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Problem of the Lublin Interglacial and stratigraphical subdivision of the Middle Polish Glaciations

The Middle Polish Glaciation (Saalian), previously considered for a stage, recently have gained a higher rank of superstage (megaglacial) in Poland. The latter comprises two cold units (stages): the Odra Glaciation (Odranian) and the Warta Glaciation (Wartanian), separated with the Lublin Interglacial (Lublinian). Previous research and new results are presented from the sites Łęczna, Grabówka, mine Bełchatów and Skorupy, where sediments of the Lublin Interglacial age occur. The studies enabled to define the Lublin Interglacial as a separate stage-rank stratigraphical unit.

INTRODUCTION

Data on stratigraphical subdivision of the Middle Polish Glaciation in Poland have been already many times presented on various occasions. Among others it was printed (textural and tabular) the idea of Middle Polish Glaciation of Middle Polish Lowland and Central Polish Upland (M. D. Baraniecka, 1984). New recapitulation was found necessary in connection with realization, coordination and instruction to the *Szczegółowa mapa geologiczna Polski* in scale of 1:50 000 (M. D. Baraniecka, 1990). Materials to this text have been collected since 1992 within the subject "Type sections of the Pleistocene of Central Poland", realized by the Państwowy Instytut Geologiczny (Polish Geological Institute) and financially supported by the Komitet Badań Naukowych (Committee for Scientific Research). This text was prepared also on occasion of participation in the Symposium of the INQUA Subcommission of Quaternary Stratigraphy of Europe, carried out in Halle as "The Saalian sequence in the type region". Areas around Halle on the Saale River and in the vicinity of Leipzig are

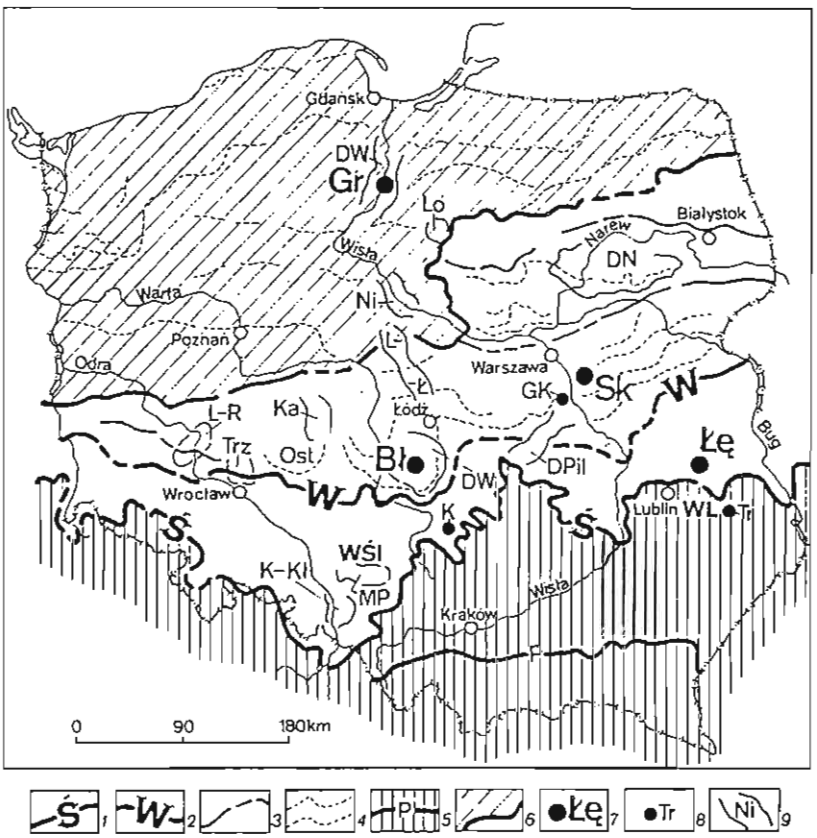


Fig. 1. Extents of the Middle Polish Glaciations (after M. D. Baraniecka, 1984, partly modified)

1 — maximum extent of the Middle Polish (Odra) Glaciations; 2 — extent of the Warta Glaciation; 3 — stadial extents; 4 — phasal extents; 5 — extraglacial area during the Middle Polish Glaciations (P — extent of the South Polish Glaciations in the Carpathians); 6 — area occupied by ice sheets of the North Polish Glaciations; 7 — selected research sites of the Lublin Interglacial (Interstadial): Łę — Łęczna, Gr — Grabówka, Bł — mine Bełchatów, Sk — Skorupy; 8 — sites with sediments containing dryas or cool floristic remains: Tr — Tarzymiechy, GK — Góra Kalwaria, K — Koniecpol; 9 — selected research areas and materials (supplying with data on subdivision of the Middle Polish Glaciation) cited in the text: WL — Lublin Upland, WŚI — Silesian Upland, DW — Lower Vistula Region, Ni — Nieszawa area, Lo — Losy near Lubawa, DN — Lower Narew Region, L-R — Lubin — Rudnik Region (Dalków Hills), Trz — Trzebnica Region (Trzebnica Hills), Ost — Ostrzeszów Hills, Ka — Kalisz Region, DWi — Widawka drainage basin, L-Ł — Lubień — Łęczyca Region, DPil — Lower Pilica Region, MP — Mała Panew Basin, K-Kł — Kłodnica Basin

