



Geomorphologic and geologic setting of Quaternary deposits in the vicinity of Janów Podlaski (Eastern Poland)

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Several examples yield that in the vicinity of Janów Podlaski (Eastern Poland), the older Quaternary is represented by preglacial (pre-Pleistocene) deposits, superimposing Oligocene and Upper Cretaceous sediments. Glaciogenic series of the Sanian 1 and Sanian 2 Glaciations, separated by fluvial deposits of the Ferdynandovian Interglacial occur above them. The younger of the mentioned series is overlain by lacustrine deposits with palynologic data representing the Mazovian Interglacial and the early glacial of the

Liviecian Glaciation, as well as probably the lowermost part of the Zbójnian Interglacial. These sediments are covered by the youngest in the area glaciogenic series (or their residua) corresponding to the Odranian and/or Wartanian Glaciations. The younger Quaternary is represented by fluvial deposits of suprainundation terraces accumulated during the Eemian Interglacial and the Vistulian Glaciation, as well as by the Holocene tidal flats and sediments occurring at floors of tributary river valleys.

INTRODUCTION

The described area is situated in the southern part of the drainage basin of Czyżówka River, left tributary of Bug River (Fig. 1). The geomorphology and Quaternary deposits of the area were the point of interest of such authors as B. Zaborski (1927), J. Nowak (1969, 1973, 1974, 1977), J. E. Mojski (1972) as well as E. Falkowski *et al.* (1984–1985, 1988) and E. Myślińska (1988). The author, as well as his undergraduate (J. Andrzejczyk, M. Aniołkowska, K. Drynda, U. Kochanowska and A. Zalewski) and postgraduate students (J. Nitychoruk, 1994, 1996) referred to results of these investigations in many geomorphologic and geologic papers (L. Lindner, 1988, 1996; L. Lindner *et al.*, 1988). Studies, conducted with the authors co-operation or by his co-workers, of the Mazovian Interglacial lacustrine deposits at Ossówka (L. Lindner *et al.*, 1990; J. Nitychoruk, 1994; K. M. Krupiński, 1995a, b, 1996a,

b), Hrud I (L. Lindner *et al.*, 1990; J. Nitychoruk, 1994; K. M. Krupiński, 1995a, b) and Pawłów Nowy (J. Nitychoruk, 1994; K. M. Krupiński, 1996c) were also located in the investigated area. The geomorphologic and stratigraphic outline of the Pleistocene near Janów Podlaski was presented in a separate paper (K. Drynda, 1994). On the basis of field and archive data the investigated area has been divided into three regions, differing mainly with the knowledge of the substrate of the Mazovian Interglacial lacustrine deposits. Due to a large number of drillings the substrate is better known in the southeastern part of the area, namely the Hrud–Janów Podlaski region. Regions of Komarno and Pawłów Nowy are situated in the central and northern part of the area, where knowledge about the substrate is considerably smaller.

HRUD–JANÓW PODLASKI REGION

Detailed field investigations point to the occurrence of a plateau surface, built of glacial and glaciofluvial deposits (Fig. 1). It is cut by the Krzywula River (tributary of Czyżów-

ka River) valley system. In the southern part of the described region this system is isolated from Klukówka River (tributary

