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Extents and Chronology of Stadial Advances of the Saalian I Ice Sheet between the Odra and Dnieper Rivers

Zasięgi i chronologia nasunięć stadialnych lądolodu Saalian I między Odrą i Dnieprem

ABSTRACT

Data showing the extents of stadial advances of the Saalian I ice sheet in the territory of Poland (where it is defined as Odranian glaciation) and in the West Ukraine (where it is defined as Dnieperian glaciation) have been compiled. Traces of the advance in the period of maximum stadial are distinctly less visible than in the period of the following advances, which are distinguished as first and second post-maximum. In the marginal zones of both post-maximum stadials there occur distinct signs of activity and advance of the ice sheet following each successive recession. Due to the TL datings of the glacial deposits occurring in the distinguished marginal zones, they could be correlated with the suitable phases of oxygen-isotope stage 8 of deep-sea sediments. The maximum stadial corresponds surely to the earliest phases of substage 8.4, the first post-maximum stadial — to the final phases of substage 8.4, and the second post-maximum stadial — to substage 8.2.

INTRODUCTION

Traces of three continental glaciations were usually found in Europe in the 20's and 30's. The middle one, i.e. the last but one glaciation was distinguished in Germany as Saale Eiszeit (K. Keilhack 1921), in Poland as Middle Polish glaciation (J. Sawicki 1922), and in the Ukraine as Dnieperian glaciation (V.I. Krokos 1934). The later stratigraphic investigations showed that so defined middle-Pleistocene glaciation had been at least bipartite. In Germany it is divided into three or, more often, two glaciations — Saale I = Drenthe, and Saale II = Warthe (A.G. Cepek 1986). In Poland it is reported about Middle Polish glaciations in the plural, or an older one as Odranian glaciation and a younger one as Wartanian are distinguished (S.Z. Różycki 1980). In the Ukraine and in Russia the older one is defined as Dnieperian glaciation, and the younger one as Moscowian (S.M. Shik and N.S. Chebotarova 1982, S.M. Shik 1982).

The German authors relate the name of this glaciation with the Saale river, in the basin of which the ice sheet reached then the maximum extent in Germany. Owing to the acivity of these authors on an international scale, this name was accepted in stratigraphic schemes worked out for whole Europe (P. Woldstedt 1958, T. Nilsson 1983). However, the extent of this ice sheet was wider in the Polish territory (the Odra river basin), and the widest in the Ukraine on an continental scale (the Dnieper river basin). Thus, it would be most proper to use the term "Dnieperian glaciation" in studies related to Europe. In the title of our paper we use the term "Saale glaciation" as it is better known on an international scale.

CHRONOSTRATIGRAPHIC LIMITS OF THE SAALIAN I GLACIATION IN EAST-CENTRAL EUROPE

Tills of the Saale I ice sheet were usually separated from older glacial deposits by organogenic series included to the Holsteinian Interglacial in Germany, to the Mazovian in Poland, and to the Likhvinian in East Europe. This interglacial was defined as "great interglacial' in the earliest papers. Later it appeared that it was polycyclic. Two interglacials s.s. (e.g. Holsteinian I and Holsteinian II — vide B. Menke 1968, A. Dücker 1969), and even four warmings (S.Z. Różycki 1964, A.A. Velichko et al. 1989) were distinguished in this period.

The lower limit of Saale I glaciation is now marked by the younger organogenic series of the great interglacial. They are defined as Wacken (Dömnitz) Warmzeit in Germany (A.G. Cepek 1986), as Zbójno Interglacial in Poland (L. Lindner and E. Brykczyńska 1980), and as the Romny Interglacial in East Europe (A.A. Velichko et al. 1989). Thus distinguished interglacial period is unanimously correlated with the oxygen-isotope stage 9. In loess profiles it is represented by forest paleosols (Podsol-Parabraunerde, Parabraunerde-Pseudogley, lessivé). In recent years these soils have been dated by the TL method for about 300 ka in Germany (H. E. S t r e m m e 1986), 330–310 ka in Poland (the GJ3a soil — vide M a r u s z c z a k 1990), and for about 330 ka in the Ukraine ("Luck soil" in the loess section in Volhynia — vide V. N. S h e l k o p l y a s et al. 1985).

