Geological Quarterly, 1999, 43 (2): 213–218

Stratigraphy of the section Antaviliai, eastern Lithuania, and its implication for the Upper Weichselian climatostratigraphic subdivision

Jonas SATKUNAS, Galina HÜTT

Satkunas J., Hütt G. (1998) — Stratigraphy of the section Antaviliai, eastern Lithuania, and its implication for the Upper Weichselian climatostratigraphic subdivision. Geol. Quart., 43 (2): 213–218. Warszawa.

The Antaviliai section in eastern Lithuania was known so far as a site bearing sediments attributed to the Antaviliai Interstadial, placed stratigraphically between the Gruda (Brandenburg) and Ziogeliai (Frankfurt) Stadials. The section Antaviliai has been studied in 1989–1991 by the authors, including drilling of 6 boreholes, structural-textural examination and thermoluminescence datings of lacustrine sediments in the outcrop, lithostratigraphic identification of the overlying and the underlying tills. Assuming conditions of occurrence, palynological characteristics and thermoluminescence age, the Antaviliai Interstadial can be most likely correlated with the Drenthian–Warthian Interstadial. So far, in Lithuania as well as in other Baltic countries there is still not found any site with reliably determined the Upper Weichselian interstadial or interphasial deposits. Therefore stadials, phases and interstadials have no proper climatostratigraphic background in the Baltic states and the Late Weichselian at present can be subdivided only into lithostratigraphic units.

Jonas Satkunas, Geological Survey of Lithuania, S. Konarskio 35, LT-2600 Vilnius, Lithuania; e-mail: jonas.satkunas@lgt.lt; Galina Hütt, Institute of Geology, Estonia Ave. 7, EE-10143 Tallinn, Estonia; e-mail: hutt@pdos.gi.ee (received: January 19, 1999; accepted: March 8, 1999).

Key words: Lithuania, Late Weichselian, Drenthian–Warthian Stage, stratigraphy, interstadials, thermoluminescence dates.

INTRODUCTION

Different criteria can be used for the stratigraphic subdivision of the Quaternary sediments in glaciated areas: geomorphologic, biostratigraphic, litho- and chronostratigraphic. Following the climatostratigraphic concept exclusively important are sediments, which can be reliably interpreted as interstadial or interglacial, separating tills or other deposits of glacial origin. Climatostratigraphic subdivision of the Late Weichselian, comprising the isotope stage 2 (K.-E. Behre, 1989; J. Mangerud, 1991) so far is very problematic in the glaciated area. Only very poor and contradictory evidence is reported on presence of interstadials which are supposed to have occurred during the Late Weichselian, e.g. Trofors Interstadial (17–21 ka BP) in Norway (L. Olsen, 1997), Raunis in Latvia (A. S. Savvaitov, J. A. Straume, 1963; A. Cerina *et al.*, 1998), and Pavyte in Lithuania (A. Gaigalas, 1988).

The territory of eastern Lithuania could be regarded as a very favourable area for the examination of the presence of interstadials or interphasials of the Late Weichselian. The maximum limit of the Weichselian Glaciation (Late Weichselian) has been traced in this area on basis of different data, including biostratigraphic, geomorphologic and lithostratigraphic, and physical datings. If fluctuations of the ice sheet margin took place during the Late Weichselian, there must have been sediments corresponding to the ice-free periods (interstadials, interphasials). Therefore, if the Late Weichselian Glaciation consists of two or more stadial advances, there is the highest possibility to find interstadial sediments in eastern Lithuania. Particularly favourable conditions to find these interstadials are supposed to be in depressions at the very front of marginal formations, where glaciolacustrine and lacustrine accumulation prevailed (J. Satkunas, 1993).

