acta
geologica
polonica

Vol. 29, No. 1 Warszawa 1979

LESZEK LINDNER & MAREK PRÓSZYŃSKI

Geochronology of the Pleistocene deposits exposed at Wąchock, northern part of the Holy Cross Mts

ABSTRACT: The determinations of absolute age (by means of the thermoluminescence method) of the Pleistocene deposits exposed at Wąchock, northern part of the Holy Cross Mts, Central Poland, are presented. The oldest deposits, the sub-till fluvial sands, dated for 352 000 BP, represent the end of the Mazovian Interglacial (Mindel *II*/Riss *I*). Supra-till silts, dated for 245,000±45,000 BP deposited at the beginning of the Lublinian Interglacial (Riss *I*/Riss *II*). The overlying cover sands, dated for 142,550±3,650 BP, represent a younger part of the Vartanian Glaciation (Riss *II*). The loesses of the uppermost part of the section, dated for 42,000±1,500 BP, 24,087±2,587 BP, and 15,830±1,830 BP, are related to the Middle and the Late Vistulian (Würm) Glaciation.

INTRODUCTION

The paper presents an analysis of the Pleistocene deposits exposed in the south-western suburb of the town Wąchock in the northern part of the Holy Cross Mts, Central Poland. Their sequence, *c* 20 m thick, is exposed in a deep ravine that developed along a roadcut in Wąchock loessy patch, that stretches at the south-western side of the Kamienna river valley (Fig. 1).

In the fifties the walls of the ravine (10—15 m high) were investigated by Karaszewski but results of his studies besides a short report on the mammoth tooth finding (Karaszewski 1954) have never been published In 1977 during the Field Symposium *"Quaternary of the western part of the Holy Cross Region"*, the first of the present authors and his collaborators started with farther studies of these deposits (*cf.* Karaszewski, Konecka-Betley, Lindner & Prószyński 1977). The datings by means of the thermoluminescence method have been done by Doc. M. Prószyński in the Institute of Geology, University of Warsaw.

Acknowledgements. The authors are indebted to Doc. Dr. W. Karaszewski, Geological Institute of the Polish Geological Survey, for assistance during the works on the section; to Prof. Dr. K. Konecka-Betley, Agricultural Academy in Warsaw, for her advice, valuable suggestions on paleopedological problems, and for physico-chemical analyses of sediments; to Doc. Dr. R. Chlebowski, University of Warsaw, for analysis of heavy minerals; to W. Stańska-Prószyńska, "Hydrogeo" Enterprise, for her help in thermoluminescence analyses.

DESCRIPTION AND INTERPRETATION OF THE SECTION

The most complete succession of the Pleistocene deposits is exposed along the western wall of the ravine (Fig. 2). The sequence is supplemented by the strata pierced by shallow drills at the bottom of the ravine (marked by a dashed line in Fig. 2).

The vari-grained sands (layer *2* in Fig. 2) are the oldest Pleistocene deposits in the area, and they overlie the Rhaetian sandstones, siltstones and clays (layer *1* in Fig. 2). These sands form the top part of fluvial sediments of the pre-Kamienna valley, and are overlain by varved clays and the till. On the basis of age determinations by the thermoluminescence method, they seem to belong to alluvial deposits of the pre-Kamienna River of Mazovian Interglacial age (Mindel *II*/Riss *I*). The overlying varved clays (layer *3* in Fig. 2), indicate the formation of a shallow proglacial lake situated close to Wąchock. The lake was formed due to plugging the river outflow within the pre-Kamienna valley by the southwardly advancing icesheet of the Odranian (Riss *I*) Glaciation.

The overlying till (layer *4* in Figs 2 and 3), is changeable in lithology. In the north-eastern, lower part of the ravine, the till is brown-grey, homogeneous and contains boulders of Scandinavian and local rocks. It can be defined as a melt-out till (*cf*. Boulton 1976, Lindner & Ruszczyńska-Szenajch 1977). In the south-western, upper part of the ravine where the Rhaetian rocks occur close to the

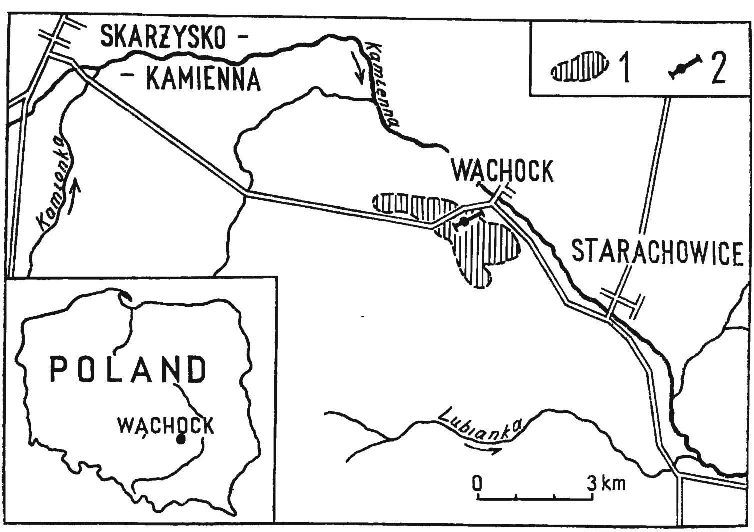


Fig. 1. Situation sketch of the Wąchock section
1 patch of loessy sediments, *2* line of geological cross-section (*cf*. Text-fig. 2) and position of the investigated exposure (*cf*. Text-fig. 3)

surface, the till contains bands either stained by cherry-colored Lower Rhaetian clays or containing a greater content of boulders and blocks of Rhaetian sandstones. All these streaks and inserts as well as the boulder and block arrangement emphasize an original structure of the lodgement-type till (*cf.* Boulton 1976, Lindner & Ruszczyńska-Szenajch 1977).