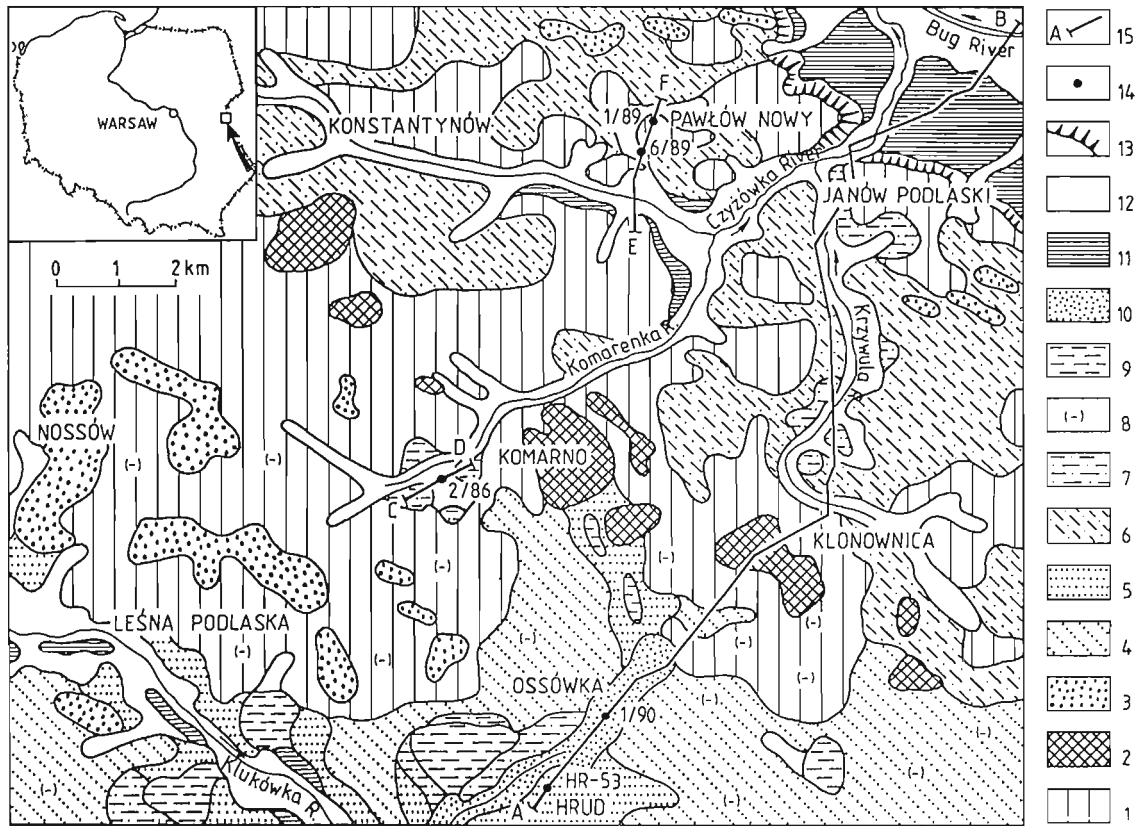


Fig. 1. Geomorphic-geologic sketch of the vicinity of Janów Podlaski (compiled from unpublished materials of the author and J. Andrzejczyk, M. Aniołkowska, K. Drynda, U. Kochanowska and A. Zalewski)

Odranian (Wartanian?) Glaciation: 1 — postglacial plateau: till, 2 — terminal moraines: sands and gravels with boulders and silts with glacial deformations, 3 — kames and dead-ice moraines: sands and gravels with boulders, 4 — first (older) outwash level: vari-grained sands with gravel and till intercalations, 5 — second (younger) outwash level: vari-grained sands with gravel and till intercalations, 6 — third (youngest) outwash level: vari-grained sands with gravel and till intercalations, 7 — kame terraces: sands, gravels and silts, 8 — melt-out depressions, 9 — melt-out depressions with younger (mainly Holocene) peats and organic muds infilling their floors, 10 — melt-out depressions reworked by fluvial processes (mainly from the Vistulian Glaciation): infilled with sands with gravel, silts, organic muds and peats; **Eemian Interglacial and Vistulian Glaciation:** 11 — suprainundation terrace: vari-grained sands, sands with gravel and silts; **Holocene:** 12 — flood plain and side river valley bottoms: sands, sands with gravel, gravels, organic muds and peats; 13 — slope of postglacial plateau; 14 — sections with palynologic data of the Mazovian Interglacial; 15 — lines of geological cross-sections (Figs. 2–4)

Szkic geomorfologiczno-geologiczny okolic Janowa Podlaskiego (opracowany na podstawie niepublikowanych materiałów J. Andrzejczyk, M. Aniołkowskiej, K. Dryndy, U. Kochanowskiej, A. Zalewskiego i autora)

Złodowacenie odry (wartany?): 1 — wysoczyzna polodowcowa: glina zwałowa, 2 — moreny czołowe: piaski i żwiry z głazami oraz mułkami ze śladami zaburzeń glaciotektonicznych, 3 — kemy i moreny martwego lodu: piaski i żwiry z głazami, 4 — pierwszy (starszy) poziom sandrowy: piaski różnoziarniste ze żwirem i wkładkami gliny zwałowej, 5 — drugi (młodszy) poziom sandrowy: piaski różnoziarniste ze żwirem i wkładkami gliny zwałowej, 6 — trzeci (najmłodszy) poziom sandrowy: piaski różnoziarniste ze żwirem i wkładkami gliny, 7 — tarasy kemowe: piaski, żwiry i mułki, 8 — zagłębienia wytopiskowe, 9 — zagłębienia wytopiskowe o dnach wysłanych młodszymi (głównie holoceńskimi) torfami i namułami organicznymi, 10 — zagłębienia wytopiskowe przekształcone przez procesy fluwialne (głównie z okresu złodowacenia wisły) wysłane: piaskami ze żwirem, mułkami, namułami organicznymi i torfami; **interglacjał eemski i złodowacenie wisły:** 11 — taras nadzalewowy: piaski różnoziarniste, piaski ze żwirem i mułki; **holocen:** 12 — taras zalewowy i dna dolin bocznych: piaski, piaski ze żwirem, żwiry, namuły organiczne i torfy; 13 — krawędź wysoczyzny polodowcowej; 14 — zbadane palinologicznie profile osadów interglacjału mazowieckiego; 15 — linie przekrojów geologicznych (fig. 2–4)

of Krzna River) basin by a watershed zone expressed between Klonowica and Ossówka by the occurrence of hills.

The hills are built of laminated sandy-gravel material with intercalations of silts, occurring often in form of standing folds, which is an evidence for glaciotectionic deformations. They presumably represent the part of a moraine chain created in the terminal area of the ice-sheet of the Odranian and/or Wartanian Glaciations. Their summits reach 156–168 m a.s.l. and ascertain the glacier stagnation (E. Falkowski *et al.*, 1984–1985, 1988). They are clearly situated in the surrounding till, overbuilt from the south with fluvio-glacial material

representing two outwash levels. The higher (first) of these levels is placed between 154–159 m a.s.l. and passes to the south into an older outwash level surface in the Klukówka River basin, while the lower level (second), occurring mainly in the upper part of a depression near Ossówka, represents the equivalent of a younger outwash level in the Klukówka–Krzna rivers basin (L. Lindner, 1996).

In several places within the mentioned outwash level surfaces, immense melt-out depressions occur (Fig. 1). They represent remainders of dead-ice blocks from the period of the last in the area Scandinavian glaciation (Odranian and/or

Wartanian). According to E. Falkowski *et al.* (1984–1985) and J. Nitychoruk (1994), such forms were created in course of squeezing out from underneath dead-ice blocks not only base moraine material but also the topmost parts of underlying lacustrine deposits, identified at Ossówka (L. Lindner *et al.*, 1990) and at Hrud I (L. Lindner *et al.*, 1991). In the vicinity of these sites, kame terraces occur on slopes of melt-out basins, while kame and dead-ice moraine hills, 2–4 m in height, jut out from the plateau surface. They are built of vari-grained sands and gravels with intercalations of silts and flow till. They originated in course of fluvio- and limnoglacial accumulation between disappearing dead-ice blocks, persisting in axial parts of melt-out basins, and on slopes of these basins built of sandy deposits representing outwash levels, exposed from underneath the ice.