The upper limit of this glaciation is marked by organogenic layers separating tills of Saalian I and Saalian II. Generally, these organogenic deposits have not typically interglacial palinological spectra. An interglacial rank is attributed to them only by some paleobotanists (e.g. B. U r b a n 1983), while only an interstadial one by others (Z. J a n c z y k - K o p i k o w a 1991). In the schemes of the German authors this period is distingushed as Kärlicher Interglazial, in Poland as Lublinian (H. M a r u s z c z a k 1987), or Lubawa Interglacial (L. L i n d n e r 1988a), and in East Europe as Odintsovian one. Thus defined "cold interglacial" or "warm interstadial" (H. M a r u s z c z a k 1987) is correlated with the oxygen-isotope stage 7, and strictly speaking with one of its younger substages. Inter-loessy soils representing this period (largely of Parabraunerde type, or the complex containing brown forest soil and superimposed chernozem) are dated by the TL method for 230–180 ka in Germany (L. Z ö l l e r et al. 1989), for 230–210 ka in Poland (H. M a r u s z c z a k 1990), and for 240–230 ka in the Ukraine (V. N. S h e l k o p l y a s et al. 1985).

Therefore, in East-Central Europe Saalian I glaciation corresponds to the oxygen-isotope stage 8 comprising the 300-240 ka period. The youngest stadials of this glaciation should be correlated with younger substages of the oxygen-isotope stage 7 of deep-sea deposits.

THE EXTENTS AND AGE OF THE MAIN STADIALS OF THE SAALIAN I ICE SHEET

The extents of older stadials are difficult to reconstruct, because the deposits and marginal forms from this period later underwent degradation and fossilization. The reconstruction for some regions can be done only for the stadial directly preceding the maximum extent (distinguished as pre-maximum stadial). An attempt of such a reconstruction for the Malopolska Uplands was presented by L. L i n d n e r (1988b). Because of the lack of data for other regions we do not mark on our map the extent of the pre-maximum stadial of the ice sheet.

M a x i m u m s t a d i a l. The Saalian I ice sheet reached then the Central European middle mountains, i.e. the Sudetes and Holy Cross Mts in the area discussed. The thickness and activity of the ice sheet piled on the slopes of mountains was considerable here. Therefore, in the Odra lobe it advanced far southwards, to the Moravia Gate separating the Sudetes from the Carpathians (Fig. 1). In the region of this Gate, after J. Macoun (1985) the ice sheet reached the Odra — Morava (Danube) watershed, to the geographical latitude 49°35′ and to the altitude of 310 m a.s.l. It was the maximum extent of the Saalian I ice sheet in Central Europe, which seems to be a good basis for defining this glaciation as Odranian in this part of Europe. Due to a considerable activity the ice sheet piling on orographic obstacles reached 350–400 m a.s.l. in the Sudetes, and it entered the lower lying intermontane basins and larger valleys. Finally, its extent is rather capricious and varied here. Besides the Sudetes and the Holy Cross Mts, the upland area of the Polish Jura was a significant orographic obstacle (Fig. 1).