A determination of absolute age of the sub-till sands for the end of the Mazovian Interglacials as well as age determinations of the overlying sediments suggest that the till was deposited by the icesheet of the Odranian (Riss *I*) Glaciation. Thus, opinions of Karaszewski (*in*: Galon & Roszkówna 1961), Łyczewska (1971) and Kosmowska-Suffczyńska (1972) are supported: the icesheet of this age passed across the Kamienna valley and advanced further south than it was previously believed (*cf.* Sawicki 1921, Samsonowicz 1925, Bartosik 1970, Różycki 1972).

In the south-western, upper part of the Wąchock ravine, at the top of the till layer, there occur sands with an insert of silt and clay (layer *5* in Figs 2 and 3). The sands have been deposited in a marginal part of the proglacial lacustrine basin formed in the Kamienna valley during deglaciation at the end of the Odranian Glaciation. The basin could therefore exist even at the beginning of the Lublinian Interglacial (Riss *I*/Riss *II*) that divided the Riss (Middle-Polish, Dnieper, Saale) Glaciation into two units.

A climatic cooling during the Lublinian Interglacial, probably in its middle part, caused a slope displacement of the lacustrine deposits (layer *5*) and a slope deposition of the overlying till (layer *6* in Figs 2 and 3). A following climatic warming in the younger part of this interglacial and the resulting stoppage of solifluction, are suggested by the occurrence of a boulder-rubble cover with sand (layer *7* in Figs 2 and 3); it contains Triassic sandstone blocks and Scandinavian boulders. A composition and extent of the layer is similar to the residuum of the washed, underlying till. Quite a considerable thickness of the pavement and a rubble content allows to suppose its partial, at least, slope displacement and a resulting enrichment in waste material of Triassic rocks that outcrop a bit higher. It also seems that the deposition of the layer *7* had lasted until it was covered by structureless sands with dust and boulder (layer *8* in Figs 2 and 3). The top part of the latter was then enriched in humus due to formation of younger soils (layer *9*).

The sands of layer *8* form a cover that originated in periglacial conditions when an aeolian abrasion of boulders within the sands took also a place. The mineral composition of the heavy fraction of sands supports their genetic connection with the underlying deposits (Fig. 3). The age of the sands, determined by the thermoluminescence method, allows to refer their deposition to a younger part of the Vartanian (Riss *II*) Glaciation. At that time the Scandinavian icesheet reached the areas several dozen kilometres north of Wąchock.

Subsequently, the sands became a substrate for soil processes. The latter are marked not only by an accumulative horizon with charcoals (layer *9* in Figs 2 and 3) but also by a well developed illuvial horizon in the upper part of layer *8*. The both discussed horizons display, according to Professor K. Konecka-Betley (*in*: Kraszewski & *al.* 1977), features of a well developed soil that is known from many loessy sections of the Central Polish Uplands (*cf.* Straszewska & Mycielska 1961, Grabowska-Olszewska 1963, Jersak 1965, Lindner 1967, Klatka 1970) and is referred to the Eemian Interglacial, and to the soil processes of the Brørup Interstadial (*cf.* Jersak 1973, Konecka-Betley & Straszewska 1977).

The accumulative horizon of the soil (layer *9* in Figs 2 and 3) is grey with a brown shade and its thickness is up to 30 centimetres. The underlying traces of ferruginization and gleization typical of the illuvial horizon of the soil (upper part of layer *8*) have been formed due to irregular infiltration of water and partial oxidation of iron. Granulometric analyses (Fig. 3) prove that the soil developed in sands with a large dust content (over 30%) and with a slight admixture of colloidal particles. Thus, in the final period of soil development the rainwaters played the most important role in the formation of soil structure. Among physical and chemical properties this influence is marked by a decalcification, very small content of colloidal particles and not overmuch concentration of iron. Certain agglomeration of iron just above the layer 7 is caused by a specific mode of water infiltration into this layer, containing up to 40% of fraction with a diameter over 1 mm. A relatively small amount of carbon in the soil proves a predominance of mineralization processes of organic matter over humification processes in the last period of soil formation, i.e. before the deposition of the overlying Würm loess (Karaszewski & *al.* 1977).

The palaeosol is covered by a loess bed, intensively gleizated at the top and with a humus band (layers *10* and *11* in Figs 2 and 3). This layer is the oldest loess in the section, superposed by younger soil processes. Previously (*cf.* Karaszewski & *al.* 1977), the deposition of this loess was referred to the so-called ascendant phase of the Würm, and the superposed soil processes were connected with the Brørup Interstadial. On the basis of thermoluminescence age determinations of the overlying loess beds, the authors conclude that the oldest loess (layer

