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Pleistocene of the Mochowo Depression in the Dobrzyń Lakeland

ABSTRACT: In the Mochowo Depression, being a deeper depression formed within the Tertiary substrate of the Płock Plateau and the Dobrzyń Lakeland, north Central Poland, an about 200 m thick sequence of Pleistocene deposits has been recently pierced by the boreholes. This sequence comprises the sediments of four glaciations, since the Podlasie (Günz) Glaciation through the Baltic (Vistulian = Würm) Glaciation, separated from one another by distinct erosion surfaces. A stratigraphic scheme proposed for the region is partly supported by thermoluminescence datings of the sediments.

INTRODUCTION

Deep depressions and high elevations, occurring in easily deformable Tertiary (Pliocene, Miocene, Oligocene) deposits, are the typical feature of the Płock Plateau and the Dobrzyń Lakeland, north Central Poland. They were mainly formed during the advance of the first Scandinavian icesheet, the frontal part of which composed of many lobes and tongues of variable size, and easily entering all the depressions in the sedimentary surface of Pliocene sediments. In most cases these were not the fluvial valleys, and the charges caused by pressure of individual lobes and tongues caused farther deepening of the depressions. Smaller and less distinct depressions occur entirely within the Upper Tertiary sediments, commonly of Pliocene age only. Larger and more fully developed ones reach the bedrock of the Upper Cretaceous (Maestrichtian) or of the Paleocene (Danian) deposits. In the interlobal areas, high elevations were formed locally, composed of intensively glaci-folded Tertiary deposits. The problem of the origin and farther evolution of depressions and elevations in the Quaternary bedrock is the subject of another paper (Lamparski 1982).

GEOLOGIC SETTING

Two large elevations of Tertiary deposits are the main geologic feature of the Płock Plateau and the Dobrzyń Lakeland. They both are separated by a vast depression, 12 km wide and over 30 km long, named by the author the Mochowo Depression, and the bottom of which is located at 98 m b.s.l. (cf. Text-figs 1—3).

The depression is bordered from the south by a huge elevation of Tertiary deposits, squeezed locally even up to 100 m a.s.l., located along the Vistula valley from Płock down to Szpetal, and named the Płock