East of the Holy Cross Mts such orographic obstacles did not exist. Therefore, the ice sheet entered onto a large, north-western part of the Lublin Plateau rising to 250 m a.s.l., and reached the Roztocze slope, which ridge was elevated 280–300 m a.s.l. Between the Holy Cross Mts and the Roztocze area it reached only the Sandomierz environs in the Vistula lobe. It probably occupied only the northern corner of the Sandomierz Basin, though its northern part rises only to 150–200 m a.s.l. at present. To be sure, some authors point to the facts which could prove that the extent of the ice sheet in the Sandomierz Basin was considerably larger. However, their arguments are not convincing. Thus, J. Buraczyński (1986) and also J. Buraczyński and J. Butrym (1989) justify their reconstruction of this ice sheet — reaching the environs of Nisko and Biłgoraj in the Sandomierz Basin — by the results of TL datings of some samples of glacial deposits. However, records proving the genetic interpretation of the dated sediments are absent in their papers. Moreover, the uncritical and mechanical use of the dating results of few samples is unacceptable. A still greater value is ascribed to this ice sheet by W. Laskowska-Wysoczańska (1983), who includes the whole north-eastern part of the Sandomierz Basin to its extent. After this author it should have reached the Szkło river valley here, i.e. the geographical latitude about 50°. Apart from not numerous datings by the TL method, the results of paleobotanic analyses of organogenic deposits are the basis for such a reconstruction. However, it should be stressed that the palynologic analysis carried out by Oszast did not give an univocal answer to the question what the age of these deposits is (vide W. Laskowska-Wysoczańska and J. Oszast 1990). Besides, in this part of the Sandomierz Basin no profile has been found in which two different tills representing two separate glacial periods would occur. At the same time the TL datings indicate that the till layer occuring in many sections should be connected with Elsterian II glaciation (J. B u t r y m et al. 1988). Therefore, the thesis about a very limited extent of Saalian I glaciation in the Sandomierz Basin should be maintained in the present state of studies. To explain the "mystery" of such an extent, the changes which had occurred in the Sandomierz Basin during this glaciation should be given attention. The Basin — wholly belonging to the zone of the peri-Carpathian foredeep — probably underwent a glacio-isostatic elevation. This movement compensated for the subsidence of the neighbouring upland belt from the north, which was loaded by the ice sheet. It was noticed, among others, by Maruszczak in his interpretation of the results of investigations of Quaternary deposits in the Sandomierz section (vide J. B u t r y m and H. M a r u s z c z a k 1985).

East of the Lublin Plateau the ice sheet reached at a short stretch the north edge of the Volhynia Plateau, only to about 220–230 m a.s.l. Its activity was very limited here. This is proved most clearly by the fact that farther to the east the ice sheet was unable to overrun rather small orographic obstacle, which was the Ovrutch Plateau (elevated — to 314 m a.s.l. — over the Polesiye Lowland and situated at a considerable distance north of the Volhynia Plateau). Only on the east side of this Plateau, i.e., where the vast Dnieper Lowland inclined southwards was spread, the ice sheet advanced far to the south. Within the huge Dnieper lobe it reached the geographic latitude 48°40′. It was the maximum extent on the European scale during Saalian I glaciation.

The relief of the marginal zone of maximum extent was strongly destroyed, and we can reconstruct it only exceptionally. In the extensive valleys and depressions we can define this extent largely on the basis of an analysis of the distribution of ice-dam lake silts. Denuded remnants of eskers or kames are preserved in some places outside the valleys. The occurrence of these deposits and glacial relief in the Odra river catchment was discussed by J. M a c o u n (1985), A. S z p o n a r (1986) and J. L e w a n d o w s k i (1987), and for the stretch betwen the Warta and Bug rivers was represented in a schematic map few years ago (L. L i n d n e r et al. 1985). V. P. P a l i e n k o (1982) reconstructed these forms for the stretch between the Bug and Horyń rivers, and A. V. M a t o s h k o (1982) — for the west stretch of the Dnieper lobe. We can add that the hills near Kaniów (beyond our map — Fig. 1), in which the glacidislocations connected with the marginal zone of maximum extent of Saalian I glaciation were found (Ju. A. L a v r u s h i n and Ju. G. C h u g u n n y i 1982), belong to the central stretch of the Dnieper lobe.

