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The geological, paleobotanical and radiometric dating of Quaternary sediments in the region of Konin (eastern Great Poland Lowland)

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Abstract: A theoretical discussion of the availability of material, the emergence of the Pleistocene glacial series and the denudation occurring in the interglacial periods. The synthetic profile of the quaternary series in the region of Konin (eastern Great Poland) described in the light of geological, paleobotanical and luminescence studies.

Key words: Wielkopolska, lithostratigraphy/its theoretical bedground, chronostratigraphy.

Introduction and theoretical background

The thickness of the Quaternary series in the Polish Lowlands varies enormously from metres to hundreds metres. There are areas where the Mesozoic or Tertiary stratum is covered by a thin layer of Quaternary sediments of the depth of several dozen centimeters only, the latter usually being the sediments of the last glaciation that occurred in the area. The thinness of the Quaternary layer is caused by the tectonic activity of the previous stratum in the Quaternary, the processes of denudation and the exaration produced by the continental ice sheets. However, the thickness of the Quaternary layer is usually much larger, and the layer comprises series originating from various periods and of varying stratigraphic completeness.

In the present paper, the stratigraphy of the Quaternary is understood as described in Stankowski 1996a & 1996b; Stankowski *et al.* 1995a & 1995b, and Stankowski's other paper in this volume.

Most authors dealing with the Quaternary series of eastern Great Poland focus on the sediments from the final and the penultimate cold Pleistocene period (the North Polish and Middle Polish glacials) and virtually disregard the sediments from the previous glacials. Although the sedimental series representing earlier cold stages (glacials) of the Pleistocene are significant, they are ignored because of the widespread belief in the extensive denudation produced by the *sensu lato* “great interglacial period”. When arguing that the Quaternary series of eastern Great Poland is more complex from the stratigraphic point of view than it was previously assumed, it can be quote the geological profiles from the region delimited by the cities of Konin, Kleczew and Ślesin. In fact, the information contained in these profiles proves that the sediments coming from before the “great interglacial” are thicker than those from after that period.

The following theoretical arguments (discussed in more detail in Stankowski *et al.* 1999) support this postulate:

(1) The available amount of glacial ice debris varied considerably throughout the Quaternary. The largest quantities of ice debris appeared at the beginning of the Pleistocene. It was at that time that extensive denudational surfaces developed on both solid substrata and thick eluvial covers in Scandinavia and its immediate southern neighbourhood. At the same time, numerous series of loose rock appeared in the Polish Lowlands, mainly in the form of late-Tertiary alluvial sediments, and mid- and early-Tertiary limnic, alluvial and marine sediments. During the pre-Pleistocene, the principal activity both in Scandinavia and in the Polish Lowlands was the redeposition and alteration of the previously developed sediments.

During the Pleistocene, the loose and slickly resistant rocks were likely to move, easily became incorporated into the ice covers, and were transported as the ice sheets migrated. The abundance of the material and the ability of the glacial ice to transport it are evidenced by the removal of the material from the centers of glaciation and their immediate neighbourhood (i.e. the Scandinavian area of glacial erosion) during the development of the oldest ice sheets. It was during that earliest = South Polish cold Pleistocene period, that the thickest layers of glacial sediments might have appeared in the European Lowlands, i.e. in the area where the Pleistocene accumulation prevailed. The inevitable aftermath of this phenomenon were intensive glaciotectonic deformations, within both the developing sedimental layers and the Tertiary substrata. The early-Pleistocene glaciotectonic forces must be considered the primary cause of the deformations of the Paleogene and Neogene, and occasionally also the Mesozoic, sediments. The numerous glaciotectonic structures should be associated principally with the vastest ice sheets from before the “great interglacial” (Holstein interglacial).

During the glacials which followed the “great interglacial”, in the course of each ice sheets appearence a new sedimental series developed, and new glaciotectonic structures, exaration levels, as well as evorsive and erosional lineal scours were produced. Although the geological and morphological characteristics of the surface were being modified, this was not tantamount to a widespread and total rebuilding of the Quaternary series and of the earlier strata; as the modifications usually ceased at a certain depth.

Thus, the present geological characteristics of the Quaternary layers and their substrata in Great Poland are the product of the glaciotectonic structures of various periods situated on different levels, rather than exclusively of the last glaciation which occurred in an area.

(2) The duration of the consecutive warm stages of the Pleistocene and their effects of denudation and erosion are incommensurable with those of the corresponding processes occurring in the Tertiary. The warm spells lasting several dozen thousand years could not have visibly affected the relief of Scandinavia and produced eluvial covers comparable with those of the Tertiary. During the glacials following the "great interglacial", the amount of the detritus transported from the distant areas of Scandinavia and the trough of the Baltic must have been significantly smaller. In the new sedimental series, most material was brought from nearby areas, and included the local substrata built of the previous Quaternary sediments or locally exposed pre-Quaternary sediments. As the amount of the available detritus decreased, the depths of the covers of glacial sediments were becoming thiner.