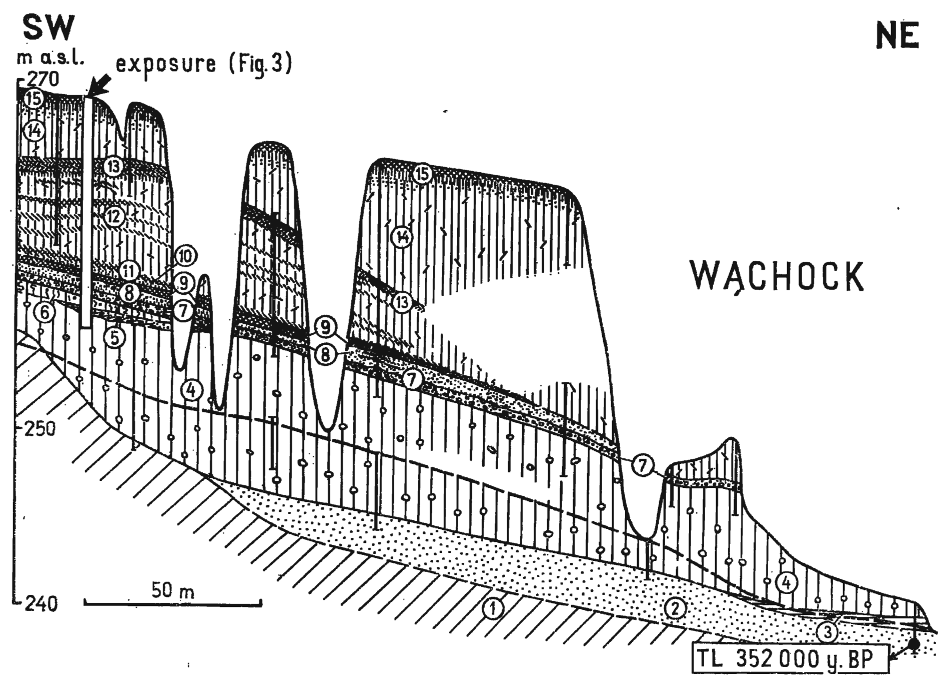


Fig. 2. Geologic section along the western wall of the Wąchock ravine; arrowed is the investigated exposure (*cf.* Text-fig. 3)

1 Rhaetian sandstones and siltstones

MAZOVIAN INTERGLACIAL: 2 vari-grained sands of fluvial accumulation

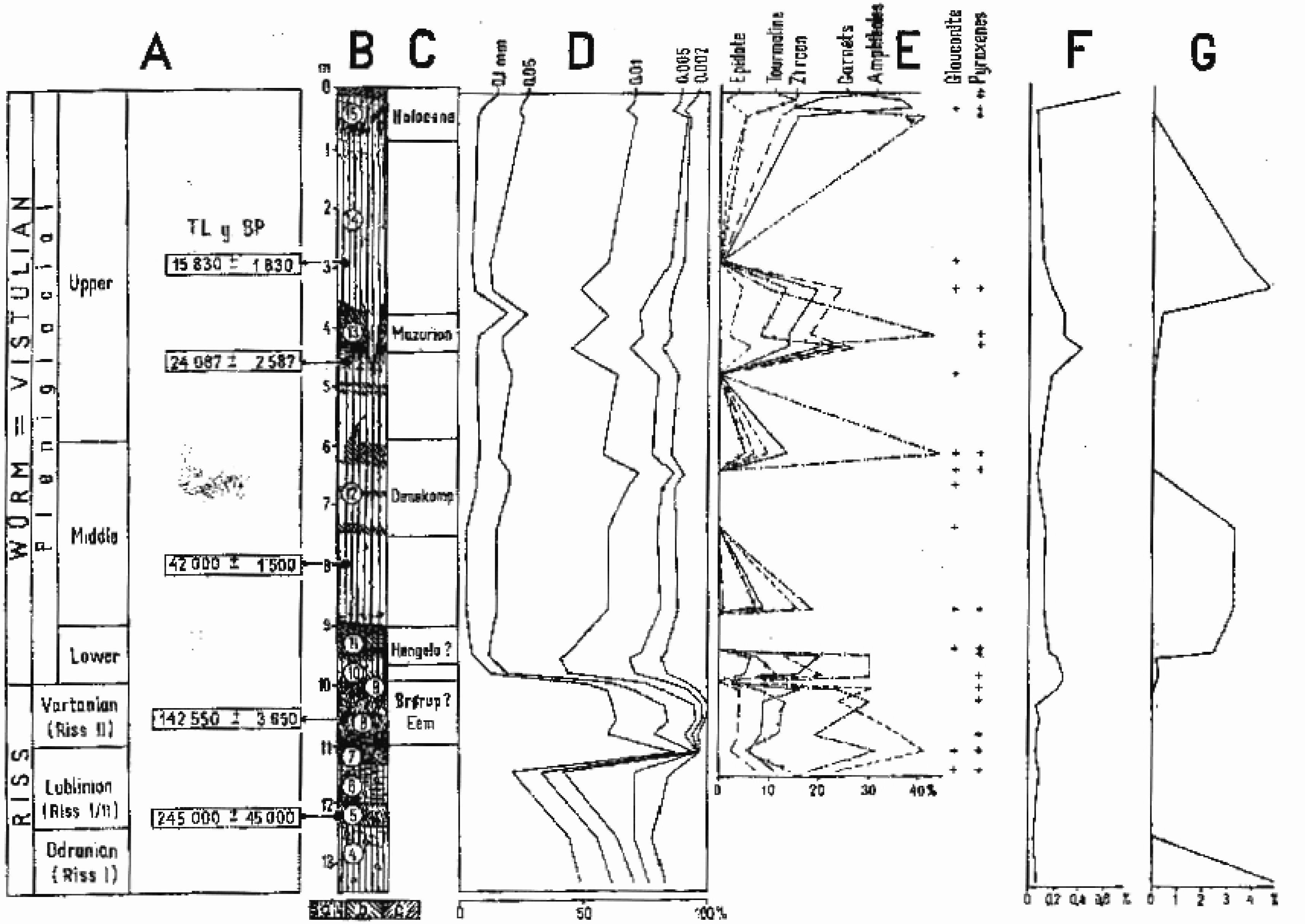
ODRANIAN GLACIATION: 3 varved clay, 4 till,