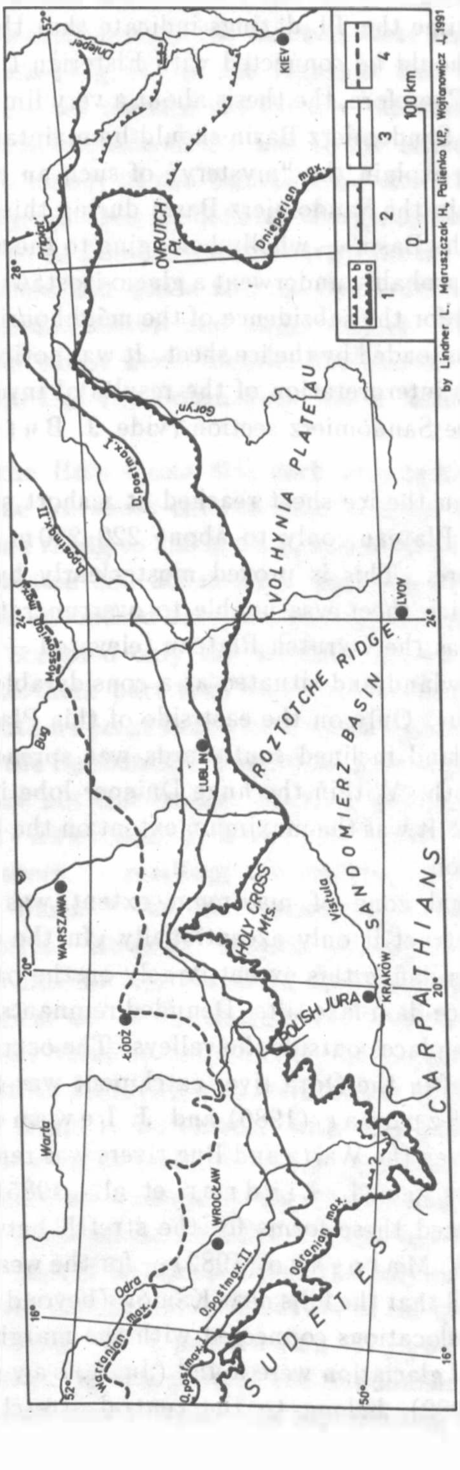

Fig. 1. Extents of stadial advances of the ice sheet during Saalian I and II bettween Odra and Dnieper rivers

1 — Saalian I ice sheet during the maximum stadial: a) extreme extent, b) extents of recession phases; 2 — extreme extent of the first post-maximum stadial of the Saalian I glaciation; 3 — extreme extent of the second post-maximum stadial of the Saalian I glaciation; 4 — maximum extent of the Saalian II ice sheet

We have got TL datings for dozens of samples of glacial deposits from the marginal zone of the maximum stadial. The review of a part of these results made a few years ago (L. Lindner et al. 1985) pointed to the interval 280–270 ka BP. The results of the datings of the glacial deposits from the Sandomierz section published later (J. Butrym and H. Maruszczak 1985) imply that the lower limit of this interval can be shifted to 290 ka. It seems that maximum stadial should be correlated with the oxygen-isotope substage 8.4 (for this substage the interval 280–260 ka BP is defined). Of course, the most probable correlation is that with the first phases of this substage (8.46?). The argument for such a correlation can result from the fact that during the stage 8 the lowest temperature of sea waters is reconstructed for the layers of the oceanic deposits dated for 277 ka BP (D.G. Martinson et al. 1987).

The recession of the ice sheet of the maximum stadial was most considerable within the Dnieper and Odra lobes, i.e. where the thickness of the ice sheet was the smallest. Within the extent of the Dnieper lobe the traces of this recession remain visible and allow reconstruction of the course of the recessive phases (A. V. Matoshko 1982) — vide Fig. 1. Outside these two regions the ice sheet retreated at a distance of 80 km.

The first post-maximum stadial. After the recession phase the ice sheet became active and advanced. Thus, a new marginal zone was formed which extent was less conditioned by the orographic pattern of the area. The influence of this pattern was most visible in the ridge of the Sudetes, and less in the Holy Cross Mts (Fig. 1). The forms of glacial relief have been better preserved in this marginal zone. Examinations of these forms show a great activity of the ice sheet. Even in lowland, i.e. without higher orographic obstacles, the zones of the frontal morainic hills with distinct glacitectonic structures were formed. It is visible most distinctly in the Polesiye Lowland (V. P. Palienko 1982) — vide Fig. 2.

Datings by the TL method of the glacial deposits of the marginal zone of the first post-maximum stadial indicate the interval 270–260 ka BP. In that case they should be surely correlated with the late phases of the oxygen-isotope substage 8.4. We can add that the temperature of sea water as low as that determined for the layers of deep-sea deposits 277 ka old is reconstructed for those dated for 267 ka (D. G. Martinson et al. 1987).