In view of the documented denudation effects of the present interglacial (holocene), it is quite inconceivable that earlier Pleistocene sediments should have been entirely removed during the "great interglacial". In fact, it is unthinkable that the vast morainal plateaus should have been completely denuded (other than in narrow valleys neighbourhood and through modifications in the outlines of hils). The only developments which the vast morainic plateaus underwent, were moderate denudation processes and the strong impact of pedogenesis and biogenesis.

An illustrative example of the extant covers of glacial sediments from before the "great interglacial" (Holstein) in the broad territory of the Lowlands are the plateaus in the southern part of the Sandomierz Basin. In spite of the vigorous denudation processes of the "great interglacial" as well as the following two interglacials (Eemian and comtemporary one = Holocene), and two marked periglacial activity periods during the Middle Polish and North Polish glacials, the early-Pleistocene glacial sediments of the outermost zone of the single ice sheet accumulation (South Polish glacial) have been preserved in that area. The glacial sediments from before the "great interglacial" are also extant in the Lublin Upland as well as in the Kielce and Sandomierz Upland. Buried sedimental series from the South Polish glacial, of a thickness up to 100 m, have been discovered at the foreland of the Sudetes Mountains as well as in the North-East Poland. Accordingly, it is evident that significant glacial series of the early Pleistocene occur in the North-European Lowlands, i.e. in the primary area of the Pleistocene accumulation. The fact that in North-West Poland so far no evidence has been provided of adequate volumes of sediments correlated with the glacial covers from before the "great interglacial", which sediments theoretically should appear in the region of the Baltic and the North Sea, further supports this postulate. Neither do residual pavements of stones, pebbles and gravel appear commonly in Poland at the stratigraphic positions where they should be expected.

The following conclusions may be drawn from the above theoretical considerations:

– In the Polish Lowlands, including the region of Konin, one should find well-developed early Pleistocene sediments, beeing the efect of ice sheet redeposition of late Tertiary sediments and of the preglacial once.

– The very thick glacial sediments from the early Pleistocene could not possible have been completely denuded during the "great interglacial". One may even propose the null hypothesis that these layers are thicker than those deriving from the last two glacials.

– If the view that eastern Great Poland lacks significant early-Pleistocene series is still accepted, this is only because there are no effective lithostratigraphic methods of the study of mineral sediments, and because up till now there have been no discoveries and exhaustive descriptions of a representative number of sites where phytogenic sediments from before the Eemian interglacial would appear.

The synthetic profile of the Quaternary series in the region of Konin

The thicknes of the Quaternary covers in Eastern Great Poland varies enormously. Thus, e.g., at the mouth of the river Powa (site Konin–Przydziałki; Stankowski *et al.* 1992), the surface of the land is composed of Paleogene sand, and the latest Pleistocene covers are in many locations discontinuous, their thicknes amounting to several dozen centimeters only, while in the areas of Mikorzyn or Kleczew and Orchowo, the Quaternary sediments are more than 100 m thick. Unfortunately the Quaternary stratigraphy of this particular area is not so complete as it was described by Lindner *et al.* (1995) and Lindner & Marks (1995).

Fig. 1 is a synthetic profile of the Quaternary series in the Konin region, compiled based on hundreds of drillings and the investigated sections in the tertiary coal mines at Konin and Turek. The account of the stratigraphy of the Quaternary sediments in the present paper is the result of many years of studies, which were periodically reported (Stankowska & Stankowski 1991; Stankowski & Krzyszkowski 1991; Stankowski *et al.* 1992, 1995a, b).

The pre-Quaternary paleosurface, produced by the most recent tectonic activity, the glacial exaration, and the glaciotectonic and evorsive impact of subglacial water, is very uneven, its elevation varying from 0 to 100 m a.s.l. Its lithological components are: Neogene sand, silts and clays or gravel, also brown coal, Paleogene glaukonite sands with fauna of mollusks, and occasional Cretaceous sediments which often are substantially weathered at the surface.