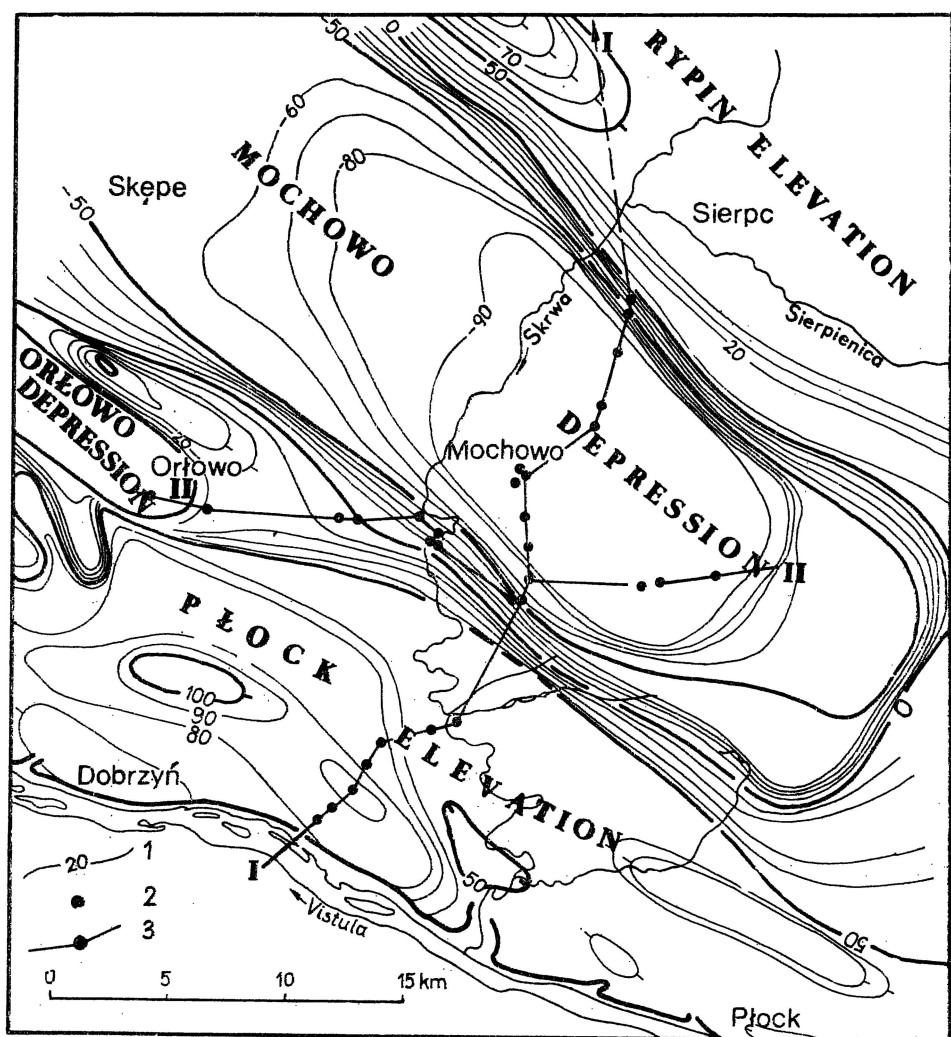


Fig. 1. Sculpture of the Pleistocene basement around the Mochowo Depression, Dobrzyń Lakeland, north Central Poland

1 contour lines every 10 metres, 2 boreholes, 3 geological sections (for I—I see Text-fig. 3A, and for II—II see Text-fig. 3B)

Elevation. A fragmentary insight into the geologic structure of this elevation is possible due to the well exposed cliffs along the Vistula near Dobrzyń, and discussed i.a. by Łyczewska (1959, 1964), Ber (1960, 1968) and Jaroszewski (1963). To the north-east the Mochowo Depression is bordered by an equally huge elevation of Tertiary deposits, and named the Rypin Elevation.

STRATIGRAPHY OF PLEISTOCENE SEDIMENTS

The Mochowo Depression comprises the most complete sequence, about 200 m thick, of Quaternary deposits in Poland with well expressed

