1984). Minerals of low resistance distinctly predominate among the transparent heavy minerals in the "Malan" loess formed during the last

glaciation; especially hornblende is very abundant (Liu Tungsheng et al. 1985, p. 103–104). Therefore, the indices of magnetic susceptibility of Chinese loesses are high and vary between 100–400x10^{-5} SI units. However, Polish loesses were accumulated in a more humid and cooler climate (periglacial loesses). They contain much fewer accessory minerals; the content of heavy minerals hardly reaches 0.1–0.2% (H. Maruszczak 1969). The content of hornblende grains in Polish loesses is about 20 times lower than in Chinese ones. Finally, the indices of magnetic susceptibility are many times lower in Polish loesses.

5. Paleosols occurring in Chinese loesses are largely of chestnut type. They are characterized by distinct signs of weathering on the surfaces of grains, including grains of heavy minerals. At the same time, loessy ferromagnetic substances are absorbed on the surface of mineral grains; there occurs also a partial transformation of augite into limonite (Liu Tungsheng et al. 1985, p.106). Lastly the magnetic susceptibility increases in soil horizons. However, in Polish loesses we have rather many horizons of interstadial gley soils and interglacial soils lessivé or leached brown types. Soil-forming processes of gleyification, browning and lessivage lead to degradation of magnetic carriers. Therefore, the magnetic susceptibility decreases in soil horizons.

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REFERENCES

Bleil U., Gard G. 1989, Chronology and correlation of Quaternary magnetostratigraphy and nannofossil biostratigraphy in Norwegian — Greenland Sea sediments. Geologische Rundschau, 78, 3, 1173–1187.

Butrym J., Maruszczak H. 1983, Termoluminescencyjna chronologia lessów z profilu Nieledew (in Polish only — Thermoluminescence chronology of loesses at Nieledew profile). Sprawozdania z badań naukowych Komitetu Badań Czwartorzędu, 5, Warszawa, 114–117.

Heller F., Liu Tungsheng 1986, Palaeoclimatic and sedimentary history from magnetic susceptibility of loess in China. Geophysical Res. Lett., 13, 11, 1169–1172.

Imbrie J., Hays J.D., Martinson D.G. and 6 others, 1984, The orbital theory of Pleistocene climate: Support from a revised chronology of the marine delta ^{18}O record. [in:] Milankovitch and climate, Part 1, Eds. Berger A.L. et al., Boston, 169–305.

Jahn A. 1952, Materiały do geologii czwartorzędu północnej części arkusza 1:300 000 "Zamość" (Materials to the Quaternary Geology of the Northern part of the map sheet 1:300 000 Zamość). Biuletyn IG, 66, Warszawa, 407–470.

Jersak J. 1969, La stratigraphie des loess en Pologne concernant plus particulièrement la dernier étage froid. Biuletyn Perygl. 20, 99–131.

Jersak J. 1973, Litologia i stratygrafia lessu wyżyn południowej Polski (Lithology and stratigraphy of the loess on the southern Polish Uplands). Acta Geogr. Lodz., 32, Łódź, 139 p.

Kes A. S. 1984, Zonation and faciality of loessic deposits. Lithology and stratigraphy of loess and paleosols, Ed. M. Pécsi, Budapest, 105–111.

Konecka-Betley K. 1968, The typology of fossil soils on the example of Nieledew. Roczniki Gleboznawcze, 19 (Supl.), 261–270.

Kukla G., Heller F., Liu Xiu Ming, Xu Tong Chun, Liu Tung Sheng, An Zhi Sheng 1988, Pleistocene climates in China dated by magnetic susceptibility, Geology, 16, 9, 811–814.

Liu Tungsheng et al. 1985, Loess and the environment. China Ocean Press, Beijing, 12+251 p.

Maher B. A. 1986, Characterization of soils by mineral magnetic measurements. Physics of the Earth and Planetary Interiors, 42, 76–92.

Maruszczak H. 1969, Genetic interpretation of lithological features of Polish loess. Geographia Polonica, 17, 293–310.

Maruszczak H. 1972, Podstawowe cechy genetyczne i stratygraficzne lessów Polski południowo-wschodniej (only in Polish — Genetic and stratigraphic features of the loess in SE Poland). Przewodnik symp. kraj. "Litologia i stratygrafia lessów w Polsce", Wydawn. Geol., Warszawa, 89–135.

Maruszczak H. 1976, Stratygrafia lessów Polski południowo-wschodniej (Loess stratigraphy of south-eastern Poland). Biuletyn IG, 297, Warszawa, 135–175.

Maruszczak H. 1985, Loess section at Nieledew. Guide-book intern. symp. "Problems Stratigr. Paleogeogr. Loesses", UMCS, Lublin, 109–113.

Maruszczak H. 1987, Loesses in Poland, their stratigraphy and paleogeographical interpretation. Annales UMCS, sec. B, 41(1986), Lublin, 15–54.

Maruszczak H. 1990a, Profil lessów w Nieledwi (Loess section at Nieledew). Main sections of loesses in Poland, Preprint, UMCS, Lublin, B. 27–34.