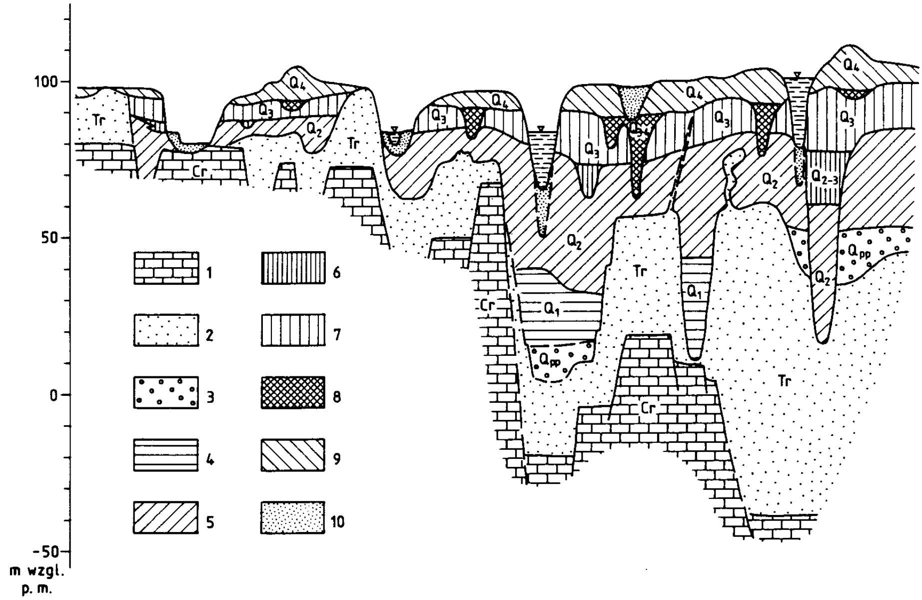

Fig. 1. Synthetic presentation of the Quaternary series stratigraphy of the Konin area.

1 – Cretaceous rocks, **2** – Tertiary rocks (Tr), **3** – pre-glacial deposits (Q_{pp}), **4** – deposits of oldest glacial (Q_1), **5** – deposits of South Polish glacial (Q_2), **6** – deposits of great interglacial ($Q_{2\text{-}3}$), **7** – deposits of Middle Polisc glacial (Q_3), **8** – deposits of Eemian interglacial ($Q_{3\text{-}4}$), **9** – deposits of North Polish (Vistuliean) glacial (Q_4), post-Vistulian deposits.

The known preglacial sediments appeared in the tectonic and erosional depressions of the pre-Quaternary horizon. They are discontinuous, and their distribution is irregular. The preglacial series consist principally of fine- and medium-grained fluvial deposits, white, cream-colored, yellowish, yellowish-greenish and light-brown. Their stratification is typically diagonal at a sharp angle or horizontal.

Four basic stratigraphic units may be distinguished within the complex of the Pleistocene sediments. These comprise sequences of one or several layers of glacial tills and/or stone residues, separated by fluvioglacial, fluvial, lacustrine and marsh-cum-peat sediments, and surfaces of unconformity.

The earliest glacial sediments of the Pleistocene include the filling of the deep depressions in the pre-Quaternary paleosurface. These deposits, known only from drillings, consist of two layers of tills separated by a thin interbedding of sand and gravel. Another vestige of the earliest glacial series are the sporadic residues of stone and gravel of Scandinavian origin. Covers of sand and gravel produced by glacier water, of a thickness of up to app. 10 m, top glacial tills and the residues of stone and gravel.

So far no evidence of sediments from the Podlasian interglacial or of buried relief shapes from that period has been identified in the discussed region.

A series of sediments from the Southern Polish glacial, of a thickness up to several dozen meters, appears above the sporadic earliest glacial deposits and first of all above Tertiary formations whose surface was exposed by exaration and under which glaciotectonic deformations of a depth of up to a dozen meters may be encountered. These sediments are composed of double layers of till separated and covered by fluvioglacial deposits.

A characteristic of the lower till layer of the Southern Polish glacial are the substantial variations in its thickness, from several up to as many as forty meters, the average value being a dozen meters. Its floor may either be level, with a clearly defined boundary (usually above a substratum of sand and gravel), or abound in incorporative and glaciotectonic structures (usually above a substratum of mixed lithological properties, especially if built of fine-grained upper Miocene sediments of the Poznań series).

At the top of the lower horizon od South Polish till we find discontinuous thin sediments of sand and gravel, sand as well as silty-sandy, or even clayly-silty deposits. These form either clearly defined layers or the filling of valleys and basins. Among such isolated pockets of water sedimentation there are visible surfaces of unconformity and structures of glaciotectonic deformations of several meters in tkickness.

The Southern Polish glacial upper till is usually app. 10 m, and never more than 20 m. This layer of till is commonly covered by layers of sand and gravel. Residual pavement occasionally appears in the erosional depressions in the paleosurface of the Southern Polish series.

The average thickness of the whole complex of glacial sediments of the Southern Polish cold Pleistocene phase is app. 25 m, exceeding 60 m in certain locations. This is the thickest widespread glacial series in the Quaternary structure of the region of Konin. This conclusion is compatible with previous theoretical considerations.

