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Stratigraphy and lithology of Quaternary sediments in the Kleczew region and in key sections of the eastern Wielkopolska Lowland, central Poland

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The stratigraphy and lithology of the Quaternary deposits of the Kleczew region are analysed in a regional context. They can be correlated with the Preglacial, Narevian(?), South Polish, Middle Polish and Vistulian Glaciations, and the Podlasian, Zbójno and Eemian Interglacials. Large glaciotectonic structures, commonly encountered in lignite mines, proved useful in correlating grey tills of the older Pleistocene glaciations. Lithology, stratigraphy, thickness and palaeomorphology of the Pleistocene sediments were presented in the key sites Konin-Marantów, Mikorzyn, Sławoszewek and in 6 borehole sections. A regional lithostratigraphic scheme of the Quaternary in the eastern Wielkopolska Lowland was constructed basing on petrographic coefficients of tills, lithology, genesis and, finally, on hypsometric setting and thickness. In the light of these studies the maximum ice sheet unit of the Oldest Glaciation should be moved to the south from Kleczew. Moreover, tills of the Odranian, Wartanian and Vistulian Glaciations were found.

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Key words: Wielkopolska Lowland, Quaternary, Pleistocene, stratigraphy, lithology, key sections.

INTRODUCTION

Geological fieldwork for the Kleczew sheet *Detailed Geological Map of Poland* at 1:50,000 scale was carried out in 1993–1996 (Stankowski *et al.*, 1996*a, b*), supplemented by the results of previous studies of Rutkowski (1967), Borówko-Dłużakowa (1967), Trembaczowski (1967), Tobolski (1991), Kozydra and Skompski (1995, 1996), Stankowski *et al.* (1999), Widera (1999) and others.

The area studied is located in the eastern Wielkopolska Lowland (central Poland), about 10 km north of Konin (Fig. 1). Three outlying sites of stratigraphical significance were also studied (Fig. 1). These are at Konin–Marantów (10 km to the south), Mikorzyn (3 km to the east) and Ruszkówek (14 km to the east).

Deposits of the two youngest glacial units of the Middle Polish and the Vistulian Glaciations have been distinguished in the eastern Wielkopolska Lowland (Krygowski, 1952, 1961; Borówko-Dłużakowa, 1967; Rutkowski, 1967). Other stratigraphical units were noted by Stankowski and Krzyszkowski (1991), and by Stankowski *et al.* (1995*a, b*, 1996*a, b*, 1999); this paper follows the stratigraphical framework of these studies.

Deposits of the Preglacial, 4 cold and 3 warm periods of the Pleistocene, and of the Holocene have been distinguished in the vicinity of Kleczew (Stankowski *et al.*, 1995*a, b*, 1996*a, b*, 1999; Widera, 1999). The main pre-Eemian stratigraphical units have been determined mainly on the basis of palynological and lithological data from the Konin–Marantów, Mikorzyn and Ruszkówek sections. Palynological examination of Eemian deposits was carried out at several sites in the vicinity of Kleczew (Fig. 1).

RESEARCH METHODS

Preliminary investigations were undertaken in the Konin Lignite Surface Mine (KWB Konin) where the Quaternary deposits could be studied in the mine walls, several kilometres long, and where samples were collected. About 1500 borehole

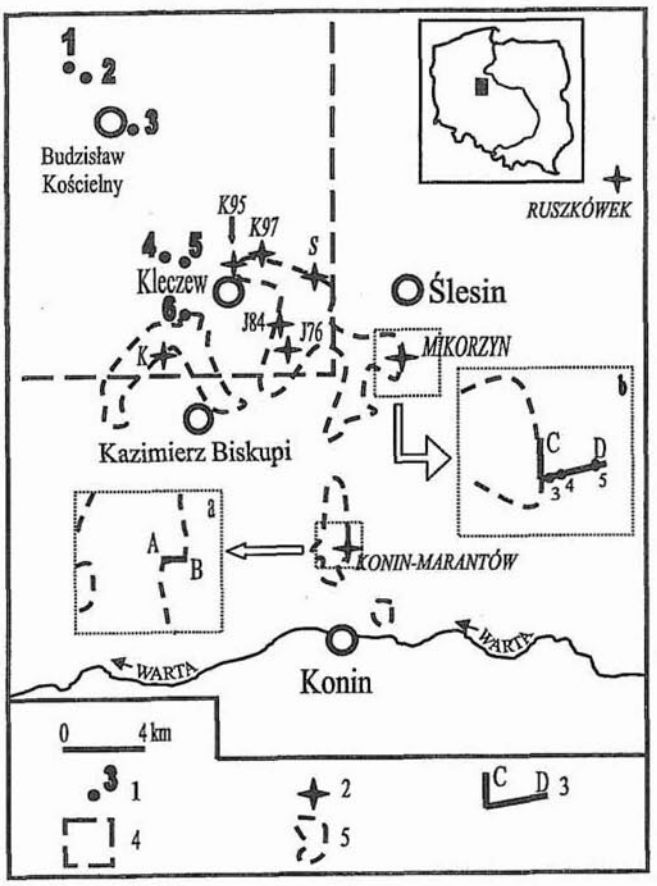


Fig. 1. Location of the studied area with main stratigraphical sites

1 — borehole; 2 — sites with stratigraphical interpretation based on palynological data for the Eemian Interglacial: K — Kazimierz, J76 — Jóźwin 76, J84 — Jóźwin 84, K95 — Kleczew N-1995, K97 — Kleczew N-1997, S — Sławoszewek; Eemian and Early Vistulian at Mikorzyn, and Zbójno Interglacial at Konin–Marantów; 3 — geological section; 4 — Kleczew sheet; 5 — lignite open cast pits; a, b — location of geological section presented in Figs. 2 and 3

sections from the KWB Konin archival were analysed, 346 of which are located on the Kleczew sheet (Stankowski *et al.*, 1996*a*). 6 borehole sections and 6 sites with palynological data were described (Fig. 1).