From its front line the ice sheet of the first post-maximum stadial retreated later at a distance of several dozens to about one hundred kilometers. Generally, this distance increased eastwards and was the biggest on the Polesiye Lowland. This stage of recession of the ice sheet can be correlated with the oxygen-isotope substage 8.3 (the interval 257–249 ka

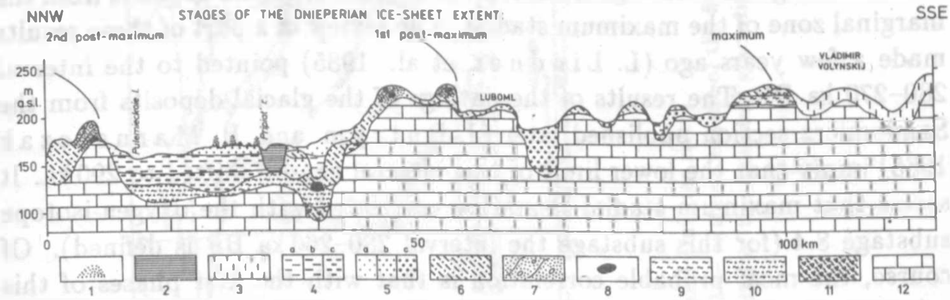

Fig. 2. Geologic-morphologic cross-section of three distinguished stadials of the Dnieperian (Saalian I) ice sheet in the west part of Volhynian Polesiye (after Palienko V.P., 1982; generalized and simplified by Maruszczak H., 1990)
Holocene and younger Pleistocene: 1 — dune sands; 2 — alluvia; 3 — subaerial loesses. Mid-Pleistocene deposits from the period of Dnieperian glaciation: 4 — fluviolacustrine of distinguished stadials (a) second post-maximum, b) first post-maximum, c) maximum); 5 — glaciofluvial of three distinguished stadials (a) second post-maximum, b) first post-maximum, c) maximum); 6 — morainic; 7 — glaciotectonically deformed glacial deposits; 8 — floes in glacial deposits. Deposits from older Pleistocene (Okanian glaciation): 9 — glaciolacustrine; 10 — glaciofluvial; 11 — morainic. Upper Cretaceous bedrock: 12 — limestones and marls

BP). In this period in SE Poland, the initial soils of chernozem type — still preserved in some sections — were developed on loess deposits; the interval of their development was defined — on the basis of the TL datings — for 255/250–245 ka BP (H. Maruszczak 1990).

The second post-maximum stadial. After this successive phase of recession the ice sheet became active again and reached the line marked on our map. The second marginal zone was formed with features similar to those in the first post-maximum stadial. In some parts the zones of frontal-morainic hills (Fig. 3) with a complete set of concomitant forms (eskers, kames, kame terraces, outwashes and outwash fans, ice-dam lakes and the like) were formed. They can be evidence of a rather long stagnation of the ice sheet in this zone. At the same time they formed the basis for attempts to reconstruct the character and progress of deglaciation in the phases preceding and following the formation of this marginal zone. The results of such reconstruction for the western part of Polesiye Lowland were published (J. Buraczyński 1986). Many glacitectonic structures evidencing a considerable activity of the ice sheet were found in the zone discussed (Fig. 2).

The datings by the TL method indicate that the second post-maximum stadial occurred probably about 250 ka BP. So, it should be correlated with the beginning of the oxygen-isotope substage 8.2 dated for 249 ka BP (J. Imbrie et al. 1984).

From the line of the second post-maximum stadial the ice sheet began to retreat during the oxygen-isotope substage 7.5 (the beginning of this substage is dated for 238 ka BP — vide J. Imbrie et al. 1984). The recession proceeded successively, in places marked by zones of hills of glacial accumulation, more weakly expressed than the marginal zones of both described post-maximum stadials. These weakly expressed zones of morainic hills, marking the successive phases of ice sheet recession, are fragmentarily shown among other things on the Geological Map of Poland 1 : 500 000 (1986), and on the General Geomorphological Map of Poland 1 : 500 000 (1980).