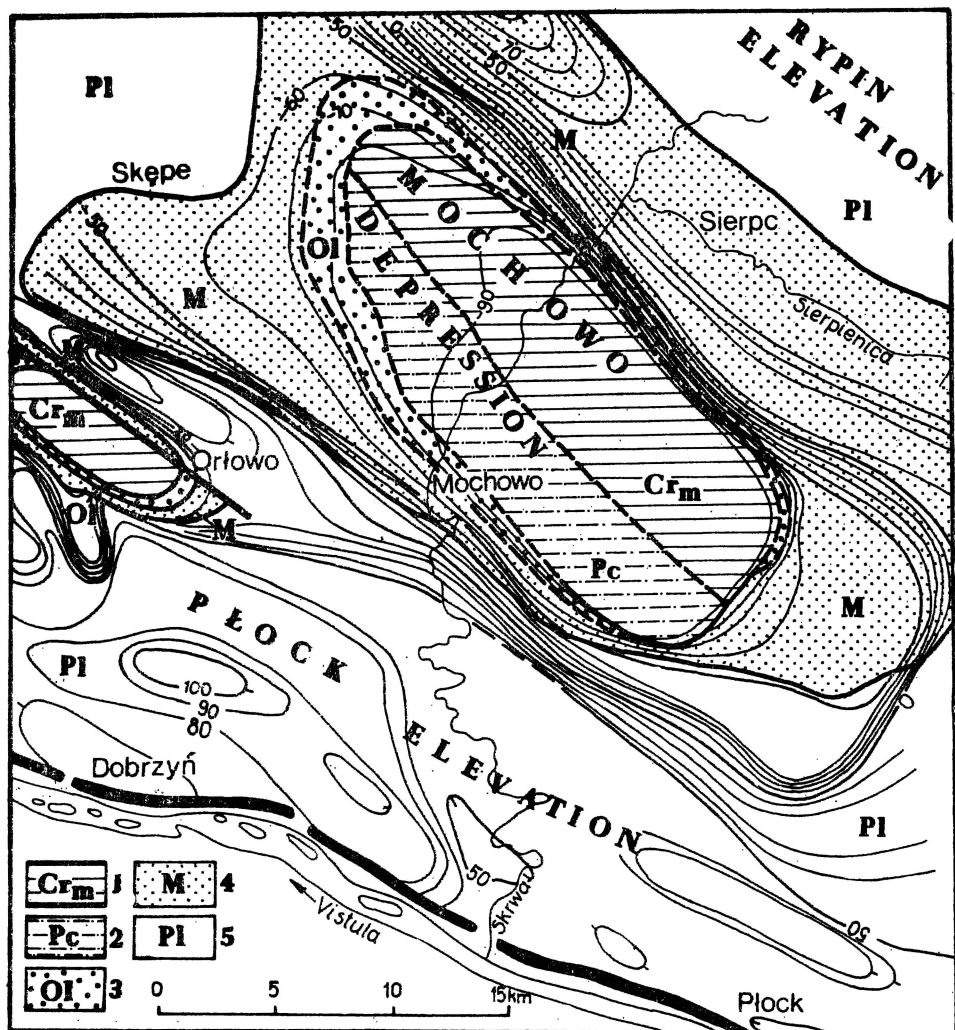


Fig. 2. Geology of the Pleistocene basement around the Mochowo Depression
 1 Upper Cretaceous (Maëstrichtian), 2 Paleocene (Danian), 3 Oligocene, 4 Miocene, 5 Pliocene

glacial horizons since the oldest Podlasie (Günz) Glaciation up to the Baltic (Vistulian=Würm) Glaciation. Previous investigations of Quaternary deposits in the region, which were made at the Płock Elevation (Skompski 1969), could not result in a broad analysis of Quaternary chronology as the older Quaternary sediments have been strongly reduced or completely removed there, whereas the younger Quaternary sediments form only a thin cover that directly overlies the Tertiary deposits.

At the bottom of the Mochowo Depression, the Quaternary sediments overlie directly the rocks of Upper Cretaceous (Maestrichtian) and Paleocene (Danian) age (cf. Text-figs 2—3). No deposits of the Tertiary younger than the Paleocene occur there while in the Płock and Rypin elevations they even reach 200 m what seems to balance a loss of these sediments due to the glacial squeezing in the Mochowo Depression. A mean thickness of Tertiary deposits in less disturbed zones is considerably smaller and equals 40—60 m.

The lowermost part of the Mochowo Depression (cf. Text-fig. 3A—B) is occupied by tills of the Podlasie (Günz) Glaciation. These tills, about 100 m thick, are composed of two series noted especially well near Tuchowo (Text-fig. 3B) where two-cyclic sediments of fluvial origin have been found in a buried valley, about 23 m deep.