Zasięgi zlodowaceń środkowopolskich (według M. D. Baranieckiej, 1984, częściowo zmienione)

1 — maksymalny zasięg zlodowaceń środkowopolskich (odry); 2 — zasięg zlodowacenia warty; 3 — zasięgi stadialne; 4 — zasięgi fazowe; 5 — obszar poza zasięgiem lądolodów zlodowaceń środkowopolskich (P — zasięg zlodowaceń południowopolskich w Karpatach); 6 — obszar w zasięgu lądolodów zlodowaceń północnopolskich; 7 — ważniejsze stanowiska badawcze interglacjału (interstadiału) lubelskiego: Łę — Łęczna, Gr — Grabówka, Bł — kopalnia Bełchatów, Sk — Skorupy; 8 — miejsca występowania osadów z florą dryasową lub chłodną: Tr — Tarzymiechy, GK — Góra Kalwaria, K — Koniecpol; 9 — ważniejsze obszary badań i materiały (dostarczające danych o podziale zlodowacenia środkowopolskiego) cytowane w tekście: WL —

considered for a type region of the stratigraphical unit known commonly in Poland as the Middle Polish Glaciation. In Germany it is the Saale Glaciation (*Saaleeiszeit*) and in the international terminology (among others of the INQUA Subcommissions) — the Saalian. The Subcommision of the Quaternary Stratigraphy of Europe reviews a state of research of successive stratigraphical units of the Quaternary and presents results to be eventually accepted by the authorities of the INQUA Congress.

Profound discussion on stratigraphical meaning of the Middle Polish Glaciation should comprise besides its subdivision, the lower and upper boundaries as well as doubtful borders of adjacent stratigraphical units. Short presentation of these issues as well as of complete subdivision of the Middle Polish Glaciation is not possible. Thus sediments that separate the Odra (Odranian) and the Warta (Wartanian) Glaciations have been chosen here as the key but discussive item. Separation of the Warta Stadial (Glaciation) from the Odra Stadial (Glaciation) is very common in Poland, with generally less and less contradictors in recent times.

At the very beginning the Warta unit has been distinguished on the basis of outstanding morainal zone. This zone, easily examined at land surface, was at first considered for a stadial in a geomorphological sense. Afterwards, geological definition of the stadial was accepted for a longer time. This latter approach beside geomorphological features and morainal sediments of the ice sheet, was based on separation of the Warta and Odra tills, and eventually — also accompanying glaciofluvial and ice-dam deposits.

Going on with studies of sediments between the tills, an interstadial was distinguished and named the Pilica Interstadial (S. Z. Różycki, 1961). Later on, discussion focused on the problem if it is an interstadial or an interglacial. In the same time, studies of several beds of older loesses (of the Middle Polish Glaciation age) resulted in a similar discussion, dealing with intervals represented by palaeosoils in loesses. One of these intervals was named the Lublin one (H. Maruszczak, 1986/1987).

The paper reminds or describes more important sites in which sediments with organic layers of the Lublin Interglacial (Interstadial) where examined. For these sediments pollen analyses were done, resulting in description of climatic conditions. No single and complete key section is known, that could fully indicate course of phenomena in this time. Examination of different areas and sites supply already with sufficient geomorphological, geological, palynological, pedological and chronostratigraphical data to consider the Lublin Interglacial (Lublinian) for a separate stratigraphical unit (stage).

Wyżyna Lubelska, WŚl — Wyżyna Śląska, DW — rejon Dolnej Wisły, Ni — okolice Nieszawy, Lo — Losy koło Lubawy, DN — rejon Dolnej Narwi, L-R — rejon Lubina — Rudnika (Wzgórze Dalkowskie), Trz — rejon Trzebnicy (Wzgórza Trzebnickie), Ost — Wzgórza Ostrzeszowskie, Ka — rejon Kalisza, DWi — rejon dorzecza Widawki, L-Ł — rejon Lubienia — Łęczycy, DPil — rejon Dolnej Pilicy, MP — Kotlina Małej Panwi, K-Kł — Kotlina Kłodnicy

HISTORY OF THE TERM OF THE MIDDLE POLISH GLACIATION

The Middle Polish Glaciation (Saalian) is of primary significance for studies of Quaternary geology of Poland and particularly, for Quaternary stratigraphy and geological mapping of the Polish Lowland and considerable part of the Middle Polish Uplands. Sediments of the Middle Polish Glaciation occupy a vast meridional zone between a young glacial landscape of the Last Glaciation to the north and the area with reduced Quaternary sedimends in uplands and in mountain foreland to the south.