Lithological and petrographic analyses focussed on heavy minerals and $CaCO_3$, gravel petrography, quartz roundness and petrographic coefficients (*Instrukcja...*, 1996). 40 samples of organic deposits of the Eemian Interglacial and the Vistulian Glaciation were collected for palynological examination. 40 samples of mollusc shells from Eemian and Holocene deposits were analysed. 11 samples of Late Vistulian and Holocene deposits were radiocarbon dated and 20 samples of Pleistocene deposits were subjected to thermoluminescence dating.

KEY SITES

The key sites of Konin–Marantów, Mikorzyn, Sławoszewek and 6 borehole profiles demonstrate the varying lithology, stratigraphy, thickness and palaeomorphology of the Pleistocene in the vicinity of Kleczew (Fig. 4).

KONIN–MARANTÓW

The Pleistocene sediments at this site (Fig. 1) are to 12 m thick, but their lithology is quite varied. They comprise 4 tills, fluvial sands and gravels, glaciofluvial sands, and also lake sands, silts, gyttjas and peats (Fig. 2). Organic sediments from Konin–Marantów were correlated with the Brörup (Lower Vistulian) by Borówko-Dłużakowa (1967), and consequently the overlying tills were referred to the Vistulian Glaciation and the underlying ones to the Middle Polish Glaciation (Borówko-Dłużakowa, 1967; Rutkowski, 1967).

Tobolski (1991) reinterpreted the pollen diagram of Borówko-Dłużakowa (1967). In his opinion the flora from Konin–Marantów was quite different from the Vistulian one at Podgłębokie (Janczyk-Kopikowa, 1969). He correlated the organic deposits from Konin–Marantów with the ones from the Zbójno site, the stratigraphical position of which was established by Lindner and Brykczyńska (1980). According to Tobolski (1991), thick grey tills beneath the organic deposits at Konin–Marantów should be correlated with the cold episodes prior to the Middle Polish Glaciations, and he assigned the two lowest tills in this area to the South Polish Glaciations (Fig. 2).

MIKORZYN

This site is located about 3 km to the east of the Kleczew sheet (Fig. 1). It contains lake and bog sediments which are anomalously thick (to 30 m) (Fig. 3), due to compaction of the underlying Tertiary lignite seams (Kozydra and Skompski, 1996) or to neotectonic movements of the Mesozoic substrate (Widera, 1999). Organic and mineral deposits occur between the two tills, the upper one of which certainly belongs to the Vistulian Glaciation. These organic sediments have been correlated with the Eemian Interglacial (Stankowski and Krzyszkowski, 1991; Stankowski *et al.*, 1995*a, b*, 1996*b*; Kozydra and Skompski, 1996).

Four tills were distinguished by Stankowski and Krzyszkowski (1991) and Stankowski *et al.* (1995*a, b*, 1996*b*) at the Mikorzyn site (Fig. 3). The lowest one is over 50 m thick and represents the South Polish Glaciations. The middle two reach up to 20 m in total and they are referred to the Wartanian Glaciation. The uppermost till, less than 10 m thick, is correlated with the Vistulian Glaciation. Kozydra and Skompski (1996) described 5 tills at the Mikorzyn site, in distinguishing 2 tills of the Vistulian Glaciation i.e. of the Leszno and Poznań phases (Kozydra and Skompski, 1996). Moreover, they correlated the lower till of the Middle Polish Glaciations with the Odranian Glaciation, and the upper one with the Wartanian Glaciation.

The superposed organic deposits of the Eemian and Vistulian at Mikorzyn were documented recently by