THE STRATIGRAPHIC RANK AND AGE OF THE PERIOD SEPARATING THE ADVANCE OF THE SAALIAN I AND SAALIAN II ICE SHEETS

After the second post-maximum stadial the recession of the ice sheet was long-lasting. Successively it retreated completely from the area of East-Central Europe. During the oxygen-isotope substages 7.3 and 7.1 in the loessy regions of Poland, the pedocomplexes or poligenic soils were formed (H. Maruszczak 1990). In the first phase of their development forest brown soils were largely formed, dated by the TL method for 230–220 ka BP. From the paleopedological point of view, the interglacial rank (after many Polish authors it is the Lublin Interglacial = Lublinian = Treenian = Odintsovian) can be ascribed to this phase of their development (corresponding to the substage 7.3). However, in the opinion prevailing among Polish paleobotanists, this period has no features typical for interglacial (Z. Janczyk-Kopikowa 1991). On the basis of paleobotanic criteria another opinion is expressed, mainly with regard to the site Losy near Lubawa (K. Krupiński and L. Marks 1986); referring to this opinion L. Lindner (1988a) proposed to distinguish this period as Lubawa Interglacial. So, the interval corresponding to the oxygen-isotope substages 7.3–7.1 is defined as "cold interglacial" or "warm interstadial" (H. Maruszczak 1987). Irrespective of the rank ascribed to it, it should be stressed that it lasted rather for a long time, i.e. not less than 20 ka.

After the period of Lublinian Interglacial/Interstadial the advance of the Saalian II = Wartanian = Moscowian ice sheet occurred. This ice sheet advanced onto the area of Central Europe only about 190 ka BP. Its maximum extent — marked on our map (Fig. 1) — was probably reached