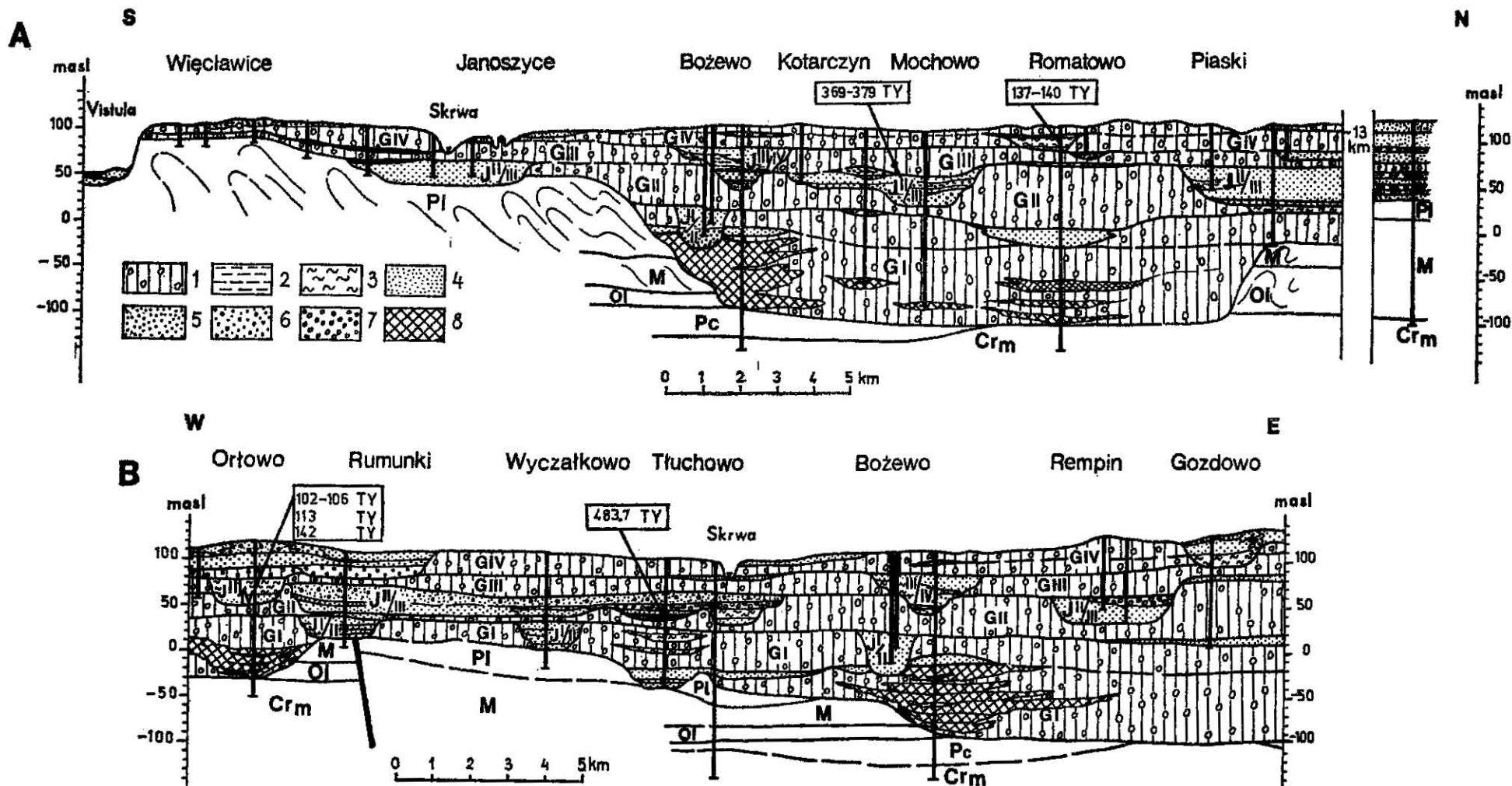
The tills of the Podlasie (Günz) Glaciation contain numerous inserts and interbeds composed of redeposited Tertiary deposits. Commonly, they were regarded as ice-transported masses of Miocene or Oligocene deposits or as Pliocene variegated clays. As apparently visible in the borehole samples, they have been usually formed due to the mixing of Miocene and Oligocene sediments, locally with an admixture of Quaternary series. They originated in result of a slope flowing of sediments, squeezed up to the elevations, and their deposition in local water reservoirs.

At the top of tills of the Podlasie (Günz) Glaciation there is a distinct erosion surface of the Przasnysz (Günz/Mindel) Interglacial. This surface (see Text-fig. 3) forms mainly relatively narrow (1—3 km) but quite deep (35—40 m) river-valley system with coarse- and medium-grained sands of fluvial accumulation, and of pretty well defined sedimentary cycles. The interglacial erosion surface separates the tills of the Podlasie (Günz) and Cracovian (Mindel) glaciations. The latter ones still usually fill the Mochowo Depression and only locally encroach the lower fragments of Płock and Rypin elevations. In spite of erosion and denudation during the Great (Mindel/Riss) Interglacial the tills outside the interglacial valleys reach locally a considerable thickness of 50—60 m. An analysis of interbeddings and lenticles of other sediments within these tills does not allow to draw a conclusion about two glacial periods in this area during the Cracovian (Mindel) Glaciation.