The term "Middle Polish" was introduced by Ludomir Sawicki (1922). A subdivision of the Middle Polish Glaciation was postulated on different bases. And so, separate till beds were distinguished by J. Lewiński (1928) at Piotrków and Ludwik Sawicki (1936) near Warsaw. Detailed analysis of landforms and sediments from a morainal zone in the Warta drainage basin was presented by J. Premik (1930, 1932). Organic sediments that subdivided presumably the Middle Polish Glaciation and their palynological analysis were reported by W. Szafer (1957). Finally, extensive subdivision of the glaciation into numerous stades was presented by S. Z. Różycki (1957) at the INQUA Congress in Spain, making this idea even broader at the INQUA Congress in Poland in 1961. It should be however mentioned that there were also the authors who opposed ascribing a greater stratigraphical significance to the members distinguished within the Middle Polish Glaciation, taking e.g. the Warta Stadial for a phase that represented only temporary standstills of an ice sheet margin.

The ice sheet of the Middle Polish Glaciation advanced far to the south in Poland (Fig.1); in the west its extent was similar, locally slightly vaster than of the South Polish Glaciation. Extent of the Middle Polish Glaciation locally passes across the southern boundary of Poland, entering the Odra valley in the Moravian Gate.

At present the Saalian is considered in Poland for a complex of units defined as the Middle Polish Glaciations (in plural). From a climatostratigraphical point of view it is subdivided into two cold units: the older — Odra and the younger — Warta (among others L. Lindner, 1984, 1991; M. D. Baraniecka, 1990). The larger units are megaglacials, superstages and the smaller — stages. In this way a megaglacial comprises besides cold stages — also separating warm stages (M. D. Baraniecka, 1990).

In some subdivisions of the Middle Polish Glaciation the so-called pre-maximum, stadials were distinguished e.g. the Pre-maximum Stadial in the Warsaw Basin (J. Nowak, 1964), the Modlin and Łęczyca Stadials (M. D. Baraniecka, 1984), the Krzna Stadial (E. Rühle, 1970) and the Pre-maximum Stadial (J. Rzechowski, 1986). The pre-maximum stadials correspond to separate tills (more or less local ones). This part of glaciation comprises also the sediments of the "infilling series" (M. D. Domosławska-Baraniecka, 1959, 1965) which fill local depressions or valleys and were deposited during ice sheet advance. They are several dozen metres thick and comprise either sands with flow till layers or ice-dam silty-clayey series deposited in several cycles. Ice-dam sediments contain organic remains, some of them determined as dryas or cool flora e.g. at Tarzymiechy, Góra Kalwaria and near Koniecpol (A. Środoń, 1954, 1974; J. Niklewski, 1966). Numerous retreat units as the Warta, Wkra and Mława Stadials have been distinguished in a final part of the glaciation. Each of these units contained also the still lower-rank ones as oscillations, phases and standstills of an ice sheet.

HISTORY OF THE TERM OF THE LUBLIN INTERGLACIAL

A principle of the subdivision of the megaglacial Saalian into two cold periods (Odranian and Wartanian) is based on definition of a stratigraphical rank of separating sediments. In this position the Pilica Interstadial was determined (S. Z. Różycki, 1961, 1972), at present the Lublin Interglacial[1] i.e. Lublinian (among others H. Maruszczak, 1980, 1986/1987, 1991; L. Lindner, 1984, 1991; M. D. Baraniecka, 1984, 1990).

Doubts on the Lublinian are connected with lack of univocal and interglacial-diagnostic floristic succession, received from pollen analyses. On the other hand, separation of the Warta Glaciation from a geomorphological, geological-cartographical and lithological points of view cannot be neglected and presence of suitable sediments seems to be proved.

There are many regions in Poland (Fig. 1) where sequences of the Saalian sediments (particularly of the Lublinian) have been lately studied in detail.

An interglacial rank of the Lublinian is particularly supported in the Lublin Region in loesses (syntheses by H. Maruszczak, 1980, 1991). The main argument comes from forest soils with three genetic layers or polygenetic soil complexes (*sensu* K. Konecka-Betley, 1987*a*). In bottoms of these forest soils there are three older loesses (LS): lowest (LSn), lower (LSd) and middle (LSs). In the top these soils are mantled with the upper older loess (LSg). The Lublinian is, according to H. Maruszczak, a cool interglacial or a warm interstadial, correlated to the ^{18}O stage 7.

In the position of the Lublinian many times sites of sediments with plant remains or with organic sediments were described e.g. Brzozowica near Będzin (S. Gilewska, L. Stuchlik, 1959; W. Szafer, 1957) or Besiekierz (H. Klatkowa, 1972). Many of these proposals are already out-of-date as their palaeoflora are already ascribed to other periods (J. Lewandowski, 1988; Z. Janczyk-Kopikowa, 1991). The discussed section Losy (K. M. Krupiński, L. Marks, 1985, 1986) is connected with the Lubawa Interglacial (L. Lindner, 1991) and taken for a new key section of the Lublin Interglacial. According to Z. Janczyk-Kopikowa (1991) an incomplete although interglacial succession cannot be found a basis to distinguish a new interglacial in a floristic sense.