LUBLINIAN INTERGLACIAL: 5 sand with silt, soliflucted, 6 boulder clay of slope accumulation, 7 rubble-boulder pavement with sand

VARTANIAN GLACIATION: 8 vari-grained sands with dust and boulders, with a superposed accumulative horizon of a palaeosol (layer 9) of the Eemian Interglacial and the Brorup Interstadial

VISTULIAN GLACIATION: 10 younger loess *I* with a humus-gley horizon (layer 11), 12 younger loess *IIa* with a humus-gley horizon and a tundra palaeosol (layer 13), 14 younger loess *IIb*, 15 recent soil

Geologic sequence of Pleistocene deposits in the upper part of the Wąchock ravine (*cf.* Text-fig. 2)



A — stratigraphic position of deposits
B — sequence of the deposits: *a* layers of ferruginous concentration, *b* gley horizons, *c* humus horizons; *4—15* lithological members explained in Text-fig. 2
C — stratigraphic position of soil horizons, D — granulometric composition, E — more important heavy minerals, F — organic carbon content, G — calcium carbonate content

10) was deposited in the Lower Pleniglacial. The superposed, younger soil (layer *11*) should be referred to the Middle Pleniglacial (Interpleniglacial) that started with climatic warmings of the Hengelo Interstadial (Van der Hammen & *al.* 1967, 1971; Zagwijn 1974).

The overlying loess (layer *12* in Figs 2 and 3), dated by the thermoluminescence method in its lower part, represents an aeolian accumulation of the middle part of the Middle Pleniglacial (Interpleniglacial). The upper part of the Middle Pleniglacial is represented by three horizons of humus-gley processes (the yongest are the best developed) a formation of which was interrupted by deposition of thin loess inserts. The whole upper part of layer *12* can be referred to climatic warmings of the Denekamp Interstadial (Van der Hammen & *al.* 1967, 1971; Zagwijn 1974). The upper part of layer *12*, at the depth from 4.5 to 6.0 m, is represented by loess deposited in the lower part of the Upper Pleniglacial. Thermoluminescence age determination of this loess suggests that its deposition preceded the maximum extent of the icesheet of the Vistulian (Würm) Glaciation.

In the top part of the loess there is a distinct soil horizon (layer *13* in Figs 2 and 3) composed of several accumulative-gley horizons and more or less developed illuvial horizons. In the studied exposure, the loess is cut by an ice-wedge filled with the overlying loessy material. The soil horizon contains much organic carbon, it is deeply decalcified and includes more colloidal particles than the overlying layer. Age determinations of the top part of the underlying loess bed as well as of the bottom part of the overlying loess bed allow to refer the soil horizon to the Mazurian (Interstadial) Interphase (*cf.* Halicki 1960); of the same age there are also the basin deposits from Reszel surroundings in the Mazury Lakeland, dated by the radiocarbon method for 17,800±250 BP (Prószyński 1978).

The thermoluminescence age determination of the lower part of the overlying loess (layer *14* in Figs 2 and 3) allows to connect its deposition with the Pomeranian Phase of the Vistulian Glaciation. Within the loess, no distinct breaks in accumulation have been stated. Instead, in its top part (as at the top of layer *12*), an increase in the content of garnets, zircon, amphiboles and epidotes is recorded (Fig. 3). This fact, as well as an upward gradual increase of sand content and even an occurrence of sandy streaks, suggest that at the same time there was a blowing away of postglacial deposits and of waste of Liassic and Triassic sandstones as well an aeolian supply of this material into Wąchock loesses. The aeolian accumulation of this loess bed was stopped probably at the beginning of the decline of the Pomeranian Phase. In the Late Glacial, the erosive slope processes dominated, and in the Holocene, the filling-up of valleys by materials of loessy origin (Jersak 1977).

ATTEMPT OF CHRONOSTRATIGRAPHIC CORRELATION

The sequence of deposits exposed at Wąchock represents a considerable part of the Pleistocene and due to absolute age determinations it is one of the key chronostratigraphic localities of the Quaternary in Poland and allows a correlation of its members with similar ones in the neighbouring areas (Fig. 4).

The oldest deposits, the sub-till sands (layer *2* in Figs 2 and 3) dated for 352 000 BP, represent the Mazovian (Holstein, Likhvin) Interglacial. With reference to the subdivision of alluvial and organogenic deposits of this interglacial (Różycki 1964), and age determinations of the optimum of this interglacial for 320,000—440,000 BP (Głazek & *al.* 1976b) and of the early interglacial period as 400,000—440,000 BP (Prószyński 1978), it seems that these sands represent the Late Mazovian Interglacial, i.e. the climatic cooling that separates the climatic warmings of Barkowice Mokre and Witaszyn (*cf.* Fig. 4). In the European part of the Soviet Union this interglacial is dated by the thermoluminescence method for 460,000 to 318,000 BP (Zubakov 1974). A climatic warming dated in caves of northern England (Yorkshire Dales) by means of the uranium method for 350,000 +? BP should be also included into this interglacial,