North of the Konstantynów–Klonowica line, that is on the northern (inner) side of partly preserved series of terminal moraines a more intense postglacial morphology is present. Apart from flat areas of the plateau composed of till, a lowermost (third) and more dismembered outwash level occurs, reaching up to 147–152 m a.s.l. It is delimited from the north-east by dead-ice moraine forms grouped in the Hrud–Janów Podlaski region (Fig. 1). Beneath this level, mainly in the Krzywula River valley, kame terraces indicating the youngest deglaciation occur. This area bears a well developed system of suprainundation terraces and flood plains of the Czyżówka River drainage basin, passing into surfaces of similar terraces in the valley of Bug River (Fig. 1).

The geological cross-section (Fig. 2) worked out for the area shows that the Quaternary substrate investigated with drillings occurs at the depth of 30–80 m (130–50 m a.s.l.) and is characterized by gravels with sand and glauconite and by Oligocene silts and clays (layer 2 on Fig. 2), as well as white chalk of Senonian age (layer 1) logged in the Bug River valley, occurring at the depth of 90 m (about 40 m a.s.l.). In the Bug River valley zone, the pre-Quaternary surface composed of the described Oligocene deposits is erosionally cut by a valley depression infilled with the pre-Pleistocene (without Scandinavian material) silts and quartz sands, and gravels with intercalations of clays (layer 3) up to 20 m thick. Between Janów Podlaski and Hrud this surface forms distinct depressions and culminations generated in course of later glacial eversion, erosion and glaciotectionic processes associated with the presence of the Pleistocene ice-sheets.

Sediments attributable to the Narevian and Nidanian Glaciations and subsequent interglacials (Podlasiian and Malopolanian) have not been recognized in the region, as opposed to the vicinity of Biała Podlaska (L. Lindner, 1988). Till corresponding to the Sanian 1 Glaciation is believed to be the oldest Pleistocene deposit. The till (layer 4) reaches 15–20 m in thickness and occurs in a depression within Oligocene deposits in the region of Klonowica, about 60–80 m a.s.l. J. Nitychoruk (1996) considers it the equivalent of the Nidanian Glaciation. Similarly to its substrate, in the Janów Podlaski area the till is cut by an ancient valley form, infilled with vari-grained sands with gravel and silt intercalations (layer 5), up to 40 m thick in total. Most probably these sediments characterize ancient fluvial series of the Ferdynandovian In-

terglacial. According to J. Nitychoruk (1996) they can represent the Malopolanian Interglacial.

Directly younger deposits are represented by ice-dam silts and clays (layer 6), up to 20 m thick, and by overlying till (layer 7), from 2 to 30 m thick. Till occurs at the depth of 20–35 m and forms an almost continuous horizon. Between Ossówka and Klonowica it is overbuilt by glaciotectionically disturbed vari-grained sands with fine gravel (layer 8), several metres thick, and in the region of Ossówka by ice-dam (lacustrine?) clays (layer 9), at least 2 m thick. Due to the presence of overlying lacustrine deposits with palynologic data pointing to the Mazovian Interglacial (see K. M. Krupiński *et al.*, 1995a, b), these sediments are believed to represent the Sanian 2 Glaciation. It cannot be excluded, however, that they characterize merely the beginning of the Mazovian Interglacial. In the vicinity of Klonowica and Janów Podlaski, J. Nitychoruk (1996) interprets them as the equivalent of the Sanian 1 Glaciation.

In the Bug River valley zone the creation of a valley form is related with the initial part of the Mazovian Interglacial. The valley is infilled with gravels and sands up to 5 m thick (layer 10), which probably underwent tectonic dislodging in the middle and younger part of the interglacial (M. D. Baraniecka, 1975; J. Nitychoruk, 1994). In the area of Hrud and Ossówka the above mentioned lacustrine deposits of this interglacial were accumulated, and are represented by gyttja and lake marl (layer 11) up to 20 m thick. In the Ossówka site K. M. Krupiński (1995b, 1996b) noted a continuous sedimentation of these sediments likewise during the younger climate cooling, which he connected with the Odranian Glaciation. The cooling was characterized by several climatic oscillations of stadial(?) and interstadial(?) range and is represented by gyttja and lake marl (layer 12), several metres thick in the region of Ossówka, and by silts and carbonate dust (gyttja?) (layer 13), up to 60 m thick in the Bug River valley region. In this region, according to J. Nitychoruk (1996), the climatic cooling corresponded to the Sanian 1 Glaciation. L. Lindner (1988, 1996) suggests it characterizes an early glacial of the Livicic Glaciation, during which the Scandinavian ice-sheet did not advance on the investigated area. During the greatest advance of the ice-sheet, lacustrine sedimentation possibly terminated and extraglacial valley flows (river, outwash?) emerged in its place, the remains of which are sands with gravel (layer 14) noted in the area of Ossówka as well as Janów Podlaski, where they reach up to 2–6 m in thickness.

According to L. Lindner (1988), the succeeding climatic warming took place during the Zbójnian Interglacial. Once more lake reservoirs were created in the area, where clays and silts accumulated (layer 15), from several tens of centimetres in thickness in the Ossówka area to 20 m near Janów Podlaski.