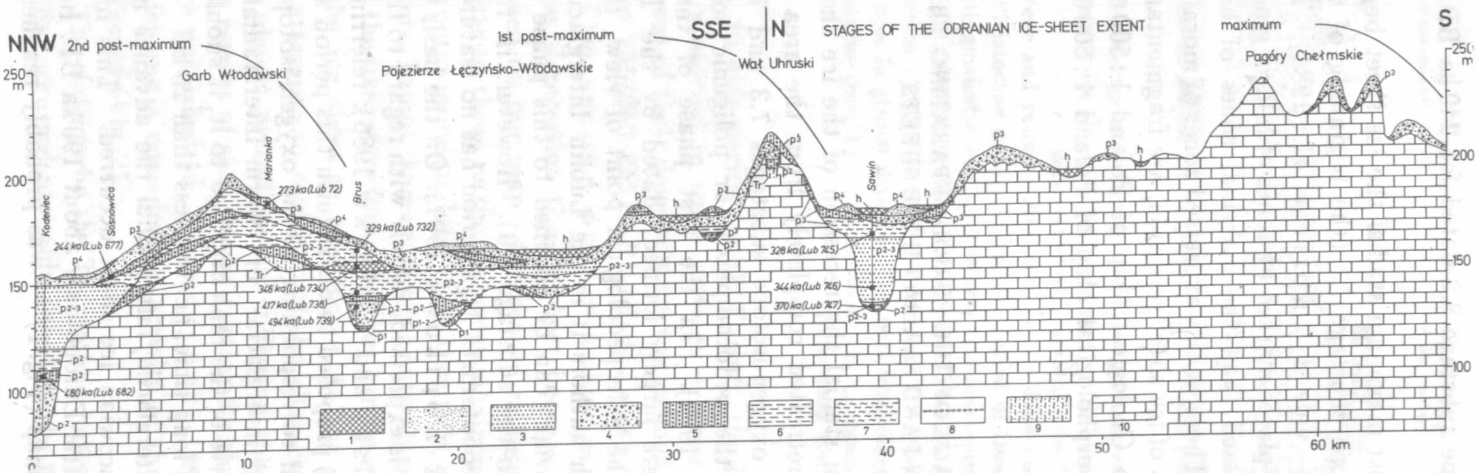

Fig. 3. Geologic-morphologic cross-section of the zone of occurrence of glacial deposits of Odranian (Saalian I) glaciation in the area of the Wieprz and Bug river interfluve. Worked out in 1990 by Wojtanowicz J., with regard to the results in the paper of Buraczyński et al. (1988), and published and unpublished materials for the Detailed Geological Map of Poland (sheets: Sosnowica, Kołacze, Sawin). The TL age of deposits according to the analyses from the Lublin laboratory (Lub). Quaternary deposits: 1 — peats, gyttja and organic muds; 2 — limnic, fluvial-periglacial and cover sands; 3 — fluvial sands; 4 — glaciofluvial sands; 5 — tills; 6 — ice-dam lake clays; 7 — muds; 8 — pavements. Tertiary deposits: 9 — sands. Upper Cretaceous and Paleocene rocks: 10 — limestones, marly limestones and opokas. Stratigraphic letter indices: P_1 — the oldest glaciation; P_2 — Sanian glaciation; P_3 — Odranian glaciation; P_4 — Vistulian glaciation; h — Holocene

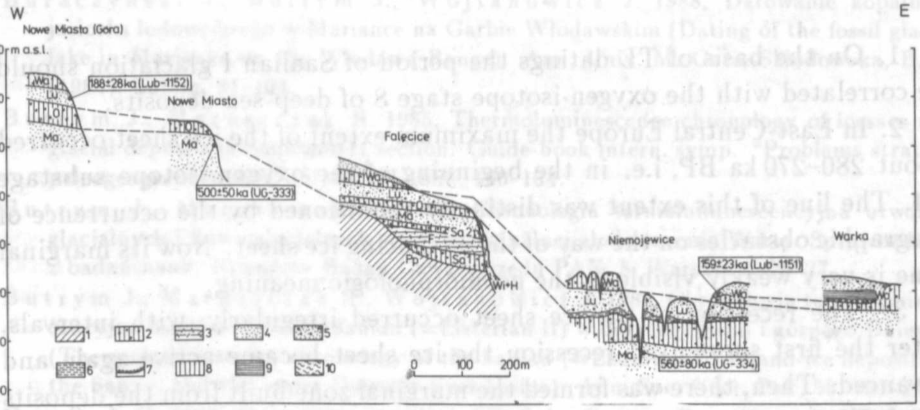

Fig. 4. Geologic-morphologic cross-section and age of Pleistocene deposits which built the morainic plateau in the zone of the northern border of the lower Pilica river valley (on the basis of the data of various authors compiled by Lindner et al. 1989). The TL age of deposits according to analyses from the Lublin (Lub) and Gdańsk (UG) laboratories

1 — preglacial deposits; 2 — till; 3 — sands, silts, clays, bituminous clays with flora; 4 — sands; 5 — sands and gravels; 6 — varve clays; 7 — boulder pavement; 8 — loess; 9 — silts and varve clays; 10 — slope sands and loams (deluvia); P_p — proto-Pleistocene; Sa1 — Sanian 1 glaciation; F — Ferdynandów Interglacial; Sa2 — Sanian 2 glaciation; Ma — Mazovian Interglacial; O — Odranian glaciation; Lu — Lubawa Interglacial; Wa — Wartanian glaciation

during the interval 180–170 ka BP. It is shown by the results of TL datings of the glacial deposits from the marginal zone of the maximum stadial of the Saalian II ice sheet (vide Fig. 4, and also earlier data published by L. Lindner 1988b, and J. Butrym and H. Maruszczak 1989). Therefore, this event can be correlated with the oxygen-isotope substage 6.6. The beginning of this substage is dated for 183 ka BP; similarly dated is the episode for which the one of the lowest temperatures of sea waters during stage 6 was reconstructed (D. G. Martinson et al. 1987).

It can be stressed that geomorphologically the border of the maximum advance of the Saalian II ice sheet is considerably better expressed than in the marginal zones of Saalian I glaciation. All forms of glacial relief characteristic for typical marginal zones are preserved — still well visible — in many stretches. Therefore, the comparisons with similar zones from the period of Saalian I evidence that we have here traces of the development of two different glacial cycles.

CONCLUSIONS

1. On the basis of TL datings the period of Saalian I glaciation should be correlated with the oxygen-isotope stage 8 of deep-sea deposits.