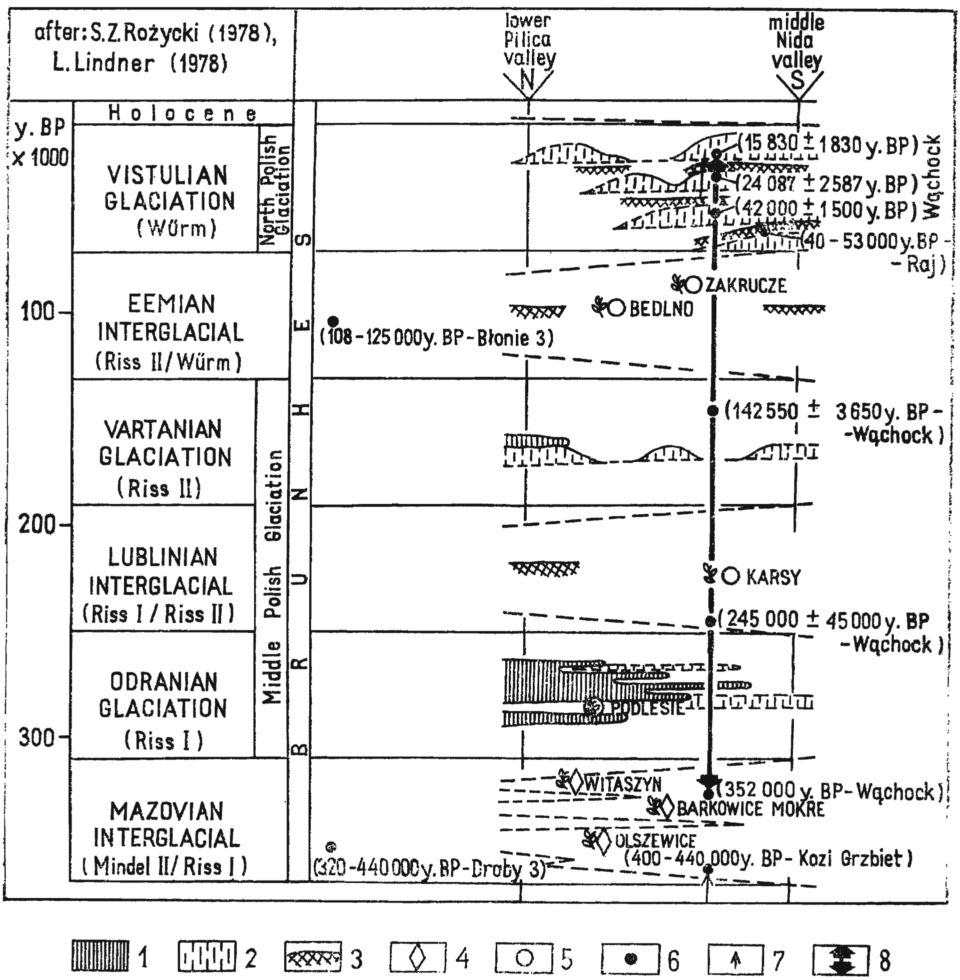


Fig. 4. Geochronologic dating of the Wąchock section on the background of Pleistocene sequence in the Holy Cross region

1 tills, *2* loesses, *3* palaeosols, *4* flora-bearing localities of the Middle Pleistocene, *5* flora-bearing localities of younger Pleistocene, *6* localities of absolute age determinations, *7* range upper part of the Kozi Grzbiet section (*cf.* Głazek & *al.* 1976a), *8* range of the Wąchock section and not into the Cromerian(?) Interglacial to which it was previously attributed (Waltham & Harmon 1977).

The younger chronostratigraphic unit, including the Odranian (Saale *1*, Dnieper) Glaciation is represented by varved clays (layer *3*) and overlying till (layer *4*). In the European part of the Soviet Union, deposits of this glaciation are dated by the thermoluminescence method for 290,000—250,000 BP (Zubakov 1974, 1978).

The Lublinian (Odincovo) Interglacial is represented by sands with a silt insert (layer *5* in Fig. 3) dated for 245,000±45,000 BP, and by the overlying slope till (layer *6*) and the pavement cover with sand (layer *7*). In Poland, the interglacial conditions of this time were suggested by Środoń (1969) for some floristic localities previously included into the Mazovian Interglacial. In the Holy Cross region, the climatic-floristic conditions of this interglacial were recognized in the locality Karsy near Ożarów (Kosmowska-Suffczyńska & Szczepanek 1979). In the European part of the Soviet Union, deposits of this interglacial are dated by the thermoluminescence method for 256,000±29,000 BP (Zubakov 1974, 1978). In northern England (Yorkshire Dales) an interglacial warming of this time is dated by the uranian method for 225,000±75/45,000 BP, and usually connected with the Hoxnian Interglacial (Waltham & Harmon 1977).

The Vartanian (Saale *2*, Moscow) Glaciation is represented by covering sands (layer *8*). The age determination for 142,550±3,650 BP suggests their formation in the younger part of this glaciation which is dated in the Soviet Union for 195,000±24,300 BP to 152,000±16,000 BP (Zubakov 1974, 1978).