The paleosurface of the South Polish glacial series displays many characteristics of post-glacial sediments: the lithologically varying tills, the fluvioglacial sediments and the stagnant-water sediments, as well as the different relief features: tunnel valleys scours of a depths of up to 60 m, which not only cut through the glacial series in question, but also penetrate the Tertiary substratum, extensive depressions of different origin, and river valleys. The scours are comonly filled with sand and silty-clayly sediments, most probably originating also from the interglacial period (cf. Fig. 1 – mark Q 2-3).

Organic interglacial sediments have been recorded in several locations. These have survived only in the places of abundant phytogenic accumulation, i.e., principally in the former tunnel valleys and partly also in large river valleys. The soil profiles of those times are unfortunately extent.

The organic sediments at the known site at Marantów represent the *sensu lato* Great Interglacial (Holstein). This profile, paleobotanicaly documented by Borówko-Dłużakowa (Borówko-Dłużakowa 1967), has been fueling stratigraphic controversies for some time now. The latest approach to its age (Tobolski 1991) is to date it to the time of the "Zbójno interglacial" (Lindner & Brykczyńska 1980). A study of the geological location and the phytostratigraphic context of this profile made it possible to identify more sites with fossil organic sediments coming from the same period. These are the above-mentioned clayly-silty sediments from a deep scour of Southern Polish till (cf. Fig. 1 – mark as Q 2-3), as well as the profiles Konin S, Ruszkowo, Zagaj, Budki Stare and Koło (Stankowski *et al.* 1995a, b), and the profile from Mikorzyn which is currently being studied (an organic series located at a larger depth, situated below of Eemian organic sediments in the same site – Stankowski *et al.* 1999).

The Middle Polish cold stage of the Pleistocene is represented in the discussed region by a series of sediments of varying thickness, amounting on the average to a dozen meters and never exceeding 20 m. These are built mainly of tills. No significant glaciotectonic deformations, or even well-developed incorporative structures, have been observed in their bottom. Till is usually arranged as a single bed, although occasionally two indistinctly separated layers are observed. It has not been possible to find evidence proving that this region underwent two glaciations with a significantly warmer period between them. Organic sediments have not been identified, and the fluvioglacial sediments appearing within the till are not well developed. The collected data seem indicative of a single glacial cover (glaciation), during which there occurred a very limited recession of the ice sheet front followed by its renewed advance. This statement is contradictory to the stratigraphic data collected in the Central and Southern Poland, where evidence of two separate glaciations is available. However, the contradiction may be only apparent, since it is conceivable that the ice sheet covered Northern Poland and parts of Central Poland continuously, while the position its front varied considerably in the south of the country.

The Middle Polish till in the Konin region is topped by a layer of fluvioglacial sediments of a thickness up to as much as 10 m.

The relief of Middle Polish cold periode paleosurface is clearly outlined, its being distinctively glacial. In fact, its appearance suggests that a lakeland existed in this region, with numerous lakes and small river valleys. For many years, the exploration of new sites has been bringing discoveries of not only interglacial mineral sediments, but also interglacial organic sediments. Eemian gyttja and peat have been found and described at the following sites: Jóźwin 76 (Stankowska & Stankowski 1976), Kazimierz (Stankowski & Tobolski 1981), Jóźwin 84 (Stankowski 1988), Władysławów (Kłysz & Stankowski 1986) and Mikorzyn (Kozydra & Skompski 1995, 1996; Stankowski, Bluszcz & Nita 1999). Upon a scrutiny of the records of previous drilling, organic sediments were identified in four holes. Two of these were drilled anew, and palynological tests were carried out at one, confirming that the organic series comes from the Eemian period. The newest site with three profiles, so call Kleczew N, is under investigations.

The glacial sediments of the last cold Pleistocene period constitute a continuous cover in the discussed area, whose thickness however varies considerably, from as little as several dozen centimeters to more than 10 m. The sediments originating from that time occasionally cover a Tertiary stratum (as mentioned above), yet typically they are superposed on the series of the Middle Polish glacial.

The sediments of the early North Polish glacial period lack traces of direct accumulation of glacier ice. Neither is there proof of a close neighbour of the ice sheet. On the other hand, the existence of numerous sedimentological hiatuses has been established. The gathered data are indicative of substantial climatic variations, characteristic of areas fairly distant from the ice sheet front. This applies to the sites: Maliniec (Stankowska & Stankowski 1979; Pazdur, Stankowski & Tobolski 1981), Jóźwin 84 (Stankowski 1988), Władysławów (Kłysz & Stankowski 1986) and Mikorzyn (Stankowski, Bluszcz & Nita 1999). Tobolski (1991) compiles the paleobotanical evidence of the fact that in eastern Great Poland the ice sheet did not appear before the time of the maximum extend of the Baltic glaciation. The changes in the climate of the early and middle part of the last cold Pleistocene stage are illustrated by the horizons of the periglacial structures and the layers of organic sediments, whose pockets are also encountered in the filling of frost wedges. The periglacial structures and organic interbeddings appear within the fluviolacustrine series, which is 8–10 m thick.