REVIEW OF SITES CORRELATED TO THE LUBLIN INTERGLACIAL

At present there are several sites in which more detailed examined sediments with material suitable to pollen analysis are undoubtedly included to the Lublin Interglacial (Lublinian). They comprise sediments from Łęczna (Wieprz drainage basin), Grabów-

[1] The term was used firstly by A. Środoń (1969), referring it to the flora from some site of the Mazovian Interglacial age. This approach is not applied at present. In the meantime the Lublin loess researchers accepted this term in a new sense (H. Maruszczak, 1986/1987, 1991)

ka area (Lower Vistula drainage basin), mine Bełchatów (Widawka drainage basin) and Skorupy (Świder drainage basin).

At **Łęczna** (J. Butrym et al., 1991) marshy-lake sediments of the Lublinian are underlain by till of the Odra Glaciation and overlain, outside extent of the Warta Glaciation, by equivalents of this glaciation. Sequence of sediments comprises:

4 — palaeosoil;
3 — colluvium;
2 — peats and peaty silts;
1 — lake silts.

In a pollen diagram of Z. Janczyk-Kopikowa for site Łęczna there are 7 levels with varying content of plant remains and level 5 represents climatic optimum of the section. The levels include:

7 — occasional pollen;
6 — NAP [2] to 20%, *Betula* to 30%, rare *Picea* and *Abies*, no temperate elements;
5 — coniferous trees (*Picea* 55%, *Abies* 16%), temperate elements are present, minimum of *Betula*, NAP 5%;
4 — trees of boreal climate, NAP to 30% (no *Quercus, Ulmus, Tilia*);
3 — trees of boreal climate (admixture of *Quercus, Ulmus, Tilia*), NAP 10%;
2 — occasional pollen;
1 — mixed pollen, exotic elements.

Similar pollen in the same geological location is known from adjacent sites at Podgłębokie and Łańcuchów. The actual correlation to the Lublinian results from revised stratigraphy of these two sites (previously ascribed to Brörup) after examination of site Łęczna (J. Butrym et al., 1991).

At **Grabówka** (A. Makowska, 1977) lake sediments are noted in several sections and occur between tills of the Radomka Stadial (equivalent of the Odra Glaciation) and the Warta Stadial. Under lake sediments and above the lower till there are also sands, silts and ice-dam clays. A complete sequence of intertill sediments is as the following (lake sediments are numbered from 3 to 6):

6 — clays, partly brecciated in the bottom (land emergence and drying);
5 — lake chalk;
4 — limy silts (clays) or clayey lake chalk;
3 — clays with humus (soil processes in the top);
2 — ice-dam clays;
1 — sands and silts.

Basing on studies of sediment sequence and connection of the latter with expertise pollen analyses of Z. Janczyk-Kopikowa in sections of the Grabówka area, A. Makowska (1977) distinguished four levels with individual climatic conditions in lake sediments. These levels are described by the following plant composition:

4 — pine-birch (*Pinus-Betula*) forest with alder (*Alnus*), abundant NAP;
3 — pine (*Pinus*) forest with oak (*Quercus*) to 22% (!);

[2] Non-tree pollen.

2 — pine-birch (*Pinus-Betula*) forest with admixture of oak (*Quercus*) about 3–6%;

1 — pine-birche (*Betula-Pinus*) forest, abundant NAP.

A. Makowska (*l. c.*) considers that "...reference of deposition of the Grabówka sediments to the Pilica Interstadial can act as important argument to increase a rank of this period to an interglacial". The level 3 could represent typical interglacial thermic conditions.

Particular situation is known from mine Bełchatów in the Widawka drainage basin (tributary of the Warta River) where not only sediments of the Lublin Interglacial but also of the Warta Glaciation were described. Sediments ascribed to the Lublinian were named the **Chojny Series** there (M. D Baraniecka, 1982; K. Brodzikowski, M. D. Baraniecka, 1982; A. Hałuszczak, 1982). The Chojny Series has been well examined in exploitation walls when mantling series was taken away in the mine. The Chojny Series overlies a till of the Odra Glaciation and speaking strictly — directly an erosive surface in top of this till. It is covered with complex of tills and accompanying glaciofluvial and ice-dam sediments of the Warta Glaciation. The erosive surface constitutes a bottom of the Chojny Series, separating an older, deformed structural stage from a younger — subhorizontal one.

The Chojny Series (Fig. 2A) comprises three fluvial-marshy subseries of a boreal climate (I, II, III), overlain with two cold steppe (IV) and arctic (V) series. Climatic conditions are based on pollen analyses of Z. Janczyk-Kopikowa (1982, 1983, 1985) and faunistic determinations (T. Czyżewska, T. Wiszniowska, 1982):

V — arctic conditions: NAP 70%, *Pinus, Betula*;

IV — cool conditions, steppe: *Mammuthus trogontherii* (Pohlig);

III — boreal (cool) conditions: *Pinus, Picea, Betula*, NAP 30–50% (mid-forest meadows);

II — boreal conditions: *Pinus, Betula, Picea, Alnus* (insignificant admixture of *Quercus, Ulmus, Tilia*), NAP 15–20%;

I — boreal conditions with temperate elements: *Pinus* (admixture of *Quercus, Ulmus, Tilia), Picea, Alnus, Betula, Salix*, varying content of NAP.