The Eemian (Mikulino, Ipswichian) Interglacial and possibly also the Brørup Interstadial, are recorded by soil processes in layers *8* and *9*. This period has its dating by the thermoluminescence method in the Błonie section (*cf.* Fig. 4) close to Warsaw (Karaszewski 1975) the same as that obtained in the European part of the Soviet Union, 110,000±±14,000 BP (Zubakov 1974) or 108,000—114,000 BP (Ivanova & *al.* 1977). In caves of northern England (Yorkshire Dales), this interglacial is dated by the uranium method for 131,000±18,000 BP to 90,000±11,000 BP (Waltham & Harmon 1977). In cores of deep-sea sediments of North Atlantic, this period is dated by means of oxygen istotopes for 110,000—125,000 BP (Wijmstra & van der Hammen 1974).

Age determinations of the loesses occurring in the upper part of the sequence (layers *12—14* in Figs 3 and 4) suggest a considerable reduction or a primary small thickness of the loess bed of the Lower Pleniglacial (layer *10*), and furthermore the presence of loessy accumulation in Middle Pleniglacial (Interpleniglacial) during a climatic cooling dated for 42,000±±1,500 BP. This cooling separates the Hengelo warming (Interstadial), dated in the Netherlands by the radiocarbon method for more than

51,600 BP to 38,700±400 BP (Zagwijn 1974), from the Danekamp warming (Interstadial) dated in the Netherlands for 38,700±2,700 BP (Zagwijn 1974), and in France (Arcy-Kesselt) for 30,370 BP (Leroi-Gourhan 1977). Likewise in deep-sea sediments of North Atlantic, a similar warming was recorded by means of oxygen isotopes for 48,000 and 31,000 BP (Wijmstra & van der Hammen 1974).

The above data allow to connect the Hengelo Interstadial with several intraloessic paleosoils of the Lublin Upland (Tyszowce, Ratyczów *1*), the top horizons of which are dated by FCl/P method for 56,000—58,000 BP and by a radiocarbon method for 41,500±2,200/1,750 BP (Wojtanowicz & Buraczyński 1978).

A confrontation of mentioned data for Hengelo and Denekamp interstadials as well as for the synchronic Upton Warren Interstadial (Mid--Devensian) in England that lasted from 50,000 to 26,000 BP (Schotton 1967, Dreimanis & Raukas 1975), suggests that in many loess localities these warmings may superpose and, thus, they may be represented only by a single soil complex, called by Jersak (1965, 1973) a soil of the "Komorniki" type.

In some loess sections of the European part of the Soviet Union the top part of the soil complex, agreeable probably with Denekamp Interstadial, is called the "Brianska soil" and is dated for 29,000—25,000 BP (Velitkhko 1975) or 30,300±2,100 BP (Ivanova & *al.* 1977).

In the European part of the Soviet Union, in the area occupied by the Vistulian (Valdai) Glaciation, there are also numerous profiles with intramorainic peats dated there for 40,380±800 BP, 39,000±800 BP and 33,650±400 BP (Zubakov 1974, 1978), that are agreeable with the discussed interstadial (Hengelo-Danekamp).

The loess bed, dated in the Wąchock section for 24,087±2,587 BP (upper part of layer *12*) represents a cooling of the Upper Pleniglacial with loess-creative processes that occurred just before the icesheet advance of the Leszno (Brandenburg) Phase (Stadial) of the Vistulian Glaciation. According to Mörner (1970) the maximum excent of this icesheet occurred at about 20,000 BP. In Hesse, the loess accumulation of this period is dated by the radiocarbon method for 18,500±950 BP and 21,000±1,400 BP (Semmel 1974). In the southern Ukraine an accumulation of this loess started at about 25,070±2,400 BP and lasted until 16,170±1,900 BP (Ivanova & *al.* 1977).

The palaeosol (layer *13*) that covers the loess originated in a period of ameliorated climatic conditions between the Leszno and Pomeranian phases; the latter phase is represented by the uppermost loess bed, the lower part of which is dated for 15,830±1,830 BP (Figs 3 and 4). Taking this data into consideration, an age estimation of the Pomeranian Phase for about 16,000 BP (Galon 1977), a deposition of lacustrine sediment with mollusk fauna close to Reszel in the Mazury Lakeland for about

17,800±250 BP (Prószyński 1978) and thus, in a period agreeable with Mazurian Interphase (Interstadial) (*cf.* Halicki 1960) it seems reasonable to regard the formation of the discussed palaeosol with this very interstadial. In the south-western part of Europe, this period corresponds to the Lascaux Interstadial dated for 17,190 and 16,100 BP (Leroi-Gourhan 1977). Possibly, the younger palaeosol of the Tyszowce section, dated by the radiocarbon method for 19,000±500 BP (Wojtanowicz & Buraczyński 1978), is also of the same age.

The uppermost loess bed (layer *14*) is synchronous with the Pomeranian Phase (Stadial) of the Vistulian Glaciation; the bottom part of this loess bed is dated for 15,830±1,830 BP. The deposition of this loess was stopped probably about 13,000—12,000 BP, i.e. at the same time as in the Lublin Upland (*cf.* Wojtanowicz & Buraczyński 1978).

Institute of Geology
of the Warsaw University
Al. Żwirki i Wigury 93
02-089 Warszawa, Poland

REFERENCES

BARTOSIK J. **1970**. Limite de la glaciation de la Pologne Centrale (Riss) en peripherie nord-est du Massif de la S-te Croix. *Acta Geogr. Lodziensia*, **24**, 61—74. Łódź.

BOULTON G. S. **1976**. A genetic classification of tills and criteria for distinguishing tills of different origin. *Ser. Geogr. UAM*, **12**, 65—80. Poznań.