The period of the younger, and at the same time the last in the area occurrence of the Scandinavian ice-sheet is connected with the sedimentation of sands with gravel (layer 16) underlying till in the area of Janów Podlaski, with glaciotectionic deformations of previously deposited lacustrine and fluvio-glacial deposits and the youngest till (layer 17). The till is characterized by a varying thickness, from several centimetres in the Ossówka area up to 20 m in Klonowica. In many places, particularly above underlying lacustrine deposits it

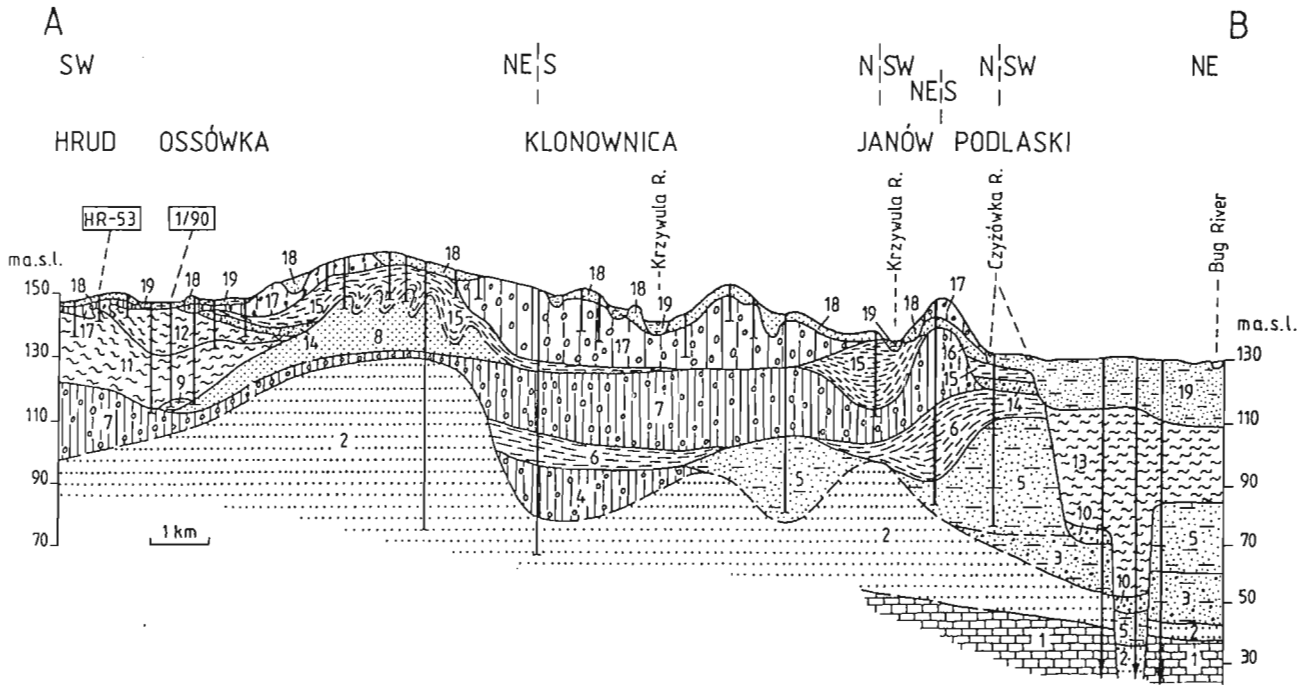


Fig. 2. Geological cross-section A-B in Quaternary deposits between Hrud and Janów Podlaski (see Fig. 1), based on archive and authors data as well as papers by J. Nitychoruk (1994) and K. M. Krupiński (1996a)

Cretaceous (Senonian): 1 — white chalk; **Tertiary (Oligocene):** 2 — gravels with sand and glauconite and silts and clays; **pre-Pleistocene:** 3 — silts and quartz sands and gravels with intercalations of clays; **Pleistocene:** **Sanian 1 Glaciation:** 4 — till; **Ferdynandovian Interglacial:** 5 — vari-grained sands with gravel and silt intercalations (fluvial?); **Sanian 2 Glaciation:** 6 — silts and clays (ice-dam), 7 — till, 8 — vari-grained sands with fine gravel (fluvioglacial?), 9 — clays (ice-dam, lacustrine?); **Mazovian Interglacial:** 10 — gravels and sands (fluvial), 11 — gyttja and lake marl; **Liviecian(?) Glaciation:** 12 — gyttja and lake marl, 13 — silts and carbonate dust (gyttja?), 14 — sands with gravel (fluvial, outwash?); **Zbójnian Interglacial(?):** 15 — clays and silts (lacustrine); **Odranian (Wartanian?) Glaciation:** 16 — sands with gravel (fluvioglacial?), 17 — till, 18 — sands, gravels and silts (fluvioglacial); **Lubavian Interglacial-Holocene:** 19 — sands, gravels, silts, muds and peats in river valleys and side watercourses; 1/90 — section with palynologic data (see K. M. Krupiński, 1995a); HR-53 — section with palynologic data (see L. Lindner *et al.*, 1991)

Przekrój geologiczny A-B przez osady czwartorzędowe między Hrudem a Janowem Podlaskim (patrz fig. 1), na podstawie materiałów archiwalnych i autora oraz prac J. Nitychoruka (1994) i K. M. Krupińskiego (1996a)