The sediments of Baltic ("Plenivistulian"), last ice cover are relatively thin. There are anaglacial sand with an admixture of gravel of fluvioglacial origin (of a thickness of no more than 1.5 m) and situated above usually in an unconformable manner, sandy tills of a thickness of several meters, never more than 7–8 m. The age of the till is at most 21,000 years BP. Bipartition is noticeable there. The interbeddings in this case consist of layers of fluvioglacial sand of varying grain size with an admixture of gravel, of a thickness of several dozen centimeters. These may have been left by fluctuations of the ice sheet margin which took place between the so called Leszno and Poznań phases. In large areas, this tills constitutes the surface of the land and provides its morphology. A part of the surface is built of thin fluvioglacial sediments developed during the deglaciation of the ice sheet in time of Poznań phase.

A distinctive characteristic of the present-day morphology of the land in the neighborhood of Konin is a spacious and well-developed path of the ice marginal valley (pradolina) and series tunnel waleys. At their deepest, the tunnel valeys penetrate into the sediments of the South Polish glacial. In the late glacial and the Holocene, these subglacial cuts were almost completely filled with thick layers of mineral and organic sediments. The earliest sediments consist of fine-grained and silty sand, their thickness amounting to 5–6 m. The subsequent layer is gyttja, up to 4 m thick, deposited between 17,700 ±800 and 7000 ±70 BP. The presence of these sediments proves that lakes were at that time more numerous and much larger than now. The final phase of the filling of the troughs left fairly thin (up to 2 m) layers of peat, which at various locations began to be deposited at various moments. The earliest layers of peat started to emerge in 11,080 ±50 BP, and this process became widespread around the year 7000 BP.

An incidental result of the geological study was the discovery (at the sites Mikorzyn and Sławoszewek) of the direct contact of organic post-Vistulian sediments and sediments from before the spreading of the ice sheet. This fact shows how thoroughly the profiles must be perused. We cannot exclude the possibility of encountering in the drill-holes even two separate interglacial series in direct contact, which find would warrant the hypothesis of the occurrence of two climatic optimums within a single interglacial.

The results of the latest palynological studies and luminescence dating

Palynological studies and luminescence dating have recently been undertaken at two sites, Mikorzyn and Sławoszewek. This activity is discussed in more detail in Stankowski, Bluszcz & Nita 1999.

At the site Mikorzyn, two organic series appear: (a) a shallower one, found at a depth of between 4–5 and app. 25 m beneath the surface, and (b) a deeper one, at between app. 28 and app. 41 m under the ground. The geological interpretation shows that the upper series represents the Eemian interglacial and a considerable portion of the last Pleistocene cold stage, while the lower one may be ascribed to the *sensu lato* "great interglacial" (Holsteinian).

A palynological study of the upper sequence of organic sediments has been conducted by M. Nita. The results show that the interglacial sediments are thiner than those from the last stage of the cold Pleistocene. Accordingly, it was possible to trace within the profile the boundary between the Eemian interglacial and the Vistulian ones. This, in turn, updated our previous knowledge which was based on the geological maping of the walls of brown coal mines and on the results of malacological studies presented in earlier literature. Table 1 is a summary of pollen chronostratigraphic order in the Mikorzyn upper organic sequences. It illustrate succession of the vegetation during a long period between the Eemian and the Vistulian glaciation, with several warmer (Brörup and Odderade) and markedly colder phases visible.

The results of the studies of the Mikorzyn profile (discused in more detail in Stankowski, Bluszcz & Nita 1999) have been compared with the conclusion and interpretations of the research discussed in Andersen 1961, Zagwijn 1961, Behre 1989, Mamakowa 1989, Tobolski 1991, and Kozydra & Skompski 1995.

At present, palynological studies are being conducted of the organic sediments of the last interglacial at the site Sławoszewek and of a deeper situated organic series at the site Mikorzyn.

Luminescence dating has been undertaken in the region of Konin for some time now (Pazdur *et al.* 1981; Stankowska & Stankowski 1987; Stankowski 1990; Stankowska & Stankowski 1991; Bluszcz *et al.* 1991). Recently lumine-

Table 1. The correlation of the local amounts of pollen from the Eemian interglacial and the Vistulian at the site Mikorzyn with the regional amounts of pollen according to various authors, in a chronostratigraphic order. Elaborated by M. Nita, original publication in Stankowski *et al*. 1999.