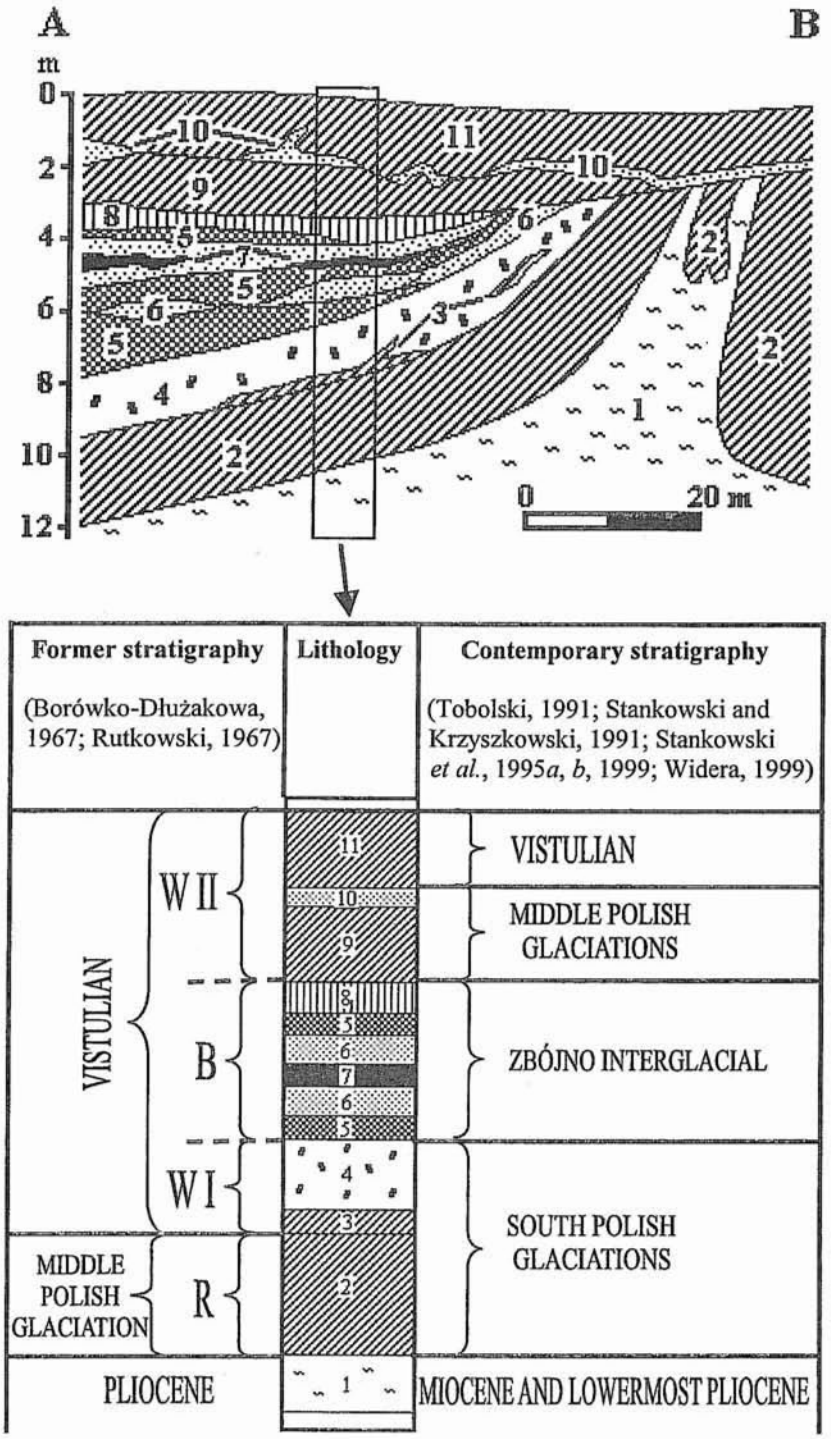


Fig. 2. Geologic section of the Quaternary deposits at Konin–Marantów in the Gosławice mine near Marantów (closed in 1974) after Rutkowski (1967, fig. 9, p. 26 and figs. 17, 18, p. 37), simplified and slightly modified; for location see Fig. 1

R — Riss, WI — Würm I, B — Brörup, WII — Würm II; Tertiary: 1 — clays; Quaternary, South Polish Glaciations: 2 — grey till, 3 — dark red weathered till, 4 — fluvial sands and gravels; Zbójno Interglacial: 5 — peats, 6 — sands, 7 — gyttjas, 8 — fluvial sands and gravels with lake silts; Middle Polish Glaciations: 9 — grey till, 10 — glaciofluvial sands; Vistulian Glaciation: 11 — brown till

Stankowski *et al.* (1999) (Fig. 3; Pl. I, Fig. 1). On palynological grounds, M. Nita (*vide* Stankowski *et al.*, 1999) ascribed the lowermost peat layer to the Eemian and the overlying deposits to the Vistulian (Fig. 3). 25 local pollen assemblage zones (from M-1 to M-25) were distinguished. Zones M-1 to M-11 were referred to the Eemian Interglacial, M-12 to M-13 — to the Herning Stadial, M-14 to M-20 — to the Brörup Interstadial, M-21 to M-22 – to the Redestall Stadial, M-23 to M-24 — to the Odderade Interstadial, and M-25 — to the Schalkholz Stadial.

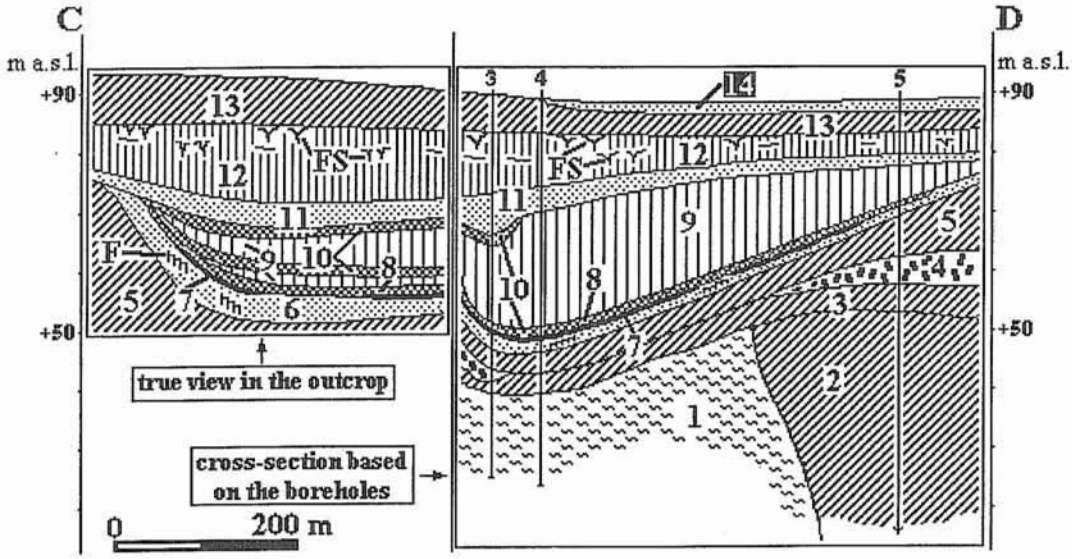


Fig. 3. Geological section of the organic deposits of the Eemian and Vistulian at the Mikorzyn site; partly after Kozydra and Skompski (1996), simplified and modified; for location see Fig. 1

Tertiary: 1 — clays and silty clays (Middle Miocene-lowermost Pliocene); Quaternary, South Polish Glaciations: 2 — dark grey till; Middle Polish Glaciations: 3 — light grey till (Odranian?), 4 — glaciofluvial sands and gravels, 5 — light grey till (Wartanian?), 6 — glaciofluvial sands with small faults; Eemian: 7 — gyttja and thin shelly layer at the top, 8 — peats; early Vistulian: 9 — sands, gyttjas and silts, 10 — peats, 11 — sands, 12 — silts and sands with frost structures; Plenivistulian: 13 — light brown till, 14 — glaciofluvial sands and gravels; FS — frost structures, F — faults

RUSZKÓWEK

This site (Fig. 1) was recognised as a key section for the Pleistocene in central Poland (Kozydra and Skompski, 1995) and its petrography, palynology and fauna were analysed. Four tills were distinguished: the lowest two represented the South Polish Glaciations, the next one was referred to the Middle Polish Glaciations and the uppermost one was correlated with the Vistulian Glaciation. Kozydra and Skompski (1995) presented petrographic coefficients for the tills. Beneath a till of the Vistulian Glaciation, lake and bog sediments up to 18 m thick were found. On palynological and faunal grounds, these were correlated with the Eemian Interglacial (Kozydra and Skompski, 1995).