LATE WEICHSELIAN STRATIGRAPHY IN LITHUANIA

Several versions of stratigraphic subdivision with climatostratigraphic implications have been proposed so

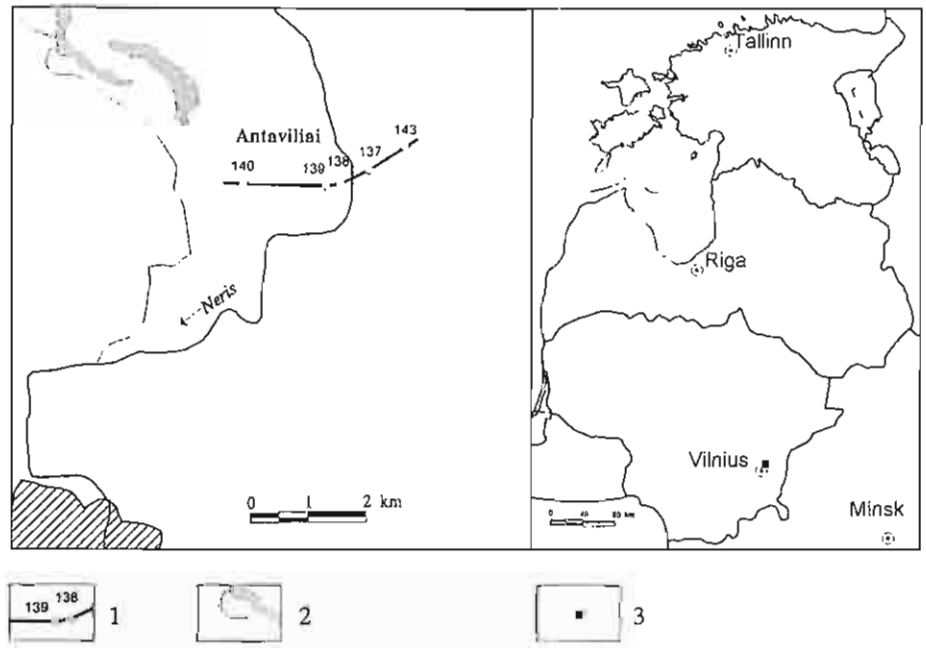

Fig. 1. Location sketch

1 — geologic cross-section; 2 — hydrographic network; 3 — site Antaviliai

far for the Late Nemunas (Late Weichselian) in Lithuania. Three stadials, i.e. Gruda, Ziogeliai and Baltija, were established within the Late Nemunas, correlated with the Brandenburg, Frankfurt and Pomeranian Stages, respectively (P. Vaitiekunas, 1969, 1971). Besides, the Antaviliai Interstadial between the Gruda (Brandenburg) and the Ziogeliai (Frankfurt) Stadials, and the younger — the Ula Interstadial between the Ziogeliai (Frankfurt) and the Baltija (Pomeranian) Stadials were established, referring to sediments found in the Ula, Antaviliai, Buivydziai and other outcrops (P. Vaitiekunas, 1969). Investigations carried out later by several researchers in all these sites have resulted in new interpretations of the stratigraphic position of these so-called interstadials.

Already R. Pirrus *et al.* (1967) established that the sediments at Ula are much younger and belong to the Late Glacial. Later studies of the Ula outcrops at Manciagire (southern Lithuania), one of the main key sites of the Ula Interstadial, have confirmed that most possible age of these sediments is the Late Glacial (A. Seibutis, 1974; N. Blazauskas *et al.*, 1996).

The organic sediments at the outcrop Buivydziai are attributed at present to the Snaigupele Interglacial (O. Kondratiene, E. Vichnevskaya, 1974). Also other interpretations of this particular interglacial can be discussed, however, attribution of the Buivydziai organic sediments to the Late Pleistocene is not feasible (A. Gaigalas *et al.*, 1989; J. Satkunas, 1997*a*).

Nevertheless, the question of presence of the interstadial between the Ziogeliai and the Baltija Stadials remains unsolved. According to the opinion of A. Gaigalas (1988), the Pavyte Interstadial has occurred between these stadials.

The paper presents new results of the investigations of the site Antaviliai, the stratotype section of the supposed Antaviliai Interstadial (*sensu* P. Vaitiekunas, 1969).

GEOLOGICAL SETTING AND MATERIAL

The site Antaviliai is located in a northern suburb of Vilnius, in a valley of the Neris River (Fig. 1). The section is exposed in a slope of the third upper terrace of the valley and displays 4–5 m thick sandy-silty complex. The Antaviliai section has been described by P. Vaitiekunas (1969) who ascribed these sandy-silty sediments as the Antaviliai Interstadial. His interpretation was based on pollen analyses by O. Kondratiene and V. Cepulyte (P. Vaitiekunas, 1969) which indicated a predominance of pine and birch pollen. However, some pollen grains of broad-leaved trees in the section were found by the authors to have been redeposited. Generally the pollen data and absence of organic material have been interpreted as showing climatic conditions of interstadial type. The till beneath the sands of the Antaviliai Interstadial were interpreted as of the Gruda (Brandenburg) age, the overlying layer of coarse gravel was interpreted as a residuum of a till of the Ziogeliai (Frankfurt) Stadial. Thus, such interpretation led to attribution of the Antaviliai Interstadial to the Late Weichselian.