The subseries I is represented by extensive sequence of sediments in the site **Buczyna Północna 4** (M. D. Baraniecka, A. Hałuszczak, 1983) and by abundant tree macrofossils (larch cones and pine branches) in bottom of the Chojny Series. A pollen diagram for the subseries I in the site Buczyna Północna can be subdivided into 5 levels:

5 — NAP, *Pinus* (presence of *Sphagnum*);

4 — AP 95%, *Pinus* 60%, *Picea* 10%, *Alnus* 20%, (admixture of *Quercus, Tilia, Corylus, Ulmus* to 10%);

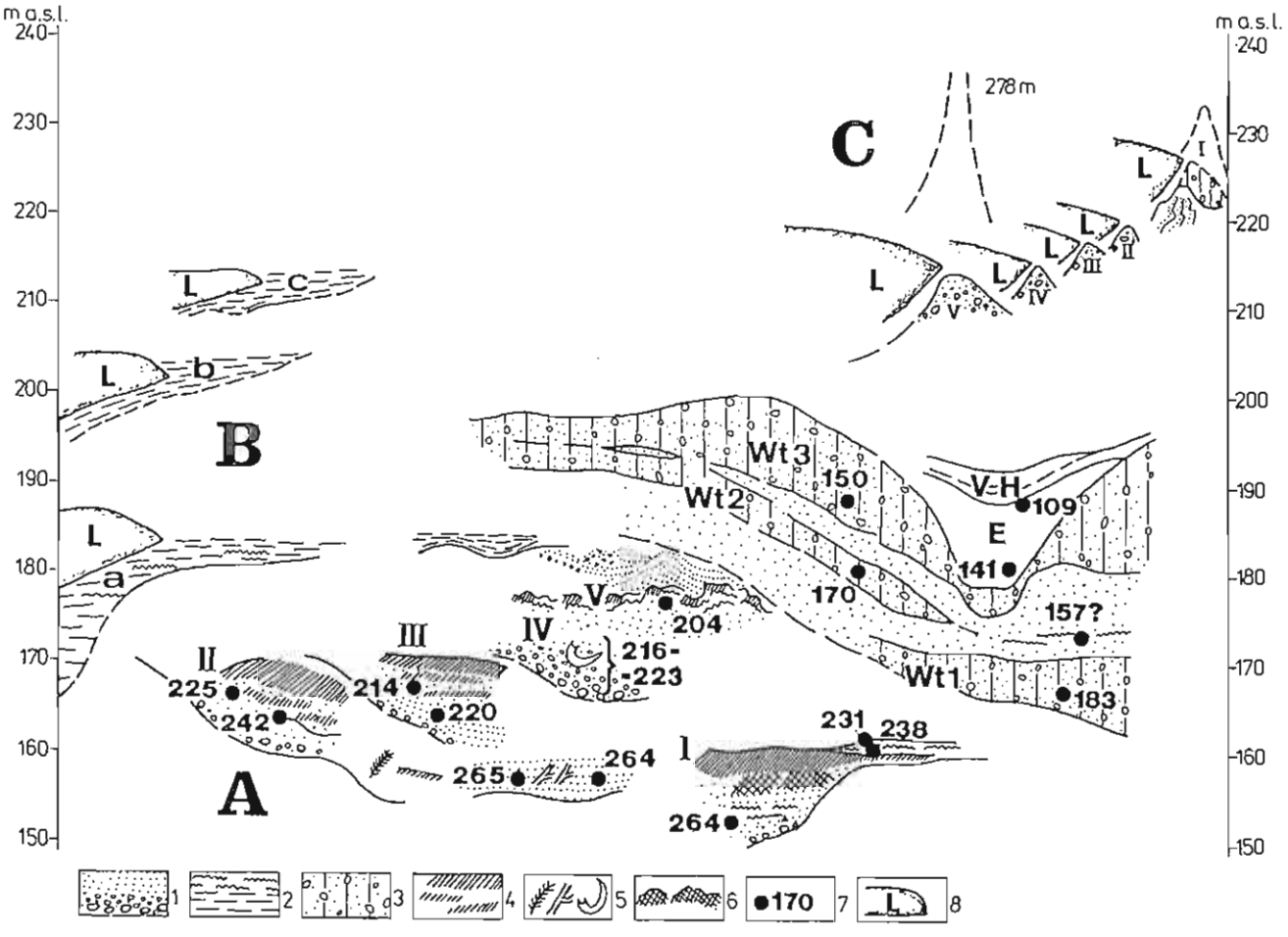
3 — NAP, *Pinus, Betula, Salix* (presence of *Selaginella selaginoides*);

2 — *Pinus*, NAP;

1 — *Pinus*, exotic elements.

In the level 4 a climatic optimum of subseries I is expressed and forms the warmest part of the Chojny Series.