OTHER SITES

Organic and mineral deposits of the Interglacial are common in the area studied (Fig. 1; Pl. I, Fig. 2). The following sites have been previously described: Jóźwin 76, Kazimierz, Jóźwin 84, Mikorzyn, Kleczew N-1995, Kleczew N-1997, Sławoszewek (Stankowska and Stankowski, 1976; Stankowski and Tobolski, 1981; Tobolski, 1991; Stankowski *et al.*, 1995*a*, *b*, 1996*b*, 1999; Kozydra and Skompski, 1996). The Sławoszewek site is fully representative of the other Eemian sites. These deposits have been subjected to palynological and malacological analyses, and to thermoluminescence dating. The Eemian lake and bog peats, gyttjas and sands (Pl. I, Fig. 2) are set between grey tills of the Middle Polish Glaciations, and clayey sands and brown tills of the Vistulian Glaciation. These interglacial sediments are clearly visible in the lignite open cast pits and render the top of the Middle Polish Glaciations and the base of the Vistulian Glaciation sediments the best-defined Pleistocene palaeosurfaces in the studied area. Moreover, it is very easy to compare the stratigraphical position of the Eemian deposits between the Kleczew sheet and its vicinity, e.g. at the Mikorzyn and Ruszkówek sites.

PREGLACIAL (PRE-PLEISTOCENE, PROTO-PLEISTOCENE)

The Preglacial deposits are younger than the Poznań Formation of the Neogene, and older than the lowermost glacial sediments. They occasionally fill depressions in the Neogene top surface, e.g. in section 3 (Fig. 4). They are fine- and medium-grained fluvial sands without $CaCO_3$, light in colour, subhorizontally laminated or with low ripples. There is a characteristic heavy mineral composition with garnet (to 37%), chlorite (to 25%) and zircon (to 12%). Other minerals such as biotite, tourmaline, staurolite are rare and usually do not exceed 5% (Stankowski *et al.*, 1996*b*). Stankowski and Krzyszkowski (1991) described a very similar heavy mineral composition in the Preglacial deposits of the lignite open cast pits Jóźwin and Lubstów.

OLDEST GLACIATION (NAREVIAN?)

Tills of this glaciation are occasionally interbedded with glaciofluvial sands and gravels (Fig. 4). Such deposits are rare and occur in deep subglacial channels. Residua of glacial deposits preserved at 40–60 m a.s.l. may be also referred to this glaciation, e.g. in section 2 (Fig. 4).