The sediments attributed to the Antaviliai Interstadial were examined in 1989–1991 during geological mapping in

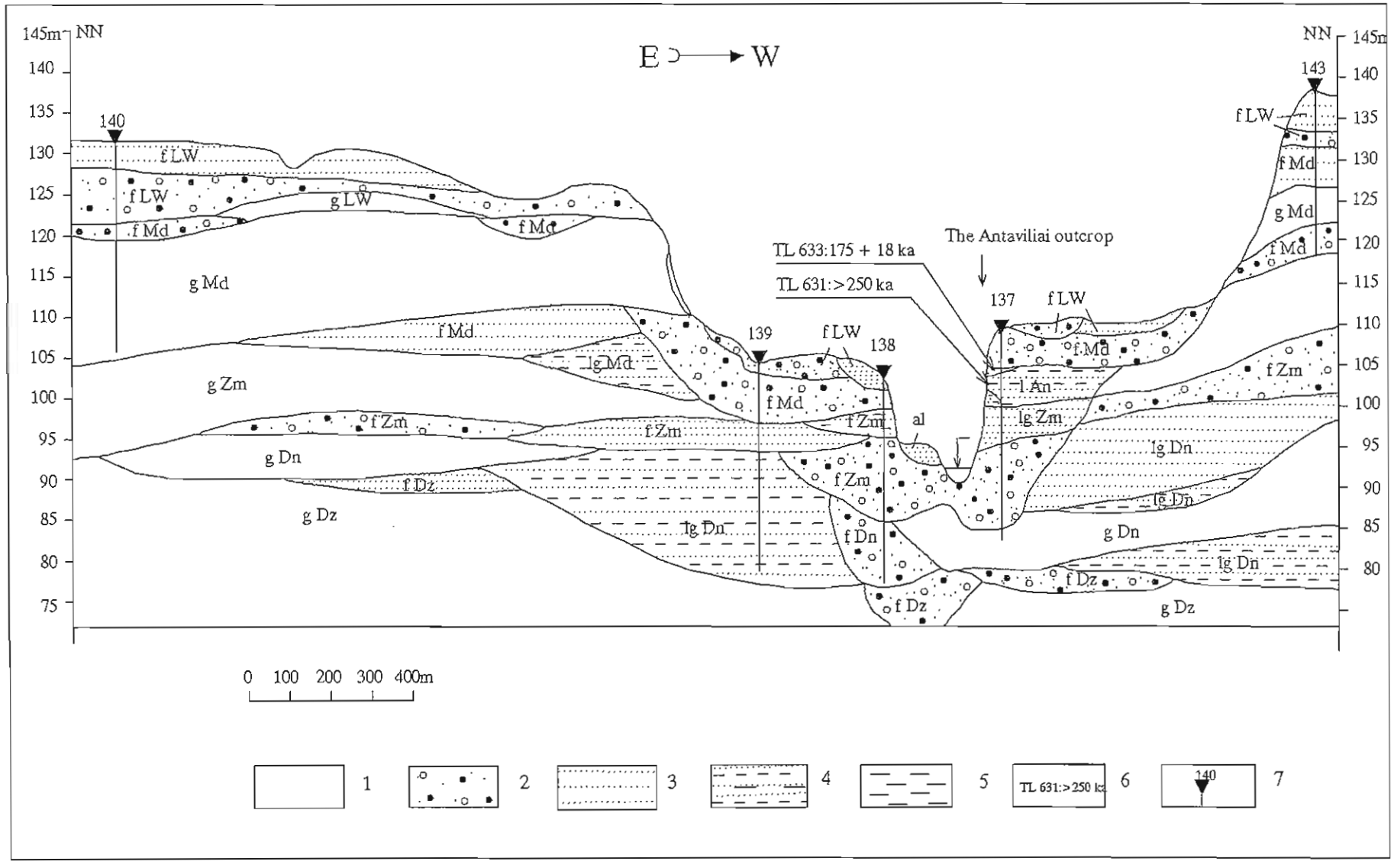

Fig. 2. Geologic cross-section of the site Antaviliai

1 — till; 2 — gravels and sands with gravels; 3 — sands; 4 — silty sands; 5 — clays; 6 — thermoluminescence date; 7 — borehole; LW — Late Weichselian; An — Antaviliai Interstadial; Md — Medininkai (Warthian) glacial stage; Zm — Zemaitija (Saalian, Drenthian) glacial stage; Dn — Dainava glacial stage (Upper Elsterian); Dz — Dzukija (Lower Elsterian) glacial stage; g — glacial; f — glaciofluvial; lg — glaciolacustrine; l — lacustrine; al — alluvial

scale of 1:50,000. In scope of these studies 6 boreholes, structural and textural examination of lacustrine sediments in the outcrop, lithostratigraphic identification of overlying and underlying tills were performed (Fig. 2).

A lithologic deseription of the Antaviliai outcrop is as the following:

Depth in m	Lihology
0.0–2.6	Coarse gravel, glaciofluvial (till residuum).
2.6–3.4	Fine-grained sand, light grey, very well sorted (61% grains to 0.16–0.10 mm), without discernible lamination; the sand is extremely rich in SiO_2 (94.2%) and a content of carbonates is low (CaO — 0.66%, MgO — 0.24%); the sands are most likely lacustrinc as indicated by a high content of mica.
3.4–5.3	Silty sand, grey, lacustrine.
5.3–7.4	Varved clay, glaciolacustrine.

The Antaviliai Interstadial is represented by sediments at depth 2.6–5.3 m.

In the paper of P. Vaitiekunas (1969) a similar section was described, but he recorded a till below the varved clay (silt) and attributed it to the Gruda Stadial of the Late Nemunas Glaciation (Late Weichselian). This till, described by P.Vaitiekunas (1969), can be correlated possibly with a brown till in the borehole 143 (lower till), located on the highest terrace of the valley (Fig. 1). This brown till was interpreted as the Zemaitija (Saalian, Drenthian) till due its characteristic texture, colour and petrographic composition of