Kreda (senon): 1 — kreda piaszcząca; **trzeciorzęd (oligocen):** 2 — żwiry z piaskiem i glaukonitem oraz mułki i ily; **preplejstocen:** 3 — pyły i piaski kwarcowe oraz żwiry z wkładkami itów; **plejstocen:** **złodowacenie sanu 1:** 4 — glina zwałowa; **interglacjał ferdynandowski:** 5 — piaski różnoziarniste ze żwirem i wkładkami mułków (rzeczne?); **złodowacenie sanu 2:** 6 — mułki i ily (zastoiskowe), 7 — glina zwałowa, 8 — piaski różnoziarniste z drobnym żwirkiem (fluwioglacialne?), 9 — ily (zastoiskowe, jeziorne?); **interglacjał mazowiecki:** 10 — żwiry i piaski (rzeczne), 11 — gytia i kreda jeziorna; **złodowacenie liwca (?)**: 12 — gytia i kreda jeziorna, 13 — mułki i pyły węglanowe (gytia?), 14 — piaski ze żwirem (rzeczne, sandrowe?); **interglacjał zbójnowski(?)**: 15 — ily i mułki (jeziorne); **złodowacenie odry (wartu?)**: 16 — piaski ze żwirem (fluwioglacialne?), 17 — glina zwałowa, 18 — piaski, żwiry i mułki (fluwioglacialne); **interglacjał lubawski-holocen:** 19 — piaski, żwiry, mułki, namuły i torfy w dolinach rzecznych i ciekach bocznych; 1/90 — profil objęty badaniami palinologicznymi (K. M. Krupiński, 1995a); HR-53 — profil objęty badaniami palinologicznymi (L. Lindner *et in.*, 1991)

lacks completely or occurs in form of residual lag. The till is covered by fluvioglacial deposits of varying thickness, represented by sands, gravels and silts (layer 18), composing kames, dead-ice moraines, outwash horizons and kame terraces preserved on the surface (Fig. 1). The till and fluvioglacial deposits can be connected with the Odranian Glaciation,

although they are also related to the Wartanian Glaciation (L. Lindner, 1996). Deposits younger from this glaciation are represented by sands, gravels, silts, muds and peats (layer 19) occurring mainly in the valleys. Their accumulation began in the interglacial following the Odranian and/or Wartanian Glaciations, and terminated in the Holocene.

KOMARNO REGION

This region is characterized by a postglacial plateau built of till of the last in the area glaciation (Odranian and/or Wartanian) and Komarenka River valley cutting it, which utilises a system of melt-out basins with kame terraces on

slopes (Fig. 1). The region is situated in the forefield of the mentioned terminal moraines and includes several kames and dead-ice moraines situated on the till.

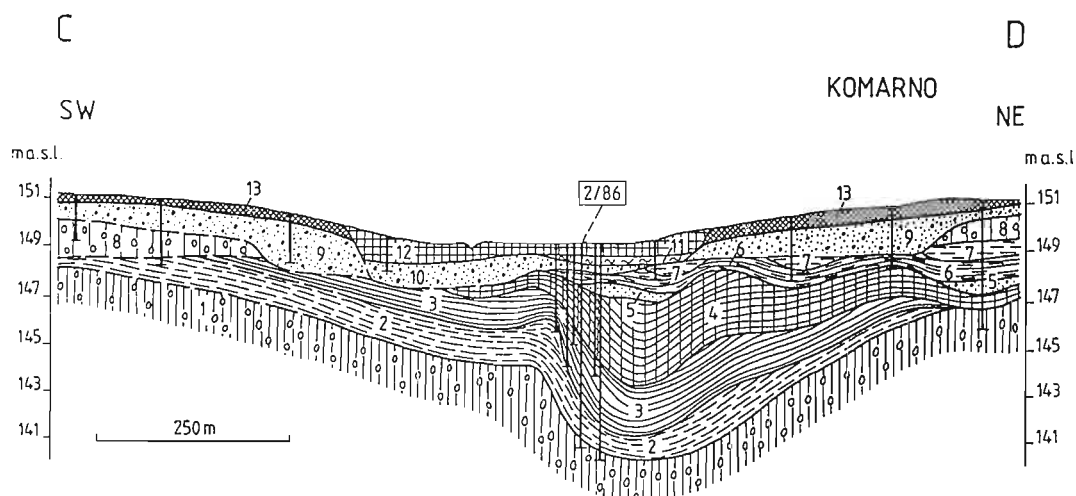


Fig. 3. Geological cross-section C-D in subsurface Quaternary deposits in the Komarno region after L. Lindner *et al.* (1988), with modifications (see Fig. 1)

Sanian 2 Glaciation: 1 — till; **Mazovian Interglacial:** 2 — grey silts, 3 — bituminous shales, 4 — shaly peats; **Liviecian Glaciation:** 5 — sands with gravel (fluvial, outwash?); **Zbójnian Interglacial:** 6 — clays (lacustrine), 7 — clayey silts (lacustrine?); **Odranian (Wartanian?) Glaciation:** 8 — till, 9 — sands with fine gravel and small boulders (fluvioglacial); **Lubavian Interglacial-Vistulian Glaciation:** 10 — sands with fine gravel and small boulders; **Holocene:** 11 — peaty silts, 12 — peats, 13 — recent soil; 2/86 — section with palynologic data (K. M. Krupiński, L. Lindner, 1991)

Przekrój geologiczny C-D przez przypowierzchniowe osady czwartorzędowe w rejonie Komarna według L. Lindnera i in. (1988), nieco zmieniony (patrz fig. 1)