Soil studies (K. Konecka-Betley, 1987*b*) proved quite a high stratigraphical rank of the subseries I, higher than indicated by pollen analyses. The sections Buczyna 4 and Buczyna Północna record presence of two soils of varying origin, thus indicating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interglacial rank and their possible separation as a separate unit (Dąbrowa Series — M. D. Baraniecka, 1987). There are two possibilities: either the Dąbrowa series could be correlated to the Mazovian Interglacial or it could be a warmer — interglacial (basing on soil sequence) fragment of the Chojny Series.

Even if the subseries I is excluded then the subseries II, III, IV and V represent a well-developed sequence of deposition and varying climatic conditions. They can be described together as a cool interglacial or a warm interstadial, similarly as done by H. Maruszczak (1986/1987, 1991) in loessy sections. The Chojny Series is therefore a good example for the Lublin Interglacial.

The Bełchatów area presents a rich inventory of sediments from advance, stay and retreat of ice sheet of the Warta Glaciation (M. D. Baraniecka, 1971). Therefore this example suggests further sequence of successive members of the Middle Polish Glaciation (Saalian). The Chojny Series passes upwards through the fluvial-marshy subseries V into glaciofluvial and ice-dam sediments of the Warta Glaciation. Glaciofluvial sediments — sands and sands with admixture of gravel overlie directly the Chojny Series, occurring above marshy organic sediments of the subseries V with arctic flora. Glaciofluvial sediments pass upwards into ice-dam sediments — varved silts and clays. In a wider area of the Widawka drainage basin (Fig. 2B) two other ice-dam series (b, c) but this main ice-dam horizon (a) were also distinguished (M. D. Baraniecka, Z. Sarnacka, 1971). They were more local and located gradually higher and higher as ice sheet advanced onto the area inclined against its movement.

Direct presence of the Warta Glaciation near Bełchatów is represented by tills. In mine exposures at first two (K. Brodzikowski et al., 1980) but then three tills (J. Goździk, 1986; D. Krzyszkowski, 1990, 1991) were noted as (Fig. 2A): the local lower till (Wt1), the middle till (Wt2) and the upper till (Wt3). The middle and upper tills are strictly connected and partly cannot be separated from each other. Tills of the Warta Glaciation form vast plains on land surface, located in inner part of the Widawka glacial lobe.

In a marginal zone of the Widawka glacial lobe a further sequence of sediments of the Warta Glaciation is formed of end moraines of the maximum extent and of retreat

Fig. 2. Stratigraphical scheme of sediments of the Lublin Interglacial and the Warta Glaciation in the mine Bełchatów and the Widawka drainage basin

A — sequence of sediments of the Chojny Series and of tills of the Warta Glaciation in the mine Bełchatów; B — transgressive ice-dam lakes of the Warta Glaciation (a–c) in the Widawka drainage basin; C — rows of end moraines (I–V) in the Widawka drainage basin; dashed line marks highest hills in rows I and V; 1 — sands, sands with gravel, boulders and rubble; 2 — silts and clays; 3 — tills; 4 — humus sediments and humus accumulations; 5 — organic remains, cones, branches, bones; 6 — remains of soil processes (but humus horizons); 7 — datings of sediments in ka BP; 8 — ice sheet

Schemat stratygrafii osadów interglacjału lubelskiego i zlodowacenia warty w kopalni Bełchatów i dorzeczu Widawki

A — sekwencja osadów serii Chojn i glin zwałowych warciańskich w kopalni Bełchatów; B — transgresywne zastoiska warciańskie (a–c) w dorzeczu Widawki; C — ciągi wzgórz moren czołowych (I–V) w dorzeczu Widawki; linią przerywaną oznaczono najwyższe wzniesienia w ciągach I i V; 1 — piaski, piaski ze żwirem, głazy i rumosze; 2 — mułki i iły; 3 — gliny zwałowe; 4 — osady humusowe i poziomy akumulacji humusu; 5 — szczątki organiczne, szyszki, gałęzie, kości; 6 — pozostałości procesów glebowych (oprócz poziomów humusu); 7 — oznaczenia wieku osadów w tysiącach lat BP; 8 — lądolód

phases (Fig. 2C). Maximum extent is represented (I) by depositional end moraines (being composed of sands with gravels and of tills) and by glacidynamic deformations of sediments. Successive retreat phases (however with advance symptoms) were marked with presence of end moraine rows (II–V). On land surface the most outstanding are end moraines I, located furthest to the south, and particularly their innermost row. Hills of the row V are the highest in the area, e.g. 278 m a.s.l. at Borowskie Góry.

Sediments of the Warta Glaciation in a marginal zone are also supplemented with sediments of eskers, kames, dead-ice depressions and moraines as well as sandrs. Detailed considerations of their mutual location play secondary role for general stratigraphy of the Warta Glaciation.

When presenting stratigraphical units of the Lublin Interglacial and the Warta Glaciation near Bełchatów and in the Widawka drainage basin, their age determinations cannot be neglected.