DREIMANIS A. & RAUKAS A. **1975**. Did Middle Wisconsin, Middle Weichselian, and their equivalents represent an interglacial or an interstadial complex in the Northern Hemisphere? *Quaternary Studies*, 109—120. Wellington.

GALON R. **1977**. Last cold period (Würm) and last Scandinavian glaciation. *Studia Geol. Polon.*, **52**, 159—168. Warszawa.

— & ROSZKÓWNA L. **1961**. Extents of the Scandinavian glaciations and of their recession stages on the territory of Poland in the light of an analysis of marginal forms of inland ice. *Przegl. Geogr.*, **33** (3), 347—364. Warszawa.

GŁAZEK J., LINDNER L. & WYSOCZAŃSKI-MINKOWICZ T. **1976a**. Interglacial Mindel I/Mindel II in fossil-bearing karst at Kozi Grzbiet in the Holy Cross Mts. *Acta Geol. Polon.*, **26** (3), 377—393. Warszawa.

— , SULIMSKI A., SZYNKIEWICZ A. & WYSOCZAŃSKI-MINKOWICZ T. **1976b**. Middle Pleistocene Karst deposits with *Ursus spelaeus* at Draby near Działoszyn, Central Poland. *Acta Geol. Polon.*, **26** (3), 451—466. Warszawa.

GRABOWSKA-OLSZEWSKA B. **1963**. Physico-mechanical properties of loess deposits of the northern and north-eastern part of the Holy Cross Mts loess--zone on the background of their lithology, stratigraphy and conditions of occurrence. *Biul. Geol. Uniw. Warsz.*, **3**, 295—304. Warszawa.

HALICKI B. **1960**. The problem of the Mazurian Interstadial Period. *Zbiór Prac i Komunikat. Treści Geol., Inst. Geol., Muz. Ziemi*, *107—123*. Warszawa.

HAMMEN T. van der, MAARLEVELD G. C., VOGEL J. C. & ZAGWIJN W. H. **1967**. Stratigraphy, climatic succession and radiocarbon dating of the Last Glacial in the Netherlands. *Geol. en Mijnb.*, **46**, 79—95. Gravenhage.

— & WIJMSTRA T. A. *(Ed).* 1971. The Upper Quaternary of the Dinkel Valley. *Meded. Rijks Geol. Dienst, N. S.* 22, 55—214. Maastricht.

IVANOVA I. K., KESH A. C. & HAUCHEVA T. A. 1977. Simpozium Komisii po lessam w SSSR. *Iz. AN SSSR, Ser. Geogr.*, **3**, 126—133. Moskva.

JERSAK J. 1965. Stratigraphie et genèse des loess aux environs de Kunów. *Acta Geogr. Lodziensia,* **20**, 1—116. Łódź.

— 1973. Lithology and stratigraphy of the loess on the Southern Polish Uplands. *Acta Geogr. Lodziensia,* **32**, 1—142. Łódź.

— 1977. The Late Pleistocene and Holocene deposits in side valleys of the Kunów region. *Folia Quaternaria,* **49**, 15—22. Kraków.

KARASZEWSKI W. 1954. O znalezieniu zęba mamuta pod Wąchockiem. *Przegl. Geol.*, **2** (11), 486—487. Warszawa.

— 1975. Age of the Warsaw ice-dammed lake sediments. *Bull. Acad. Pol. Sci., Sér. Sci. Géol. Géogr.*, **22** (3—4), 151—154. Warszawa.

— , KONECKA-BETLEY K., LINDNER L. & PRÓSZYŃSKI M. 1977. Wąchock: Stratigraphic position of Pleistocene deposits with a particular regard to loess complex and fossil soils. *Przewodnik Symp. Teren., „Czwartorzęd zachodniej części regionu świętokrzyskiego”*, 94—102. *Wyd. Geol.*, Warszawa.

KLATKA T. 1970. Caractère pédologique et position stratigraphique du complexe sol fossile dans les loess du Massif de la S-te Croix. *Acta Geogr. Lodziensia,* **24**, 259—276. Łódź.

KONECKA-BETLEY K. & STRASZEWSKA K. 1977. Palaeopedologic investigations of loess in the Sandomierz area on the ground of is stratigraphy. *Studia Geol. Polon.*, **52**, 215—234. Warszawa.

KOSMOWSKA-SUFFCZYŃSKA D. 1972. The extend of the Middle Poland glaciation in Holy Cross Mts, Central Poland. *Rocz. P. T. Geol. (Ann. Soc. Géol. Pologne),* **42** (1), 93—104. Kraków.

— & SZCZEPANEK K. 1979. Interglacjał lubelski z Kars koło Ożarowa na Wyżynie Sandomierskiej *(In press).*

LEROI-GOURHAN A. 1977. Les climats, les plants et les hommes (Quaternaire supérieur d'Europe Occidentale). *Studia Geol. Polon.*, **52**, 249—262. Warszawa.

LINDNER L. 1967. L'île loessique de Borkowice près Przysucha. *Acta Geol. Polon.*, **17** (3), 443—462. Warszawa.

— 1978. Palaeogeomorphologic evolution of the western part of the Holy Cross region in Pleistocene. *Rocz. P. T. Geol. (Ann. Soc. Géol. Pologne),* **48** (3/4). Kraków.

— & RUSZCZYŃSKA-SZENAJCH H. 1977. The problem of genetic differentiation of tills and related deposits. *Przegl. Geol.*, **25** (8—9), 432—438. Warszawa.