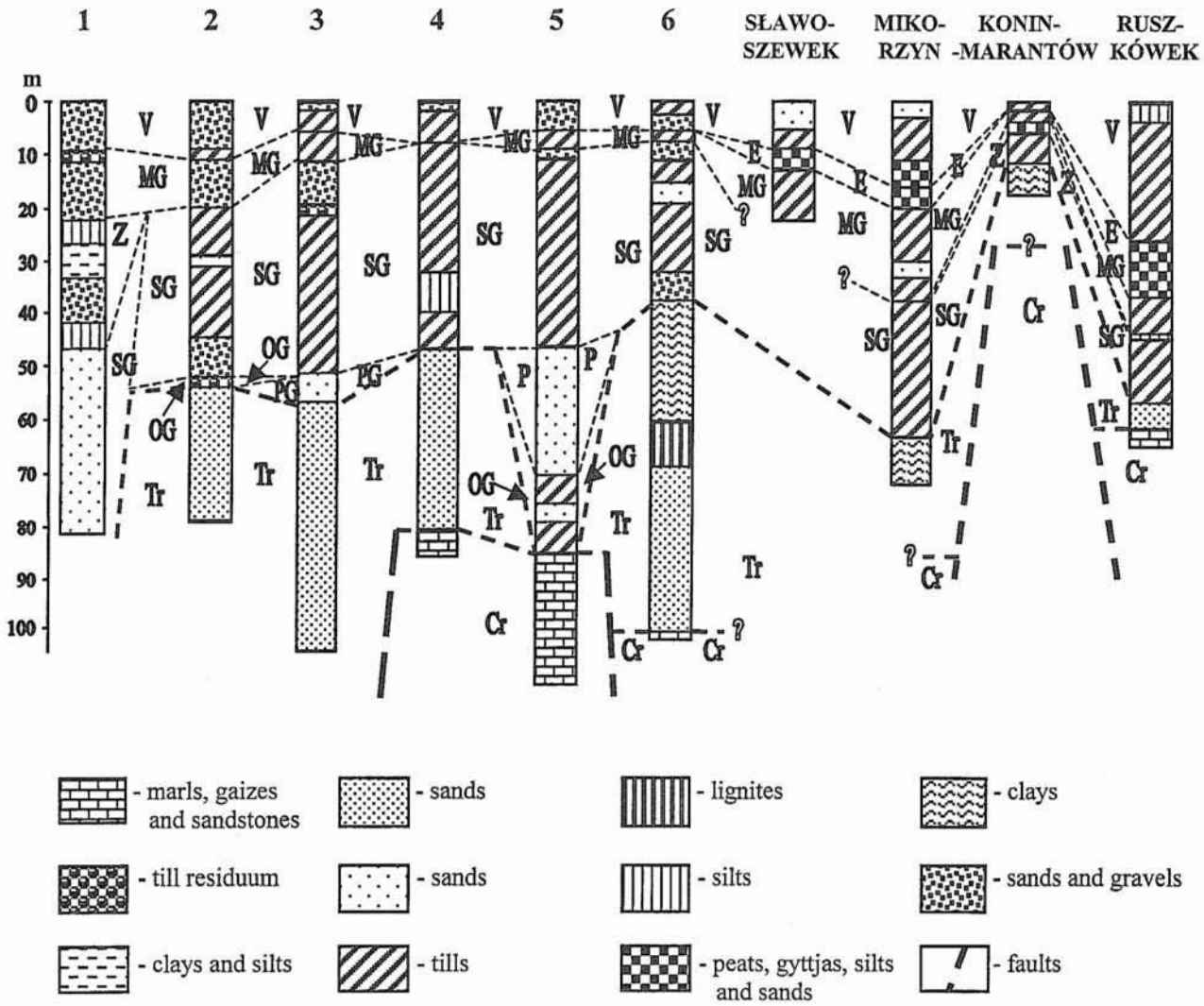


Fig. 4. Key Pleistocene sections on the Kleczew sheet and in the surrounding area; for location see Fig. 1

Cr — Cretaceous, Tr — Tertiary, PG — Preglacial, OG — Oldest Glaciation (Narevian?), P — Podlasian Interglacial, SG — South Polish Glaciations, Z — Zbójno Interglacial, MG — Middle Polish Glaciations, E — Eemian Interglacial, V — Vistulian Glaciation

PODLASIAN INTERGLACIAL

Sandy deposits between tills of the Oldest and the South Polish Glaciations were referred to the Podlasian Interglacial, e.g. in profile 5 (Fig. 4). This interpretation is based exclusively on stratigraphical setting (Stankowski *et al.*, 1996*b*, 1999; Widera, 1999).

SOUTH POLISH GLACIATIONS

One or two dark grey tills (Fig. 4) represent deposits of this cold interval. In lignite open cast pits they are separated by sands with glacial deformations such as folds, thrust slices, faults and convolutions. Deposits of the South Polish Glaciations reach a thickness of 50 m in sections 3–5 (Fig. 4), but on the average they are about 25 m thick. The age of these deposits was determined on the basis of a palynological study from Konin–Marantów (Tobolski, 1991) and of analysis of organic sediments from Mikorzyn where there are peats between the grey tills (Stankowski *et al.*, 1996*b*, 1999).

ZBÓJNO INTERGLACIAL

Organic deposits of this interglacial were found at Konin–Marantów and Mikorzyn (Figs. 1–2, 4) (Tobolski, 1991; Stankowski *et al.*, 1995*a*, *b*, 1996*b*, 1999; Widera, 1999). Mineral deposits of this warm period are rare on the Kleczew sheet and preserved in subglacial channels as silts with intercalations of clays, sands and gravels (Fig. 4).

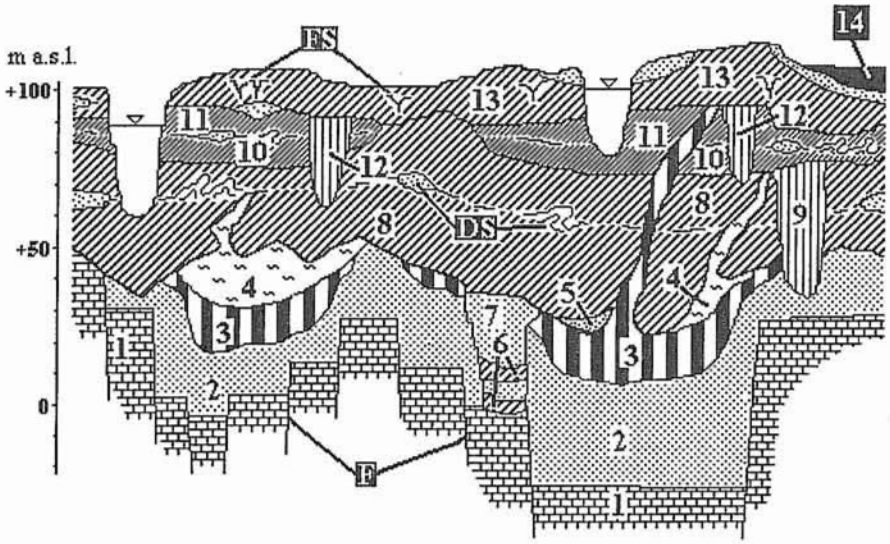


Fig. 5. Synthetic geological section across the Cainozoic deposits

Cretaceous: 1 — marls or carbonate sandstones (Lower Maastrichtian); Tertiary: 2 — sands and silts with intercalations of lignite (Lower Miocene — Middle Miocene), 3 — lignite with intercalations of sands (Middle Miocene), 4 — clays and silty clays (Middle Miocene-lowermost Pliocene); Quaternary, Preglacial: 5 — sands; Oldest Glaciation: 6 — tills and their residua in deep glacial tunnel valleys; Podlasian Interglacial: 7 — sands; South Polish Glaciations: 8 — dark grey tills with sandy bodies and tectonic structures; Zbójno Interglacial: 9 — peats and silts with clays and sands; Middle Polish Glaciations: 10 — light grey tills (Odranian?), 11 — light grey tills with sandy bodies and tectonic structures at the base (Wartanian?); Eemian: 12 — sands, gyttjas and peats; Vistulian Glaciation: 13 — silts, gyttjas, peats and sands with frost structures (Lower Vistulian), brown tills, sands and gravels (Plenivistulian); Late Glacial and Holocene: 14 — sands, gyttjas, peats; FS – frost structures, DS — sands with tectonic structures, F — faults

MIDDLE POLISH GLACIATIONS

In the Kleczew area these glaciations are represented by a single and occasionally by two light grey tills. They are separated by fluvial sands which are locally folded and faulted (Pl. II, Fig. 2). These deposits are up to 20 m thick, e.g. at Mikorzyn, but they do not form a continuous cover (Fig. 4). They are overlain by late-glacial sands and gravels, Eemian deposits or by organic and mineral sediments of the last glaciation (Fig. 4). The tills were thermoluminescence dated at 150–110 ka (Stankowski *et al.*, 1996*b*, 1999) which agrees with dates obtained for this interval elsewhare in Poland (Różycki, 1978; Lindner, 1988; Bluszcz *et al.*, 1991; Lindner and Marks, 1995; Marks *et al.*, 1995). However, most thermoluminescence dates are too old and stratigraphical correlation based on them may lead to significant mistakes.