gravels. Another brown till, very possibly of the Medininkai (Warthian) age was detected in the borehole 143 above the Zemaitija till and in the borehole 140. So, it looks most feasible that deposits of the Antaviliai Interstadial occur between the Zemaitija and the Medininkai tills. A very compact green-grey till was determined in the bottom of the borehole 137, located just above the very outcrop (Figs. 1 and 2). This particular till is traceable in a broad area and according to data of geological mapping, it is attributed to the Dainava Glaciation (Elsterian). This till occurs 15 m below the Antaviliai sediments in the type site (Fig. 2).

Thermoluminescence age of the Antaviliai sands was determined in two samples, collected from the fine-grained light grey sands (depth 2.6–3.4 m). Dating, using alkali feldspars as palaeodosemeters (G. Hütt, A. Smirnov, 1983), was performed in the Institute of Geology of the Tallinn Technical University. The thermoluminescence age of the Antaviliai sands is equal to 175±18 ka BP (TL-633) and >250 ka BP (TL-631). It is worth to emphasize that the lake sediments, as it is in the case of the Antaviliai section, are rather a good object for both TL or OSL technique.

According to the European time division (D. Q. Bowen *et al.*, 1986), the age of the Antaviliai sands looks closest to the Drenthian–Warthian ice-free stage, which comprises the geochronological interval 198–252 ka BP. Sediments of the contemporaneous Odranian–Wartanian Interstadial are known from the margin area of the Wartanian Glaciation in central Poland and are characterised by pollen assemblages of interstadial type (J. Goździk, Z. Balwierz, 1994). So, assuming conditions of occurrence, palynological characteristics and thermoluminescence age, the Antaviliai Interstadial sands, previously attributed to the Late Weichselian, have to be attributed to much more older stratigraphic units and a possible correlation of the Antaviliai Interstadial with the Odranian–Wartanian Interstadial can be considered.