An analysis of the new research boreholes enabled to define the shape and direction of a valley formed during the Great (Mindel/Riss) Interglacial; moreover, the erosive socles formed in the tills of the Cracovian (Mindel) Glaciation have been recognized (see Text-fig. 4).

An absolute dating of varved clays at the top of the Cracovian (Mindel) Glaciation tills and at the bottom of fluvial series of the Great (Mindel/Riss) Interglacial is an important key for geochronology when any interglacial organogenic sediments are lacking. These clays sampled in the borehole at Tuchowo (cf. Text-fig. 3B), were dated by S. Stańska-Prószyńska and M. Prószyński by a thermoluminescence method for 483.7 thousand

Geologic sections (A and B) throughout the Mochowo Depression (cf. Text-fig. 3)



LITHOLOGY: 1 tills, 2 varved clays, 3 silts, 4 medium- and fine-grained sands, 5 coarse-grained sands, 6 sands with gravels, 7 gravels, 8 redeposited Tertiary deposits

STRATIGRAPHY: Cr_m — Upper Cretaceous (Maestrüchtian), Pc — Paleocene (Danian), Ol — Oligocene, M — Miocene, Pi — Pliocene, GI — Podlasie (Günz) Glaciation, JI/II — Przasnysz Interglacial, GII — Cracovian (Mindel) Glaciation, JII/III — Great (Mindel/Riss, i.e. Holstein) Interglacial, GIII — Middle Polish (Riss) Glaciation, JIII/IV — Eemian Interglacial, GIV — Baltic (Würm) Glaciation

years. Instead, the silts of a fluvial accumulation, sampled in the borehole at Mochowo (cf. Text-fig. 3A) were dated for 369—379 thousand years by the same method.

Consequently, the age of the most distinct key horizon, i.e. the Great (Mindel/Riss) Interglacial deposits were also defined. The top of these sediments, being the bottom of tills of the Middle-Polish (Riss) Glaciation, is localized mostly at 60—70 m a.s.l. within the investigated area. In spite of small grain size differentiation, the sediments of the Great Interglacial represent the three sedimentary cycles. The sediments of the third, uppermost cycle end with silts of fluvio-glacial origin at the advance of the Middle-Polish Glaciation. The cycles are not to be connected yet with similar cycles of fluvial accumulation distinguished in valleys of greater Polish rivers of that time (Różycki 1972).

A considerably greater area than by the tills of the Podlasie and the Cracovian glaciations, is occupied by tills of the Middle-Polish Glaciation. Their extent is much vaster than of the Mochowo Depression and of several smaller depressions; they occupy the Płock and Rypin elevations, localized at higher altitudes. The tills of the Middle-Polish Glaciation are well preserved not only in the depression, and it probably happened due to smaller erosion and denudation during the Eemian (Riss/Würm) Interglacial than during the Great (Mindel/Riss) Interglacial as already suggested by Różycki (1972).

The sediments of the Eemian (Riss/Würm) Interglacial were studied at Bożewo (Text-fig. 3A) and Orłowo (Text-fig. 3B). They lie in valleys 30—45 m deep and filled in their lower parts by cyclic sediments of fluvial accumulation and in the upper part by deposits of a final phase of this very accumulation. At Orłowo the latter sediments are the gray silts, 20 m thick, whereas at Bożewo, they are both the silts and fine-grained sands. Within the Eemian valleys there appear numerous erosive socles cut in the till of the Middle-Polish Glaciation and locally; also in the tills of the Cracovian Glaciation. The age of these sediments that are considered for the Eemian Interglacial, was also defined by the thermoluminescence method. The datings of three samples of gray silts from Orłowo appeared, successively from the bottom to the top of the series, as 142, 113 and 106—102 thousand years.