Samples from all subseries distinguished in sediments of the Lublin Interglacial (Chojny Series) were collected and then thermoluminescence dated by J. Butrym in the Lublin laboratory. These determinations (Fig. 2A) throw light on lasting and therefore, stratigraphical rank of the Chojny Series, constructing additional important argument to ascribe the series to the interglacial. In any case sequence of changing fluvial deposition with fluvial-lake or fluvial-marshy phases, lasting presumably 60 thousand years, cannot be connected with ephemeral phenomena or insignificant and secondary stratigraphical unit. Results of these datings were also supplemented with age determination of bones by fluoro-chloro-apatite and collagen method (T. Wysoczański-Minkowicz, 1985). Age of the Lublin Interglacial on this base is comprised from 265 to 204 ka BP. Selected age determinations are presented in schematic section (Fig. 2A) and full list of data is in preparation.

I do expect that considerable number of 200 samples which have been TL dated for Central Poland comes from sediments of the stratigraphical unit of the Warta Glaciation. About twenty samples collected by me in the mine Bełchatów form a set that is not any smaller than for the Chojny Series. Determinations were done in the Lublin laboratory by J. Butrym and partly in the Warsaw laboratory by M. and W. Prószyński and H. Prószyńska-Bordas. All age determinations against geological location have been prepared on another occasion but unfortunately have not been published. A schematic section (Fig. 2A) presents a representative set of age determinations of the three tills with reference to sediments of the Eemian Interglacial in the site Rogowiec (M. D. Baraniecka, J. S. Goździk, 1992; J. Butrym, 1992; Z. Baiwierz, 1992).

Age determinations of the Warta Glaciation are comprised between 183 and 150 ka BP and correspond to other datings of this stratigraphical unit, also among others from the mine Bełchatów in other sections. The Eemian Interglacial sediments in top of tills of the Warta Glaciation are enclosed in the site Rogowiec between 141 and 109 ka BP.

Organic sediments from the site **Skorupy near Celestynów** in the Świder drainage basin have been indirectly ascribed lately to the Lublin Interglacial. Geological setting of this site has been connected since the very beginning to the Eemian Interglacial or the Bug-Narew Interstadial (M. D. Baraniecka, 1976). Materials to pollen analysis

have been received there from a borehole, done for needs of mapping of the sheet Otwock, *Szczegółowa mapa geologiczna Polski* in scale of 1:50 000 (M. D. Baraniecka, 1975, 1976). Z. Janczyk-Kopikowa (1977/1978) compared the pollen diagram with the more broadly examined section Podgłębokie, considered previously for an equivalent of the Brörup (J. E. Mojski, J. Rzechowski, 1969; Z. Janczyk-Kopikowa, 1969). On this basis she ascribed organic sediments from Skorupy to the Brörup. In this sense the site was included in a synthetical study of fluvial sediments of the Warsaw area (M. D. Baraniecka, K. Konecka-Betley, 1987). At present the authors of the section Łęczna (J. Butrym et al., 1991) revised the section Podgłębokie and correlated it to the interval within the Middle Polish Glaciation i.e. to the Lublinian. Therefore the organic sediments from Skorupy can be indirectly connected with the Lublin Interglacial. Geological setting in the section (M. D. Baraniecka, 1975, 1976) does not support but also does not contradict such a possibility. Sandy sediments with palynologically-analyzed organic inserts overlie a till of the maximum extent of the Middle Polish (Odra) Glaciation. In place with organic sediments there is no till of the Warta Glaciation age. This till forms a thin layer aside to sands with organic layers.

In other regions of Poland more recent examinations indicate also the sediments that separate the Odranian and the Wartanian, and which could be ascribed to a relatively warm interval — presumably the Lublin Interglacial/Interstadial. Organic remains in such a stratigraphical setting are noted in the Silesian Upland (Malice, Wielki Bór and Herby — J. Lewandowski, 1982, 1988). In the Narew drainage basin sediments of this stratigraphical horizon are defined as the ones of the Pilica Interstadial, being represented by residual sediments that indicate a degradation period (A. Bałuk, 1988, 1991). In this area subdivision of this glaciation into three stadials i.e. maximum or Odra, Warta and Mława is still supported. From a stratigraphical point of view the latter stadial is treated similarly as in previous studies for this region (among others Z. Michalska, 1967; K. Straszewska, 1968). An extended fluvial series of the Lublin Interglacial was described widely from the Nieszawa area on the Vistula (J. Jeziorski, 1991).