2. In East-Central Europe the maximum extent of the ice sheet occurred about 280–270 ka BP, i.e. in the beginning of the oxygen-isotope substage 8.4. The line of this extent was distinctly conditioned by the occurrence of orographic obstacles on the way of the advancing ice sheet. Now its marginal zone is very weakly visible in the geomorphologic meaning.

3. The recession of the ice sheet occurred irregularly, with intervals. After the first short-lived recession the ice sheet became active again and advanced. Then, there was formed the marginal zone built from the deposits which TL age allows us to correlate them with the final phases of substage 8.4. The next phase of recession should be correlated with the oxygen-isotope substage 8.3. Signs of reactivation of the ice sheet and of formation of the second post-maximum zone should be correlate with substage 8.2.

4. The marginal zones of both post-maximum stadials are better visible in lowland areas. In these areas they are geomorphologically much better expressed, than the marginal zone of the maximum stadial.

5. After the second post-maximum stadial the recession was long-lasting. The ice sheet wholly retreated from the area of East-Central Europe in the oxygen-isotope substage 7.3. The climatic conditions of this period are mainly defined by paleobotanists as typical for the exceptionally warm interstadial. From the paleopedological point of view this period had interglacial features. It would be the cold Saalian I/Saalian II = Lublinian = Odintsovian = Treenian Interglacial.

6. The advancing Saalian II ice sheet had its maximum extent about 180–170 ka BP, i.e. during the oxygen-isotope substage 6.6. In many lowland areas its marginal zone with the whole set of typical relief forms has been preserved till now. Therefore, the geomorphological and geochronological criteria seem to reveal that the Saalian I (= Odranian = Dnieperian) ice sheet and Saalian II (= Wartanian = Moscowian) ice sheet represented two separate glacial cycles.

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STRESZCZENIE

Zestawiono dane ilustrujące zasięgi stadialnych nasunięć lądolodu Saalian I na obszarze Polski (gdzie wyodrębniany jest jako lądolód Odry) oraz Ukrainy zachodniej (gdzie wyodrębniany jest jako lądolód Dniepru). W dorzeczu Dniepru lądolód ten osiągnął największy zasięg w skali europejskiej. Najbardziej logiczne byłoby więc wyodrębnić to zlodowacenie jako Dnieprian. Pomimo tego w tytule opracowania jest określenie Saalian I, jako najbardziej znane w międzynarodowych schematach stratygrafii czwartorzędu Europy.

Ślady nasunięcia z okresu maksymalnego stadiału są znacznie słabiej czytelne niż z okresu następnych nasunięć, które wyodrębniono jako I i II postmaksymalne (ryc. 1). Dlatego też najwięcej wątpliwości wzbudzają rekonstrukcje zasięgu maksymalnego. Przedstawiono go więc najobszerniej, ze szczególnym zwróceniem uwagi na kontrowersyjne opinie odnoszące się do obszaru Kotliny Sandomierskiej. W strefach marginalnych obu stadiałów postmaksymalnych są stwierdzone wyraźne oznaki aktywizacji i transgresji lądolodu, która następowała po każdej kolejnej regresji. Do oznak tych należą przede wszystkim liczne struktury glacitektoniczne (ryc. 2, 3). Dzięki datowaniu metodą TL utworów glacjalnych, występujących w wyróżnionych strefach marginalnych. można było skorelować je z odpowiednimi etapami 8 stadium krzywej izotopowo-tlenowej osadów głębokomorskich. Stadiał maksymalny odpowiada zapewne najwcześniejszym fazom substadium 8.4. I stadiał postmaksymalny końcowym fazom substadium 8.4, a II stadiał postmaksymalny — substadium 8.2.

W rozdziale końcowym zwrócono uwagę na warunki paleogeograficzne, czas trwania oraz rangę stratygraficzną interwału dzielącego nasunięcia lądolodów Saalian I i Saalian II. Stwierdzono duże różnice wieku osadów glacjalnych ze stadiałów maksymalnych tych nasunięć (ryc. 4). Fakt ten, a także zachowane dotychczas i dobrze czytelne zespoły strefy marginalnej maksymalnego stadiału lądolodu Saalian II. świadczą. że te dwa lądolody (tzn. Odry i Warty według schematów polskich) reprezentują odrębne cykle glacjalne.