<table>
<tr><th>Local amounts of pollen (Mikorzyn)</th><th colspan="2">Regional amounts of pollen in the region of Konin (Tobolski 1991)</th><th>Regional amounts of pollen (Mamakowa 1989)</th><th colspan="2">Chrono-
-stratigraphy</th></tr>
<tr><td>M-25 Poaceae-Pinus</td><td colspan="2">Wła 5 Salix-Equisetum</td><td>EV5 Gramineae-
-Betula nana</td><td>Schalk-
holz Stadial</td><td rowspan="5">Vistulian</td></tr>
<tr><td>M-24 Pinus-Betula-Poaceae
M-23 Betula-NAP</td><td>Wła 4</td><td>Pinus
Pinus-
-Betula</td><td>EV4 Pinus-Betula</td><td>Odderade
Interstadial</td></tr>
<tr><td>M-22 Poaceae-Artemisia-
-Betula nana
M-21 NAP-Betula
nana-Pinus</td><td colspan="2">Wła 3 NAP I</td><td>EV3 Gramineae-
-Artemisia-
-Betula nana</td><td>Rederstall Stadial</td></tr>
<tr><td>M-20 Pinus-Betula-Larix
M-19 Pinus II
M-18 NAP-Pinus
M-17 Pinus I
M-16 Betula-Pinus
M-15 NAP-Betula
M-14 Betula</td><td>Wła 2</td><td>Pinus

Betula-NAP
Betula-Larix
NAP-Betula</td><td>EV2 Betula-Pinus</td><td>Brörup
Interstadial</td></tr>
<tr><td>M-13 NAP-Betula
nana-Juniperus
M-12 NAP-Pinus-Salix</td><td colspan="2">Wła 1 Artemisia-NAP</td><td>EV1 Gramineae-
-Artemisia-Betula
nana</td><td>Herning
Stadial</td></tr>
<tr><td>M-11 Pinus-Betula-NAP
M-10 Pinus-Picea-Carpinus</td><td colspan="2">Pinus</td><td>E7 Pinus</td><td colspan="2" rowspan="7">Eem Interglacial</td></tr>
<tr><td>M-9 Picea-Abies-Carpinus</td><td colspan="2">Picea-Abies</td><td>E6 Picea-Abies-Alnus</td></tr>
<tr><td>M-8 Carpinus-Corylus-Alnus
M-7 Carpinus-Corylus-Tilia</td><td colspan="2">Carpinus</td><td>E5 Carpinus-
-Corylus-Alnus</td></tr>
<tr><td>M-6 Corylus-Tilia-Alnus
M-5 Corylus-Quercus</td><td colspan="2">Corylus</td><td>E4 Corylus-
-Quercus-Tilia</td></tr>
<tr><td>M-4 Quercus-Fraxinus-Ulmus</td><td colspan="2">Quercus</td><td>E3 Quercus-
-Fraxinus-Ulmus</td></tr>
<tr><td>M-3 Pinus-Betula-Ulmus</td><td colspan="2">Pinus-Betula</td><td>E2 Pinus-Betula-
-Ulmus</td></tr>
<tr><td>M-2 Betula-Pinus-Ulmus
M-1 Pinus</td><td colspan="2">Betula</td><td>E1 Pinus-Betula</td></tr>
</table>

scence dating has been carried out at the sites Mikorzyn and Sławoszewek. The applied methods revealed the TL and OSL age of the samples, as specified in the Bluszcz's paper in this volum (see also Stankowski *et al.* 1999). The latest results are proofing the previous ones.

None of the applied dating methods yielded a credible date of the sediments produced by the direct accumulation of the glacier ice, i.e., the tills as well as sands of glacial origin. This is another proof of how difficult, if not impossible, it is to date tills. Characteristic of the water sediments is the occurrence of the inversed dates and the geological unacceptability of certain dates. This is mainly the case of the TL dating. Nevertheless, the sequence of the dates are in many cases compatible with the current state of geological knowledge. It must be emphasized that the OSL dating produces more credible results. The results of the luminescence dating show how essential it is to furnish accurate geological descriptions of studied profiles and the samples taken from them, and to remain prudent when quoting the established dates in stratigraphic reports.

Conclusions

After long geological studies of the Konin region, the Quaternary series was divided into preglacial sediments, four groups of sediments coming from the cold stages of the Pleistocene (the Oldest, South Polish, Middle Polish and North Polish glacial periods) and three groups of sediments from the warm stages of the Pleistocene (equivalent of Cromerian, Holsteinian and Eemian interglacial periods). The latest studies emphasizes the presence of sediments coming from glacial periods before the so-called "great interglacial" (Holsteinian). Based on theoretical considerations, the results of thousands of drillings and maping of the mine walls, it has been demonstrated that the sediments from before the "great interglacial" are thicker than those later than that interglacial period. The paleorelief from the times of the "great interglacial" has been described, as well as – more importantly – the lakeland landscape of the Eemian period, featuring numerous tunnel valleys, lakes and a system of small river valleys.