Zlodowacenie sanu 2: 1 — glina zwałowa; **interglacja mazowiecki:** 2 — mułek szary, 3 — łupek bitumiczny, 4 — torf łupkowany; **zlodowacenie liwca:** 5 — piasek ze żwirkiem (rzeczny, sandrowy?); **interglacja zbójnowski:** 6 — il (jeziorny), 7 — mułek ilasty (jeziorny?); **zlodowacenie odry (warty?):** 8 — glina zwałowa, 9 — piasek z drobnym żwirkiem i gładzikami (fluwioglacjalny); **interglacja lubawski-zlodowacenie wisły:** 10 — piasek z drobnym żwirkiem i gładzikami; **holocen:** 11 — mułek torfiasty, 12 — torf, 13 — współczesna gleba; 2/86 — profil objęty badaniami palinologicznymi (K. M. Krupiński, L. Lindner, 1991)

Boreholes and based on them geological cross-section (Fig. 3) indicate that the subsurface of the area is built of lacustrine deposits with intercalations of sands with gravel, occurring between two tills (L. Lindner *et al.*, 1988). The older till (layer 1 on Fig. 3), probably representing the Sanian 2 Glaciation, was not drilled through. It is covered by grey silts (layer 2) and bituminous shales (layer 3) as well as shaly peats (layer 4), characterizing the Mazovian Interglacial and the subsequent interstadial climatic warming and post-interstadial cooling (K. M. Krupiński, L. Lindner, 1991). The overlying sands with gravel (layer 5) is connected with the extraglacial river (outwash?) accumulation during the Liviecian Glaciation, while covering clays (layer 6) and clayey silts (layer 7) are located within the Zbójnian Interglacial.

All the mentioned sediments, the lacustrine series in particular, bear glaciotectionic deformations (L. Lindner *et al.*,

1988; E. Myślińska, 1988) caused by a later ice-sheet of the Odranian and/or Wartanian Glaciation, the remnant of which is the younger till (layer 8). In marginal zones of the subsequent melt-out basin the till was removed most probably already during this glaciation by coexistent fluvioglacial flows, determining the accumulation of the above mentioned kame terraces composed of sands with fine gravel and small boulders (layer 9). Remains of till and sands occurring above were removed from the axial part of the melt-out basin by a younger valley flow persisting probably from the Lubavian (= Lublinian) Interglacial to the Vistulian Glaciation. This is testified by a following younger series of sands with fine gravel and small boulders (layer 10). The whole Quaternary sedimentation sequence in the region is terminated by peaty silts (layer 11) and overlying peats (layer 12) of Holocene age.

PAWŁÓW NOWY REGION

A postglacial plateau occurs in the area, cut by the lower section of Czyżówka River valley and its tributary Komarenka River (Fig. 1). Geomorphologic forms typical for the Janów Podlaski area extend within this plateau. A vast plateau lobe reaching 147–159 m a.s.l., overbuilt with low accumulation hills of terminal moraines of the Klonowica-Konstanty-

nów series occurs to the west of the river junction. To the north of the Czyżówka River valley, areas of till occurrence are present. The till is overbuilt with fluvioglacial deposits of the third outwash level and irregular elevated kame and dead-ice moraine forms. Within the described plateau a vast melt-out basin occurs near Pawłów Nowy, related to disappearance of

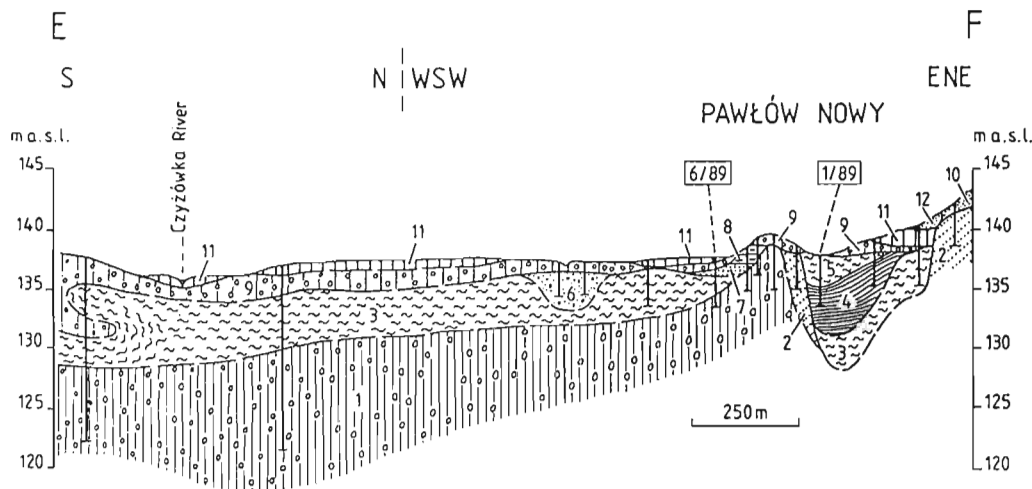


Fig. 4. Geological cross-section E-F in subsurface Quaternary deposits in the Pawłów Nowy region after J. Nitychoruk (1994), with modifications (see Fig. 1)

Sanian 2 Glaciation: 1 — till, 2 — vari-grained sands (fluvioglacial); **Mazovian Interglacial:** 3 — gyttja, 4 — bituminous shales, 5 — gyttja; **Liviecian Glaciation(?)**: 6 — sands with gravel (fluvial, outwash?), 7 — medium-grained sands (fluvial, outwash?); **Zbójnian Interglacial:** 8 — clays (lacustrine); **Odranian (Wartanian?) Glaciation:** 9 — till, 10 — medium- and coarse-grained sands (fluvioglacial); **Holocene:** 11 — peats and muds, 12 — sands and silts (deluvial); 6/89 and 1/89 — sections with palynologic data (K. M. Krupiński, 1996c)

Przekrój geologiczny E-F przez przypowierzchniowe osady czwartorzędowe w rejonie Pawłowa Nowego według J. Nitychoruka (1994), nieco zmieniony (patrz fig. 1)