Maruszczak H. 1990b, Zróżnicowanie stratygraficzne lessów w Polsce (Stratigraphical differentiation of Polish loesses). Main sections of loesses in Poland, Preprint, UMCS, Lublin, A. 13–35.

Maruszczak H., Tkacz M. 1987, The importance of paleomagnetic investigations for the stratigraphic analysis of loesses on the example of the section at Łopatki (SE Poland). Annales UMCS, sec. B, 41, Lublin, 229–243.

Maruszczak H., Wilgat M. 1978, Zróżnicowanie stratygraficzne i paralelizacja profili lessowych z Nieledwi i Odonowa w świetle badań minerałów ciężkich (Stratigraphic differentiation and parallelization of loess profiles from Nieledew and Odonów in the light of heavy minerals investigations). Folia Soc. Scis. Lubl., 20, 2, Lublin, 89–95.

Mojski J. E. 1956, Less i inne utwory geologiczne okolic Hrubieszowa (Loess and other geological deposits in the vicinity of Hrubieszów). Biuletyn IG, 100, Warszawa, 463–501.

Mojski J. E. 1965, Stratygrafia lessów w dorzeczu dolnej Huczwy na Wyżynie Lubelskiej (Loess stratigraphy in the drainage basin of the lower Huczwa River in the Lublin Upland). Biuletyn IG, 187, Warszawa, 145–216.

Mojski J. E. 1972, Profil lessowy w Nieledwi (only in Polish — Loess section at Nieledew). Przewodnik sympozjum kraj. "Litologia i stratygrafia lessów w Polsce", Wydawn. Geol., Warszawa, 182–187.

Nawrocki J. 1990, Zmienność podatności magnetycznej w polskich lessach i utworach lessopodobnych i jej zastosowanie w badaniach stratygraficznych tych utworów (only in Polish — Variability of magnetic susceptibility within Polish loess and loess-like deposits and its stratigraphic value). Przegląd Geol., 38, 10, 445-446.

Prell W. L., Imbrie J., Martinson D. G. and 6 others 1986, Graphic correlation of oxygen isotope stratigraphy application to the late Quaternary. Paleoceanography, 1, 137-162.

Racinowski R. 1969, Le profil du loess à Nieledew sur le Plateau de Lublin à la lumiere de l'analyse de minéraux lourds. Biuletyn Perygl., 20, 179-205.

Tretyak A. N. 1983, Estestvennaya ostatochnaya namagnichennost i problema paleomagnitnoy stratifikatsii osadochnykh tolshch. Naukova Dumka, Kiev.

Tucholka P. 1976, Korelacja profili lessowych Nieledew i Komarów Górny na Wyżynie Lubelskiej na podstawie badań paleomagnetycznych (Correlation of loess profiles from Nieledew and Komarów Górny in the Lublin Upland on the basis of paleomagnetic investigations). Biuletyn IG, 297, Warszawa, 249-263.

Tucholka P. 1977, Magnetic polarity events in Polish loess profiles. Biuletyn IG, 305, Warszawa, 117-123.

STRESZCZENIE

Analizowano podatność magnetyczną warstw profilu z Nieledwi, jednego z najbardziej znanych oraz istotnych dla stratygrafii lessów w Polsce. Dzięki temu, że występują w nim trzy gleby kopalne rangi interglacjalnej, od dawna wzbudzał on zainteresowanie różnych specjalistów (H. Maruszczak 1990). Stwierdzono, że podatność magnetyczna w tym profilu jest wyraźnie zróżnicowana w zależności od stopnia zwietrzenia i przekształcenia pedogenetycznego, a więc pośrednio także od wieku lessów (ryc. 1). Na wykresach zmniejszoną podatnością wyróżniają się górne poziomy gleb interglacjalnych oraz gleby interstadialne, a szczególnie typu glejowego. Największą zaś podatnością charakteryzują się warstwy niezwietrzalych, tzn. węglanowych lessów. Jest ona w przybliżeniu tym wyższa, im młodsze są utwory. Podobne zróżnicowanie podatności magnetycznej wykazują lessy z innych profili w Polsce.

Zależność podatności magnetycznej lessów polskich od warunków klimatycznych ich akumulacji oraz pedogenetycznego przekształcenia jest odwrotna niż w lessach chińskich (J. Kukla et al. 1988). Występujące bowiem wśród tych drugich gleby kopalne wyróżniają się znacznym wzrostem wielkości tego wskaźnika. Tłumaczy się to tym, że w warunkach znacznie suchszego klimatu, w których powstawały gleby, wśród lessów chińskich następował — odwrotnie niż w przypadku polskich — wzrost koncentracji nośników namagnesowania. Odwrotność przebiegu krzywych podatności magnetycznej lessów polskich i chińskich odpowiada więc odrębności warunków klimatycznych akumulacji i pedogenetycznego przekształcania tych utworów w Europie środkowej (lessy peryglacjalne) i Azji SE (lessy perydesertyczne).