The results of palynological study and luminescence dating are generaly compatibil with geological interpretation. In the Mikorzyn site the palynological studies revealed the thinness of the interglacial sediments and the complex sequence of the sediments from the last cold stage (precede of last ice sheet presence). The results of the luminescence dating, especially those obtained by means of the OSL technique, are on the whole compatible with the current state of geological knowledge.

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References

ANDERSEN S. TH., 1961: Vegetation and its environment in Denmark in the early Weichselian glacial (last glacial). *Denmarks Geological Underse ge lise*, R. II, 75: 1–175.

BEHRE K. E., 1989: Biostratigraphy of the last glacial period in Europe. *Quaternary Scienc. Rev*, 8: 25–44.

BLUSZCZ A., in this volume: Combined OSL and TL dating of young sediments – possibilities for new interpretations.

BLUSZCZ A., FEDOROWICZ ST., OLSZAK I. J. & STANKOWSKI W., 1991: Wiarygodność datowań TL glin morenowych i utworów pochodzenia wodnego (The reliability of TL dating of glacial till and deposits of fluvial origin). Przemiany środowiska geograficznego obszaru Konin–Turek. Wyniki realizacji Programu RR. II. 14 w okresie 1986–1990, Instytut Badań Czwartorzędu UAM, Poznań: 89–105.

BORÓWKO-DŁUŻAKOWA Z., 1967: Badania paleobotaniczne osadów młodoplejstoceńskich (Brörup) w Koninie–Marantowie (summ.: Paleobotanical studies of late Pleistocene deposits (Brörup) in the Konin–Marantów area). *I. G. Prace*, 48: 81–136.

KŁYSZ P. & STANKOWSKI W., 1986: Organiczna seria okresu Riss/Würm ze stanowiska Władysławów koło Turka (summ. Riss/Würm organic series at the Władysławów test site in vicinity of Turek). *Bad. Fizjogr. nad Polską Zach.*, 34 A: 95–105.

KOZYDRA K. & SKOMPSKI S., 1995: Unikalne stanowisko interglacjału eemskiego w Ruszkówku na Pojezierzu Kujawskim (Unique character of the Eemian Interglacial site in Ruszkówek (Pojezierze Kujawskie, Central Poland)). *Przegl. Geol.*, (43)7: 572–575.

– 1996: Osady międzymorenowe w okolicy Mikorzyna na Wysoczyźnie Konińskiej (Interglacial sediments in the vicinity of Mikorzyn in Konin region (Central Poland)). *Przegl. Geol.*, 9: 945–949.

LINDNER L. & BRYKCZYŃSKA E., 1980: Organic deposits at Zbójno by Przedbórz, western slopes of the Holly Cross Mts., and their bearing on stratigraphy of the Pleistocene of Poland. *Acta Geol. Pol.*, 30, 2: 153–163.

LINDNER L., DZIERŻEK J., LAMPARSKI Z., MARKS L. & NITYCHORUK J., 1995: Zarys stratygrafii czwartorzędu Polski; główne poziomy osadów glacjalnych i interglacjalnych oraz ich rozprzestrzenienie (Outline of Quaternary stratigraphy in Poland; main glacial and interglacial horizons and their extents), *Przegl. Geol.*, 43(7): 586–591.

LINDNER L. & MARKS L., 1995: Zarys paleogeomorfologii obszaru Polski podczas zlodowaceń skandynawskich (Outline of palaeogeomorphology of the Polish territory during the Scandinavian glaciation), *Przegl. Geol.*, 43(7): 591–594.

MAMAKOWA K., 1989: Late Middle Polish Glaciation, Eemian and Early Vistulian vegetation at Imbramowice near Wrocław and the pollen stratigraphy of this part of the Pleistocene in Poland. *Acta Palaeobotanica*, 29 (1): 11–176.

PAZDUR M. F., STANKOWSKI W. & TOBOLSKI K., 1981: Litologiczna i stratygraficzna charakterystyka profilu z kopalnymi utworami organogenicznymi w Malińcu koło Konina (A lithological and stratigraphical characteristic of the profile with organic sediments at Maliniec near Konin). *Bad. Fizjogr. nad Polską Zach.*, A, 33: 79–88.

STANKOWSKA A. & STANKOWSKI W., 1976: Sytuacja geologiczna kopalnych utworów organicznych z odkrywki Jóźwin Kopalni Węgla Brunatnego w Koninie (Geological situation of fossil organic deposits from the Jóźwin exposure of the brown coal at Konin). *Bad. Fizjogr. nad Polską Zach.*, 29: 167–177.