The sediments of the Eemian Interglacial at Orłowo are overlain, similarly as in other sites, by 10—20 m horizon of tills of the Baltic (Würm) Glaciation. These tills are composed of the two distinct series of unknown stratigraphic significance; it is especially noted in a marginal zone of the ice sheet extent, north-west of Płock. The Baltic Glaciation till occurs horizontally at a level of 80—100 m a.s.l. A particular situation that enabled an absolute dating of the till bottom, appeared in the boreholes close to Romatowo (Text-fig. 3A). In a depression developed in the lower till horizon of the Baltic Glaciation, there occurs an almost 20 m thick series of sands and silts overlain by another till horizon. The obtained age of these silts, 137—140 thousand years (cf. Text-fig. 3A) does not however seem to be accepted.

CONCLUSIONS

The Pleistocene deposits of the Mochowo Depression represent the glacial and interglacial series of successive age. They usually rest horizontally and, in spite of common opinions on great significance of glacioclacations within the Pleistocene deposits, they can be easily correlated. The only problem in the regional correlation is that the

sediments of earlier glaciations and interglacials occur at the bottoms of deep but local depressions which are separated by high elevations of Tertiary deposits. It makes then a necessity of an accurate recognition of stratigraphy of everyone depression before any attempt of wider stratigraphic correlations. It makes also the paleogeomorphologic mapping here more difficult than in the zones of the Tertiary elevations, formed mainly by the advance of the first icesheet, and where the processes of erosion and denudation predominated.