EEMIAN INTERGLACIAL

There are numerous sites with the Eemian deposits in the study area: Kazimierz, Jóźwin 76, Jóźwin 84, Mikorzyn, Kleczew N-1995, Kleczew N-1997, Sławoszewek and Ruszkówek (Stankowska and Stankowski, 1976; Stankowski and Tobolski, 1981; Tobolski, 1991; Kozydra and Skompski, 1995, 1996; Stankowski *et al.*, 1995*a, b*, 1996*b*, 1999). The Eemian sands, silts, gyttjas and peats are usually less than 10 m thick but reach up to 20 m at Ruszkówek (Fig. 4).

VISTULIAN GLACIATION

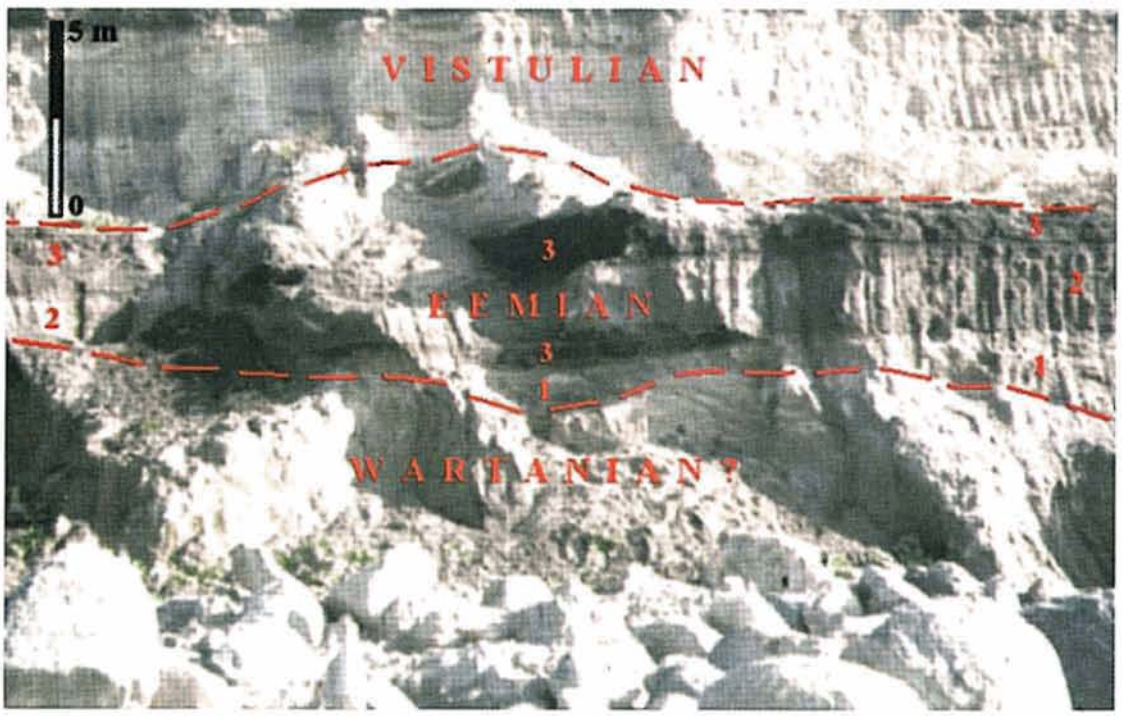
The Vistulian succession begins with organic sediments (e.g. at Mikorzyn), overlain by interbedded glacial, glaciofluvial and lake deposits (Fig. 4). These are a few metres thick and occasionally reach up to 30 m (Figs. 3, 4; Pl. I, Fig. 1; Pl. II, Fig. 1). During the Early Vistulian (until 21–20 ka) the Kleczew area was in an extraglacial zone and forest flora predominated (M. Nita *vide* Stankowski *et al.*, 1999). There were brief periglacial episodes with tundra and frost weathering structures (Pl. II, Fig. 1). Organic matter preserved in frost wedges has been radiocarbon dated at about 45 and 22 ka. (Stankowski *et al.*, 1996*b*, 1999). These dates correspond with Maliniec I and Maliniec II, well-known organic horizons in the Wielkopolska Lowland (Stankowska and Stankowski, 1979; Kozarski, 1980, 1986). The overlying tills and glaciofluvial deposits represent the Plenivistulian. The Late Glacial sediments are composed of sands, silts, gyttjas and peats (PL. II, Fig. 2), the oldest of which were radiocarbon dated at about 17.7 ka (Stankowski *et al.*, 1996*b*, 1999).

HOLOCENE

These deposits are similar to those of the Late Glacial, with lake and boggy sands, silts, gyttjas and peats (PL. II, Fig. 2). Peat deposition predominated, especially during the Atlantic Period when its thick beds (up to 12 m) were formed. Most