– 1979: The Vistulian till covering stagnat waters sediments with organic sediments. Symp. on Vistulian Stratigr., Poland 1979, Guide-Book of Excursion, Warszawa.
– 1987: ^{14}C and TL dating of Neopleistocene sites in the Konin Region. *Zesz. Nauk. Polit. Śląskiej*, 56, *Geochronometria*, 4: 85–92.
– 1991: Morfo-, lito- i chronostratygrafia vistulianu we wschodniej Wielkopolsce. Geneza, litologia i stratygrafia utworów czwartorzędowych (Morpho-, litho- and chronostratigraphy of Vistulian deposits in eastern Great Poland), Wyd. Nauk. UAM, Seria Geogr., 50: 563–571.

STANKOWSKI W., 1988: Pozycja stratygraficzna szkieletu słonia leśnego w świetle analizy geologicznej stanowiska Jóźwin 84. Muzeum Okręgowe w Koninie, *Zeszyty Muzealne*, 2: 95–102.

STANKOWSKI W., 1990: Wiarygodność datowań neoplejstocenu metodą TL na przykładzie okolic Konina (Reliability of TL dating of Neoplejstocene sediments evaluated from results obtained in the Konin region). *Zesz. Nauk. Polit. Śląskiej*, 61, *Geochronometria*, 6: 219–222.
– 1996a: Glacjał to nie zlodowacenie. Streszczenia referatów. Polskie Tow. Geol., Oddz. Poznański, V, Instytut Geologii UAM, 5–10.
– 1996b: Wstęp do geologii kenozoiku, ze szczególnym odniesieniem do terytorium Polski. Inst. Geol., Wyd. Nauk. UAM, Poznań.
– in this volume: Glacials, Interglacials and Ice Covers.

STANKOWSKI W., BIEDROWSKI Z., BIERNACKA J., CISZEWSKA M., STANKOWSKA A. & WOJEWODA J., 1992: Trzeciorzędowe osady morskie, jeziorne i bagienne oraz czwartorzędowe osady glacjalne rejonu Konina (Marine lacustrine and peat sediments (Tertiary), and glaciogenic sediments (Quaternary) of the Konin area). Sem. Sed. „Osady i procesy sedymentacji w środowiskach i systemach depozycyjnych w zapisie współczesnym i kolalnym". Poznań, 31 sierpnia – 2 września 1992, Instytut Geologii UAM, Poznań.

STANKOWSKI W., BIEDROWSKI Z., STANKOWSKA A., KOŁODZIEJ K., WIDERA M., WILKOSZ P., 1995a: Litologia i stratygrafia kenozoiku okolic Konina. *Przegl. Geol.*, 43(7): 559–564.
– 1995b: Cainozoic of the Konin area with special emphasis on the stratigraphy of Quaternary deposits. *Quaternary Studies in Poland*, Polish Academy of Sciences, Branch Office in Poznań, Committee of Quaternary Research, vol. 13, Poznań: 101–108.

STANKOWSKI W., BLUSZCZ A. & NITA M., 1999: Stanowiska osadów górnoczwartorzędowych Mikorzyn i Sławoszewek w świetle badań geologicznych datowania radiowęglowego i luminescencyjnego oraz analiz palinologicznych (The upper quaternary sediment sites in Mikorzyn and Sławoszewek in the light of geological studies, radiocarbon and luminescence datin methods and palynological analyses). [In:] Geochronologia górnego czwartorzędu Polski w swietle datowania radiowęglowego i luminescencyjnego. Instytut Fizyki Politechniki Śląskiej w Gliwicach. WIND J. Wojewoda, Wrocław: 87–111.

STANKOWSKI W. & KRZYSZKOWSKI D., 1991: Stratygrafia czwartorzędu okolic Konina (The Quaternary stratigraphy of the Konin area). Przemiany środowiska geograficznego obszaru Konin–Turek. Wyniki realizacji Programu RR. II. 14 w okresie 1986–1990, Instytut Badań Czwartorzędu UAM, Poznań: 45–85.

Stankowski W. & Tobolski K., 1981: Osady torfowe i limniczne wieku eemskiego z odkrywki Kazimierz kopalni węgla brunatnego w Koninie – doniesienie wstępne (summ. Eemian peat and lacustrine deposits from the Kazimierz exposure of the brown coal mine Konin – preliminary report). *Bad. Fizjogr. nad Polską Zach.*, A, 34: 171–178.

Tobolski K., 1991: Biostratygrafia i paleoekologia interglacjału eemskiego i zlodowacenia Wisły rejonu konińskiego (Biostratigraphy and paleoecology of the Eemian interglacial and the Vistulian glaciation of the Konin region). Przemiany środowiska geograficznego obszaru Konin–Turek. Wyniki realizacji Programu RR. II. 14 w okresie 1986–1990, Instytut Badań Czwartorzędu UAM, Poznań: 45–85.

Zagwijn W. H., 1961: Vegetation, climate and radiocarbon dating in the Late Pleistocene of the Netherlands. Part 1; Eemian and Early Weichselian. *Mededelingen Geologische Stichting NS*, 14: 15–45.