Złodowacenie sanu 2: 1 — glina zwałowa, 2 — piasek różnoziarnisty (fluwiogłacialny); **interglacjał mazowiecki:** 3 — gytia, 4 — łupki bitumiczny, 5 — gytia; **złodowacenie liwca (?)**: 6 — piasek ze żwirami (rzeczny, sandrowy?), 7 — piasek średnioziarnisty (rzeczny, sandrowy?); **interglacjał zbójnowski:** 8 — ily (jeziorne); **złodowacenie odry (warty?)**: 9 — glina zwałowa, 10 — piasek średnio- i gruboziarnisty (fluwiogłacialny); **holocen:** 11 — torfy i namuty, 12 — piaski i mułki (deluwialne); 6/89 i 1/89 — profile objęte badaniami palinologicznymi (K. M. Krupiński, 1996c)

a dead-ice block left by the ice-sheet of the Odranian and/or Wartanian Glaciation. The basin is partly drained by the Czyżówka River system. In the Czyżówka and Komarenka rivers valleys and in the section of the Bug River valley presented on the geomorphologic-geologic sketch (Fig. 1), a well developed suprainundation terrace occurs, 2–3 m in height and with a surface modelled during the Vistulian Glaciation, and an underlying Holocene flood plain with bottoms of tributary rivers flowing onto it.

With the help of data from logs within the largest melt-out basin, a geological cross-section was worked out for subsurface Quaternary deposits of the region (Fig. 4). Data collected this way, particularly palynologic data from lacustrine deposits (K. Bińka *vide* J. Nitychoruk, 1994; K. M. Krupiński, 1996c), point to a similar succession of sedimentation series in the Pawłów Nowy region like the case of a melt-out basin near Komarno.

The oldest noted deposits in the Pawłów Nowy region are represented by till (layer 1 on Fig. 4) and overlying vari-

grained sands (layer 2). They correspond to the Sanian 2 Glaciation due to their direct covering by lacustrine deposits of the Mazovian Interglacial (K. Bińka *vide* J. Nitychoruk, 1994; K. M. Krupiński, 1996c): gyttja (layer 3), bituminous shales (layer 4) and gyttja again (layer 5). Sands with gravel (layer 6) and medium-grained sands (layer 7) are younger than this series and connected with an extraglacial river (outwash?), flowing during the Liviecian Glaciation. The overlying clays (layer 8) are probably connected with a re-creation of a water reservoir during the Zbójnian Interglacial. In the Pawłów Nowy region all the mentioned deposits are overlain by an almost continuous till (layer 9) from the Odranian and/or Wartanian Glaciation. Accumulation of medium- and coarse-grained sands (layer 10) in the northern part of the presented section and composing a part of the third outwash level is also connected with this glaciation. The youngest Quaternary deposits in this region are peats and muds (layer 11), and deluvial sands and silts (layer 12) of the Holocene age.

RECAPITULATION

Presented data (Fig. 5) entitle to emphasise that in the vicinity of Janów Podlaski the pre-Pleistocene (preglacial) deposits and a younger till corresponding probably to the

Sanian 1 (= Elsterian I) Glaciation occur. Due to glacial erosion, the ice-sheet of this glaciation removed tills of the older glaciations (Narevian and Nidanian) and the covering

interglacial deposits (Podlasiian and Malopolanian), preserved in the vicinity of Biała Podlaska (L. Lindner, 1988). Its equivalent in the neighbouring area of Belarus was the ice-sheet of the Servech Glaciation (L. N. Voznyachuk, 1985) and more to the east — of the Don Glaciation (V. A. Zubakov, I. I. Borzenkova, 1990). Deposits of this glaciation are overlain by fluvial(?) deposits, represented by sands with gravel and intercalations of silts, located at the position of the Ferdynandovian (= Voigtstedt) Interglacial, which corresponds to the Bielovezha Interglacial in Belarus (L. N. Voznyachuk, 1985). They are covered by ice-dam silts and clays, overlying till and fluvioglacial(?) sands with fine gravel, probably representing the Sanian 2 (= Elsterian II) Glaciation. In Belarus it corresponds to the Berezina Glaciation (L. N. Voznyachuk, 1985), and in the Russian Plain — to the Oka Glaciation (V. A. Zubakov, I. I. Borzenkova, 1990).

In four sites with palynologic data (Hrud I, Ossówka, Komarno, Pawłów Nowy) the sediments of this glaciation are overlain by lacustrine series representing the Mazovian (= Holstein) Interglacial and an early glacial of the Liviecian (= Fuhne) Glaciation, which correspond in Belarus to the Aleksandriya Interglacial and the Kopysk Glaciation (L. N. Voznyachuk, 1985), and to the Likhvin Interglacial and the Kaluga Glaciation in the Russian Plain, respectively (V. A. Zubakov, I. I. Borzenkova, 1990). Sands with gravel pointing to extraglacial fluvial accumulation (outwash?) during the maximum advance of the ice-sheet of the Liviecian (= Fuhne = Kopysk = Kaluga) Glaciation occur above them, overlain again by lacustrine series representing a climatic warming within the Zbójnian (= Dömnitz) Interglacial. Its equivalent in Belarus is the Grodno Interglacial (L. N. Voznyachuk, 1985), and in the Russian Plain — the Chekalin Interglacial (V. A. Zubakov, I. I. Borzenkova, 1990).