ŁYCZEWSKA J. 1971. The Quaternary of the Holy Cross Region. *Prace Inst. Geol.*, **64**, 5—108. Warszawa.

MÖRNER N. A. 1970. Comparision between Late Weichselian and Late Wisconsion ice marginal changes. *Eiszeit und Gegenw.*, **21**, 173—176. Ohringen.

PRÓSZYŃSKI M. 1978. Studium geochronologii czwartorzędu i termoluminescencji osadów czwartorzędowych. *Komitet Bad. Czwartorzędu PAN, Sprawozd. z Bad. Nauk.*, **2**, 49—63. Warszawa.

RÓŻYCKI S. Z. 1964. Les oscilations climatiques pendant le “Grand Interglaciaire”. *Rep. of the VIth Intern Congr. on Quatern.* **2**, 211—225. Łódź.

— 1972. Plejstocen Polski Środkowej, 2nd ed. PWN. Warszawa.

— 1978. Od „Mocht" do syntezy stratygrafii plejstocenu Polski. *Rocz. P. T. Geol. (Ann. Soc. Géol. Pologne)*, **48** (3/4), Kraków.

SAMSONOWICZ J. 1925. Sur la limite de la seconde glaciation entre la Iłżanka et la Vistule, versant nord du Massif de Święty Krzyż. *Pos. Nauk. P. I. G. (C.-R. Séanc. Serv. Géol. Pologne)*, **12**, 9—10. Warszawa.

SAWICKI L. 1921. Über die mittelpolnische Endmoräne. *Rozpr. Wydz. Mat.-Przyr. PAU, Ser. 3*, **21** (A), 26—35. Kraków.

SCHOTTON F. W. 1967. Age of the Irish Sea Glaciation of the Midland Lands. *Nature*, **215** (5108). London.

SEMMEL A. 1974. Der Stand der Eiszeitforschung in Rhein-Main-Gebiet. *Rhein--Mainische Forschungen; H* **78**. *„Das Eiszeitalter im Rhein-Main-Gebiet"*.

STRASZEWSKA K. & MYCIELSKA E. 1961. Gołębice. *Guide-Book of Excursion from the Baltic to the Tatras, VI INQUA Congr. Poland.* Warszawa.

ŚRODOŃ A. 1969. Stratigraphic position of fossil floras in the Lublin region referable to the Mazovian Interglacial. *Biul. Inst. Geol.*, **220**, 5—12. Warszawa.

VELITKHKO A. 1975. Problemy paleogeografi lessovykh i periglacyalnykh oblastej. *Akad. Nauk SSSR*, 1—173. Moskva.

WALTHAM A. C. & HARMON R. S. 1977. Chronology of cave development in the Yorkshire Dales, England. *Proc. 7th Intern. Speleolog. Congress*, 423—425. Sheffield.

WIJMSTRA T. A. & HAMMEN T. van der 1974. The Last Interglacial — glacial cycle: state of affairs of correlation between data obtained from the land and from the ocean. *Geol. et Mijnb.*, **53** (6), 386—392. Gravenhage.

WOJTANOWICZ J. & BURACZYŃSKI J. 1978. Materials to the absolute chronology of the loesses of Grzęda Sokalska. *Ann. Univ. Mariae Curie-Skłodowska, Sec. B*, **30/31**, 37—54. Lublin.

ZAGWIJN W. H. 1974. Vegetation climate and radiocarbon datings in the Late Pleistocene of the Netherlands. *Meded. Rijks Geol. Dienst. N. S.*, **25** (3), 101—111. Maastricht.

ZUBAKOV V. A. *(Ed.)*. 1974. Geokhronologia SSSR, Noveyshy etap (pozdny pliocen — chetvertichnyj period). *Nedra*, Leningrad.

— 1978. Pozdnikainozoiskaja lednikovaja epokha: khronologija i periodizacija. *Chtenja pamjati L. S. Berga. Akad. Nauk SSSR*, 7—33. Leningrad.

L. LINDNER i M. PRÓSZYŃSKI

GEOCHRONOLOGIA OSADÓW PLEJSTOCEŃSKICH W PROFILU WĄCHOCKA

(Streszczenie)

Na podstawie sześciu oznaczeń wieku bezwzględnego (metodą termoluminescencji) osadów plejstoceńskich w profilu Wąchocka (fig. 1) określono ich pozycję geochronologiczną. Najstarsze z tych osadów, podglinowe piaski rzeczne (warstwa *2* na fig. 2) datowane są na 352 000 lat BP i reprezentują schyłek interglacjału mazowieckiego (Mindel *II*/Riss *I*). Nadglinowe mułki zbiornikowe (warstwa *5* na fig. 2 i 3), datowane na 245 000±45 000 lat BP, odniesiono do początkowej części interglacjału lubelskiego (Riss *I*/Riss *II*). Wyżej występujące piaski pokrywowe (warstwa *8* na fig. 2 i 3), datowane na 142 550±3650 lat BP, powstały w młodszej części zlodowacenia Warty (Riss *II*). Najwyżej występujące lessy (warstwy *12*—*14* na fig. 2 i 3), datowane na 42 000±1500 lat BP, 24 078±2587 lat BP i 15 830±1830 lat BP, związano ze środkową i młodszą częścią zlodowacenia Wisły (Würm). Uzyskane oznaczenia stawiają badany profil w pierwszym rzędzie reperowych stanowisk geochronologicznych plejstocenu Polski zarówno pod względem ilości jak i rozciągłości dat (fig. 4).