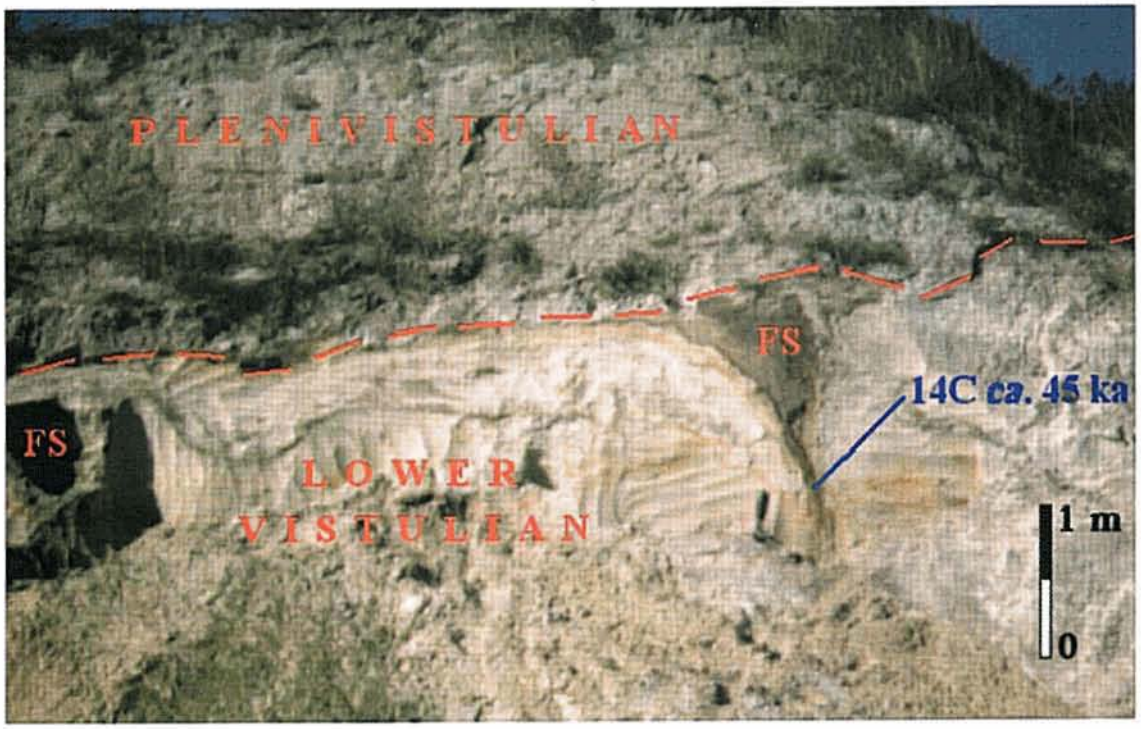
PLATE I

1. Pątnów open cast at Mikorzyn, general view in 1995. Eemian Interglacial: peats and gyttjas with a thin shelly layer at the top; Vistulian: gyttjas, peats, silts, sands, sands and gravels, brown till. South is on the right side

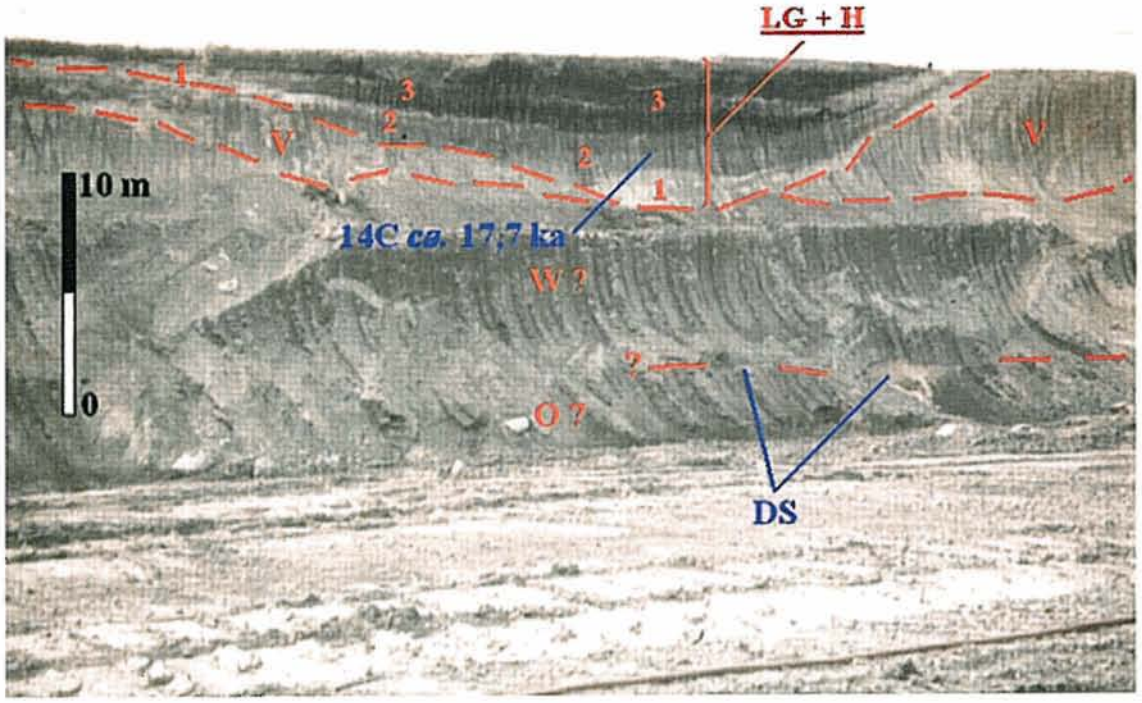


2. Jóźwin open cast pit at Sławoszewek in 1998. Eemian sands (1), gyttjas (2) and peats (3) underlain by brown till and clayey sands of the Middle Polish Glaciation (Wartanian?) and overlain by light grey till of the Vistulian. East is on the right side

PLATE II



1. Pątnów open cast pit at Mikorzyn in 1995. Lower Vistulian: sands and silts with frost structures (FS) and organic matter (^{14}C — radiocarbon date); Plenivistulian: brown tills. South is on the right side



2. Pątnów open cast pit at Kleczew in 1997. O? — Odranian?: light grey till; W? — Wartanian?: light grey till; V — Vistulian: brown till; LG + H — Late Glacial and Holocene: 1 — sands, 2 — gyttjas, 3 — peats. DS – sandy bodies with tectonic structures, ^{14}C — radiocarbon date. East is on the right side

radiocarbon dates are from about 11 ka to about 6 ka (Stankowski *et al.*, 1996*b*, 1999). Peat deposition was less intensive during the last 6 ka and it has been limited in recent times by human activity.