GENERAL REMARKS ON THE MIDDLE POLISH GLACIATION IN WESTERN POLAND

In western part of the Polish Lowland a sequence of the Quaternary and particularly of the Saalian is vertically reduced. A zone where sediments of the Middle Polish Glaciation occur on land surface is also reduced. This fact remains in connection with delimiting of this zone to the south by more northward location of the mountains (Sudetes) if compared to the Carpathians, and with delimiting to the north by a far extent of the Last Glaciation. It is more extended to the south there than in central and eastern Poland. Therefore there is no place where considerable areas could be covered on the surface with sediments of the Middle Polish Glaciation. In western Poland there are also more numerous (than in remaining part of Poland) deformations of sediments and they are larger. Discussed is also (and discussive) extent of the Warta Glaciation and age of deformations. Some authors admit an outstanding role of the

Warta Glaciation in glaciotectonic deformations of the hill zones Ostrzeszów, Trzebnica, Dalków and near Mużaków. The others find the Warta Glaciation to reach the older hills of presumably varying origin. In any case, individuality of the Warta stratigraphical unit in this part of the country is quite commonly recognized.

CONCLUSIONS

Presented studies on subdivision of the Middle Polish Glaciation indicate a considerable amount of materials that define separate stratigraphical rank of the Lublin Interglacial. These materials support therefore the already published, e.g. by S. Z. Różycki (1978), L. Lindner (1984) and others, idea of the "Middle Polish Glaciations" (in plural) as a superior unit if referred to separate glaciations. Units of this higher order in the *Instrukcja w sprawie opracowania* ... (1977) have been moved to a superstage-rank (M. D. Baraniecka, 1990; *Nowelizacja instrukcji...*, 1991). The rank of stage was gained by the Odra and Warta Glaciations.

The Lublin Interglacial gained also a stage-rank. The most serious in this case are geological arguments — presence of sediments (of extensive and variable series) and of processes of this interval in many areas of the Polish Lowland. There are also palaeopedological arguments — presence of horizons diagnostic for interglacial episodes. Faunistic remains of *Mammuthus trogontherii* (Pohlig) and bone dating are the next indices. Palynological sections indicate at least interstadial and in some sites — interglacial thermic conditions. Thermoluminescence datings determined the age of this interglacial at 164–204 ka BP.

Together, the main stratigraphical units within the superstage (megaglacial) of the Middle Polish Glaciations comprise the stages: the Odra Glaciation, the Lublin Interglacial and the Warta Glaciation. If applying the names of international meaning for the Saalian superstage, there are in Poland the stages: Odranian, Lublinian and Wartanian. The Lublinian has been better and better recognized in various parts of Poland.

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PROBLEM INTERGLACJAŁU LUBELSKIEGO I PODZIAŁ STRATYGRAFICZNY ZLODOWACEŃ ŚRODKOWOPOLSKICH

Streszczenie

Zlodowacenie środkowopolskie (Saalian) ma pierwszorzędne znaczenie dla badań stratygrafii czwartorzędu oraz dla kartografii geologicznej Niżu Polskiego. Występowanie osadów tego zlodowacenia jest powszechne na powierzchni w środkowej, równoleżnikowej strefie Polski, jak też w przekroju osadów czwartorzędowych na przeważającym obszarze Polski. Zlodowacenie środkowopolskie dotychczas uznawane w stratygrafii za piętro (*stage*), obecnie podniesione jest do rangi nadpiętra (*superstage*) jako zlodowacenia środkowopolskie (w liczbie mnogiej). Równocześnie wyodrębnia się jako piętra trzy jednostki: dwie — odry i warty — oraz między nimi interglacjał lubelski (lublinian). Ranga lublinianu jest kluczowym i dyskusyjnym problemem dla podziału saalianu. Obszerne materiały dotyczące interglacjału lubelskiego pochodzą z lessów i dzielących je gleb kopalnych na Wyżynie Lubelskiej.

W niniejszym opracowaniu (fig. 1) na podstawie literatury i własnych prac omówiono nowsze stanowiska badawcze z osadami organicznymi. Wymieniono też obszary, dla których przyjmuje się inne kryteria podziału zlodowaceń środkowopolskich na mniejsze jednostki stratygraficzne. Analizy pyłkowe przeprowadzono dotychczas dla osadów z Łęcznej, Grabówki, kopalni Bełchatów i Skorup. Większość wykazała ciepłotę interstadiału, a niektóre mają większą rangę. W kopalni Bełchatów (fig. 2) występują diagnostyczne dla interglacjałów poziomy gleb kopalnych. Z odkrywek tej kopalni uzyskano też reprezentatywny zespół próbek, które poddano oznaczeniom wieku. Na fig. 2 przedstawiono 8 oznaczeń wieku dla serii Chojn (interglacjał lubelski) oraz 6 oznaczeń dla osadów zlodowacenia warty i przykrywających je utworów eemskich. Oznaczenia wieku interglacjału lubelskiego zawierają się w przedziale 265–204 tys. lat BP. Jednostka ta paralelizowana jest z 7 stadium izotopowo-tlenowym ^{18}O z profili oceanicznych. Wiek zlodowacenia warty zawiera się między 183 a 150 tys. lat BP. Osady warciańskie ogranicza od góry data 141 tys. lat (w spągu utworów eemskich).

Na podstawie przeglądu osadów, obecności osadów organicznych, znalezisk makroskopowych szczątków flory i fauny, analiz palinologicznych, opracowań gleb kopalnych i oznaczeń wieku lublinian można uważać w Polsce za samodzielną jednostkę rzędu piętra.