The above mentioned deposits are covered by glaciofluvial sediments and more or less preserved till or its lag and younger glaciofluvial deposits. Presented data prove that they represent the last in the area Scandinavian glaciation. Occurrence of these sediments directly above mentioned lacustrine series points out to their correspondence with the Odranian (= Drenthe) Glaciation, the equivalent of which to the east of Bug River is the Dnieper Glaciation (L. N. Voznyachuk, 1985; V. A. Zubakov, I. I. Borzenkova, 1990). Nevertheless, taking into account TL-datings of this till at Hrud I site at 161–174 ka (L. Lindner *et al.*, 1991) and at Ossówka site at 163–168 ka (J. Nitychoruk, 1994) it can be declared that the till could come from the Wartanian Glaciation correlated with the Sozh Glaciation in Belarus (L. N. Voznyachuk, 1985) and with the

		CLIMATOSTRATIGRAPHIC UNITS		SEDIMENTARY ENVIRONMENTS		
		GLACIATIONS	INTERGLACIALS			
QUATERNARY	U.P.L.			HOLOCENE	deluvial fluvial and mire (flood plain)	
		VISTULIAN			fluvial and periglacial (suprainudation terraces)	
				EEMIAN	fluvial	
	MIDDLE PLEISTOCENE	Middle-Polish Glaciations	WARTANIAN		LUBAVIAN	glaciofluvial, glacial ice-lake
			ODRANIAN			
		South-Polish Glaciations	ZBÓJNIAN		Great Interglacial	lake and/or mire fluvial(?)
			LIVIECIAN			fluvial and/or glaciofluvial lake and ice-dammed
	L.P.L.	South-Polish Glaciations	MAZOVIAN		Great Interglacial	lake and mire fluvial
			SANIAN 2			glaciofluvial and ice-lake glacial, ice-lake
		Middle-Polish Glaciations	FERDYNANDOVIAN			fluvial
			SANIAN 1			glacial
			NIDANIAN		MAŁOPOLANIAN	hiatus
		PODLASIAN				
		NAREVIAN				
		PRE-PLEISTOCENE			fluvial	

Fig. 5. Stratigraphy of Quaternary deposits in the vicinity of Janów Podlaski
L. PL. — Lower Pleistocene, U. PL. — Upper Pleistocene
Stratygrafia osadów czwartorzędowych w okolicy Janowa Podlaskiego
L. PL. — dolny plejstocen, U. PL. — górny plejstocen

Moscow Glaciation in Russia (V. A. Zubakov, I. I. Borzenkova, 1990). A similar point of view was presented several years ago by J. Nowak (1973, 1974, 1977), who saw in this till an equivalent of the distinguished at that time Mazovian-Podlasiian (= Wartanian) Stadial. Lack of the Odranian Glaciation till could be explained by its removal by the ice-sheet of the Wartanian Glaciation (stadial) or by contemporary meltwaters (outwash). Upper parts of lacustrine deposits correlated with the Zbójnian Interglacial have been also subjected to glacial erosion.

The younger Quaternary is documented in the area by deposits of suprainudation terraces, the accumulation of which began during the Eemian (= Mikulino) Interglacial and terminated in the extraglacial conditions of the Vistulian (= Valdaj) Glaciation and by the Holocene deposits of flood plains and bottoms of the tributaries.

Translated by Anna Żylińska

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SYTUACJA GEOMORFOLOGICZNA I GEOLOGICZNA OSADÓW CZWARTORZĘDU W OKOLICY JANOWA PODLASKIEGO (WSCHODNIA POLSKA)

Streszczenie

Na udokumentowanych przykładach (fig. 1–5) wykazano, że w rejonie Janowa Podlaskiego (wschodnia Polska) starszy czwartorzęd reprezentują osady preglacjalne (preplejstoceniowe) odznaczające się brakiem materiału skandynawskiego, leżące na utworach oligocenu i kredy górnej. Osady te korespondują z utworami poziomu daumantaj w zachodniej części Równiny Rosyjskiej. Wyżej występuje glina zwałowa pozostawiona przez łądół skandynawski zapewne w czasie zlodowacenia sanu 1 (= elstery I, serweckiego). łądół ten w wyniku procesów egzarcacyjnych doprowadził do usunięcia glin zwałowych starszych zlodowaceń (narwi i nidy) oraz przykrywających je osadów interglacjalów podlaskiego (= augustowskiego) i małopolskiego, zachowanych w rejonie Białej Podlaskiej. Jego glina zwałowa leży poniżej osadów rzecznych odniesionych do interglacjalu ferdynandowskiego (= voigtstedt, białowieskiego) przykrytych gliną zwałową korelowaną ze zlodowaceniem sanu 2 (= elstery II, berezyny). Osady tego zlodowacenia w

zbudanych palinologicznie stanowiskach (Hrud I, Ossówka, Komarno, Pawłów Nowy) są przykryte serią jeziorną reprezentującą interglacjal mazowiecki (= holsztyński, aleksandryjski) i wczesny glacial zlodowacenia liwca (= fuhne, kopyskiego). Nad nimi występują osady rzeczne (sandrowe?) akumulowane w warunkach ekstraglacialnych tego zlodowacenia, a wyżej ponownie seria jeziorna ułokowana w pozycji wiekowej interglacjalu zbójnowskiego (= dömnitz, grodzieńskiego). Wspomniane osady przykryte są najmłodszą w tym rejonie serią glacialną (lub jej rezydium) zlodowacenia odry (= drenthe, dniewprowskiego) i/lub warty (= sońskiego, moskiewskiego). Młodszy czwartorzęd stanowią zachowane w dolinach rzecznych osady tarasów nadzalewowych, akumulowane w interglacjale cemskim (= mikulińskim) i w warunkach ekstraglacialnych zlodowacenia wisty (= waldajskiego), oraz osady holocenijskich tarasów zalewowych i w dnach dolin bocznych.