REGIONAL LITHOSTRATIGRAPHICAL SCHEME

The regional Quaternary lithostratigraphical scheme around Kleczew is based on petrographical coefficients of till lithology and genesis and finally, on hypsometric setting and sediment body thickness (Fig. 5). Mean value of the petrographic indices O/K, K/W and A/B for tills of the South Polish Glatiations are 1.51, 1.16, 1.31; for tills of the Middle Polish Glaciations: 1.37, 1.05, 1.30; and for tills of the Vistulian Glaciation: 0.91, 2.00, 0.78 in the Kleczew sheet (Stankowski *et al.*, 1996*b*). Comparison with the petrographic indices of Trembaczowski (1967), Kozydra and Skompski (1995) and Stankowski *et al.* (1996*b*) is difficult, because Trembaczowski (1967) applied a different methodical approach. Values of the K/W index are lower than those of O/K and A/B for tills of the South Polish Glaciations. Petrographic coefficients of the younger tills can occasionally vary widely in a single bed and so stratigraphical correlation cannot be based exclusively on this method. Apart from interglacial organic sediments at key sections, two tills could be distinguished on the basis of the intervering sands (Fig. 5; Pl. II, Fig. 2).

The lithostratigraphical scheme of the Quaternary in the study area given here comprises more stratigraphical units than in some previous papers (Krygowski, 1952, 1961; Borówko-Dłużakowa, 1967; Rutkowski, 1967), though it is in agreement with the most recent research (Stankowski and Krzyszkowski, 1991; Stankowski *et al.*, 1995*a, b*; Kozydra and Skompski, 1995, 1996; Stankowski *et al.*, 1996*a, b*, 1999; Widera, 1999). Glacial deposition is represented mainly by tills and also by glaciofluvial sands with gravels. Residual gravels and boulders are an effect of denudation. Fluvial accumulation represents sands. Lake and bog sediments are peats, gyttjas, silts and sands for warm conditions, and silts for cold ones. Peats and gyttjas were deposited in cold intervals of the Pleistocene, e.g. during the Vistulian Glaciation. Therefore, organic deposits between tills do not necessarily imply interglacial conditions (Pl. I, Fig. 1; Pl. II) but could record cold periods of the Pleistocene when no Scandinavian ice reached the area studied (Stankowski *et al.*, 1999; Widera, 1999).

Synthetic geological sections through the Cainozoic succession around Kleczew correspond to the lithostratigraphical scheme (Fig. 5), a compilation of key sections, boreholes and faces examined in the KWB Konin lignite mine.

Pleistocene sediments are from a few up to 100 m thick (Fig. 5), being thickest in subglacial channels and in tectonic grabens with lignite seams (Widera, 1998). In the mine faces glaciotectonic structures as diapirs, rafts, folds, thrust slices and faults can be seen (Fig. 5). Diapirs, folds and faults were also documented in the area studied by Rutkowski (1967, figs. 9, 12–14) and Stankowski *et al.* (1999, phot. 6.1, 6.2). Moreover, among homogenous grey tills of the South Polish and Middle Polish Glaciations there are fluvial sands with glaciotectonic structures (Fig. 5; Pl. II, Fig. 2). These were useful in establishing the lithostratigraphy of the Pleistocene in eastern Wielkopolska Lowland.

DISCUSSION

Several geological problems have emerged recently. The most important of these are discussed below, accompanied by suggestions for further investigations.

If the stratigraphical setting of deposits of the Oldest Glaciation (Narevian?) is confirmed, its maximum ice sheet limit should be pushed into the Kleczew region, about 50 km to the south of the proposed ice limit of Lindner and Marks (1995, fig. 1A).

Odranian Glaciation deposits of which have been, recognized by some authors (Mańkowska, 1983; Klatkowa, 1994; Kozydra and Skompski, 1996; Trzmiel, 1996; Widera, 1999) but not by others (Stankowski and Krzyszkowski, 1991; Czubla, 1999). The Odranian Glaciation has been an integral part of the Pleistocene chronostratigraphy scheme of Poland in many publications (among others: Różycki, 1978; Lindner, 1988; Lindner and Marks, 1995; Marks *et al.*, 1995). Therefore, there is no reason why deposits of the Odranian should not occur in the vicinity of Kleczew.

The third geological problem concerns the postulated presence of deposits of the Poznań and Leszno phases of the last glaciation at Mikorzyn (Kozydra and Skompski, 1996). The maximum ice sheet limits determined for this glaciation (Kozarski, 1980, 1986), and the pattern of ice sheet advances and retreats in the eastern Wielkopolska Lowland do not support this opinion. The Mikorzyn site is located between two marginal zones of the Vistulian Glaciation and it should not be possible to distinguish tills of the Poznań and Leszno phases there. The tills may rather correspond to the combined Leszno–Poznań Phase or they may be simply tills of the Vistulian Glaciation or the Plenivistulian in general.

CONCLUSIONS

1. Deposits of the Preglacial, four cold and three warm periods of the Pleistocene, and of the Holocene may be distinguished in the vicinity of Kleczew.

2. The age of deposits older than the Zbójno Interglacial was determined on the basis of their stratigraphical setting; the younger sediments were examined by lithological, palynological and malacological methods, supplemented with thermoluminescence and radiocarbon dating.

3. Numerous sites with organic deposits of the Eemian Interglacial are present in the Kleczew area: Kazimierz, Jóźwin 76, Jóźwin 84, Mikorzyn, Kleczew N-1995, Kleczew N-1997 and Sławoszewek.

4. Glaciotectonic deformations in the lignite open cast pits represent rafts, diapirs, folds, thrust slices, faults, *etc.*

5. The maximum ice sheet limit of the Oldest Glaciation (Narevian?) should be moved at least 50 km to the south of Kleczew.

6. There is some reasons to distinguish tills of the Odranian from those of the Wartanian Glaciations and little reason to

separately distinguish tills of the Leszno and the Poznań phases of the Vistulian Glaciation around Kleczew.

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