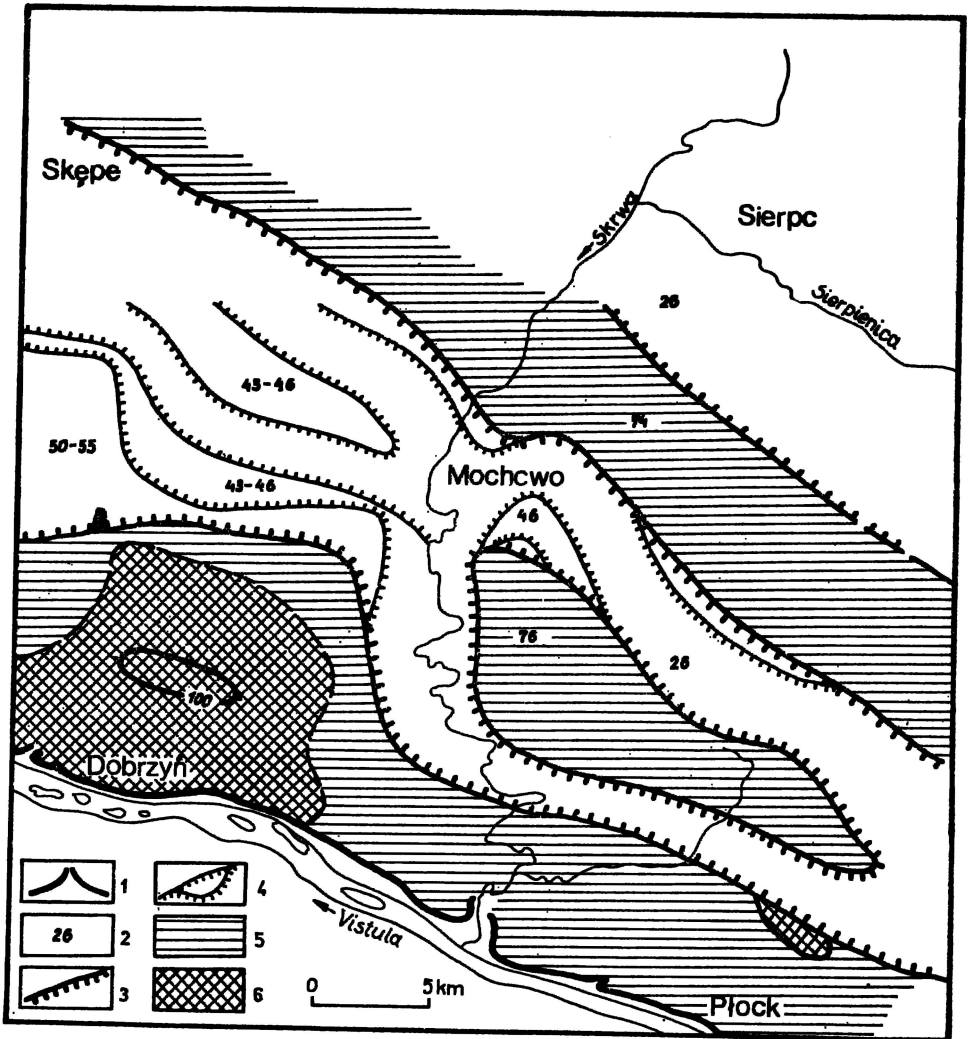


Fig. 4. Great (Mindel/Riss) Interglacial valleys around the Mochowo Depression
 1 escarpment of the Holocene Vistula, 2 altitude of socles and morainic plateaux, 3 valley banks, 4 edges of socles, 5 denuded surfaces of morainic plateaux, composed of the Pleistocene deposits, 6 denuded surfaces of morainic plateaux, composed of the Pliocene deposits

The discovery of bipartite sediments of the Podlasie (Günz) Glaciation within the Mochowo Depression makes a supplement to the hitherto known data on this glaciation and its extent in Poland (cf. Różycki 1972).

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Z. LAMPARSKI

PLEJSTOCEN DEPRESJI MOCHOWA**(Streszczenie)**

W podłożu osadów czwartorzędu Wysoczyzny Płockiej i Pojezierza Dobrzyńskiego występują łatwo odkształcalne osady trzeciorzędu, w których pod wpływem nacisku lodolodu powstały głębokie depresje i wysokie elewacje (fig. 1). W większych depresjach sięgających dnem zwięzłych osadów kredy lub starszego trzeciorzędu (fig. 2), występują najpełniejsze i najlepiej zachowane profile osadów czwartorzędu (fig. 3). Towarzyszące depresjom elewacje zbudowane z silnie spiętrzonych osadów pliocenu i miocenu pokryte są tylko bardzo cienką pokrywą osadów czwartorzędu.

W depresji Mochowa największej spośród tych depresji zachował się pełny profil osadów czwartorzędu (fig. 3). Dno depresji zajmują dwudzielne osady zlodowacenia podlaskiego, których dwudzielność dokumentuje dolina wypełniona osadami dwucyklicznej akumulacji rzecznej (fig. 3). W glinach zwałowych zlodowacenia podlaskiego, sięgających miąższość 100 m, występują często wkładki osadów trzeciorzędu zmytych z sąsiednich elewacji do lokalnych zbiorników wodnych.

W stropie glin zlodowacenia podlaskiego wykształcona jest powierzchnia erozyjna z okresu interglacjału przasnyskiego (fig. 3). Doliny rzeczne tego wieku sięgają głębokości 25—40 m i wypełnione są osadami dwucyklicznej akumulacji rzecznej. Leżące wyżej gliny zwałowe zlodowacenia krakowskiego o miąższości do 70 m nie wykazują rozdzielności.

W okresie interglacjału wielkiego ponad depresją Mochowa uformowała się rozległa dolina rzeczna (fig. 4) z licznymi cokołami erozyjnymi, wypełniona osadami dwucyklicznej akumulacji rzecznej. Gliny zwałowe zlodowacenia środkowopolskiego wykraczają daleko poza obszar depresji Mochowa i występują w strefie sąsiednich elewacji.

Osady interglacjału eemskiego występują w dwóch dolinach rzecznych, stwierdzonych w okolicach Bożewa (fig. 3A) i Orłowa (fig. 3B). Zlodowacenie bałtyckie reprezentowane jest jednym lub dwoma poziomami glin zwałowych.