CONCLUDING REMARKS

The research of the Antaviliai Interstadial section led to interpretation that the Antaviliai lake deposits ought to be attributed to the Middle Pleistocene, most likely to the Drenthian–Warthian ice-free stage. This interpretation is supported by conditions of occurrence, palaeoclimatic characteristics and thermoluminescence dating. So, it can be assumed that so far in Lithuania as well as in the other Baltic countries there are still not found any sites with reliably determined the Upper Weichselian interstadial or interphasial deposits. Therefore, stadials, phases and interstadials have no proper climatostratigraphic background and the Upper Weichselian in the Baltic States at present can be subdivided only into lithostratigraphic units. Similar problems may be pointed out in respect of the phases of the Baltija Stadial (J. Satkunas, 1997*b*). Most of the present topography of Lithuania has been formed by the Baltija glacial advance (stadial). This advance is traditionally subdivided into the Eastern, Southern, Middle and North Lithuanian Phases, traced geomorphologically. Any signs of interphasial deposits are not known so far and, furthermore, only in a very few sections (e.g. Rokai), it is possible to distinguish different phasial till layers attributed to the Baltija glacial advance (A. Gaigalas, 1997). Detailed lithologic studies of the marginal moraines of these phases have displayed similarities of lithologic composition, especially between the eastern and the southern Lithuanian, and between the north and the middle Lithuanian phasial moraines (V. Baltrunas, 1989).

Acknowledgements. Authors express cordial thanks to Professor Anto Raukas and unknown reviewer for valuable comments improving the manuscript.

REFERENCES

BALTRUNAS V. (1989) — A comparative lithological-geochemical analysis of till deposits of the Lithuanian Baltic stage (in Russian with English summary). Geologija, **10**: 121–134.

BEHRE K.-E. (1989) — Biostratigraphy of the last glacial period in Europe. Quatern. Sc. Rev., **8**: 25–44.

BLAZAUSKAS N., KUCINSKAITE V., SINKUNAS P. (1996) — Ula–Weichselian (Nemunas) Interstadial, preliminary results of new investigations. Correlation of stratigraphic events of Upper Pleistocene in central and peripheral parts of the Last Glaciation. Abstract Volume and

Excursion Guide, Intern. Workshop in Lithuania (eds. J. Satkunas, A.-M. Robertsson): 9–12.

BOWEN D. Q., RICHMOND G. M., FULLERTON D. S., SIBRAVA V., FULTON R. J., VELICHKO A. A. (1986) — Correlation of Quaternary glaciations in the Northern Hemisphere. Quatern. Sc. Rev., 5: 509–510.

CERINA A., JAKUBOVSKA I., SAVVAITOV A., STELLE V. (1998) — Raunis Interstadial deposits in Latvia. Field Symposium on Glacial Processes and Quaternary Euvironment in Latvia: 8–10. Riga.

GAIGALAS A. (1988) — Geochronological evaluation of the evolution of palaeocnvironments during Late Pleistocene and Holocene in Lithuania (in Russian). In: Isotope-geochemical investigations in the Baltic region and Belarus: 23–33. Tallinn.

GAIGALAS A. (1997) — The Rokai outcrop: the Middle Nemunas (Weichselian) Interstadial. The Late Pleistocene in Eastern Europe: stratigraphy, palaeoenvironment and climate. Abstract Volume and Excursion Guide of the INQUA-SEQS Symposium: 82–84. Lithuania.

GAIGALAS A. J., HÜTT G. I., BITINAS A. K., MELESYTE M. J. (1989) — Thermoluminescence age of the Late Quaternary sands in outcrop Pnnzonys (Buivydziai) (in Russian). In: Gcochronological and isotope-geochemical investigations in Baltic Region and Belarus: 42–43. Vilnius.

GOŹDZIK J., BALWIERZ Z. (1994) — Rogowiec. The sediments of the Odra/Warta Interstadial and the upper units of the Wartanian complex. In: The Cold Warta Stage — lithology, paleogeography, stratigraphy. SEQS Symposium, Excursion Guide-book: 34–40. Łódź.

HÜTT G., SMIRNOV A. (1983) — Thermoluminescence dating of deposits by means of the quartz and feldspars inclusion. PACT, 9: 463–473.

KONDRATIENE O., VICHNEVSKAYA E. (1974) — New data on interglacial deposits in Buivydziai (in Russian). In: Questions of investigations of Quaternary deposits of Lithuania. LitNIGRI, 27: 100–118. Vilnius.

MANGERUD J. (1991) — The last interglacial/glacial cycle in Northern Europe. Quaternary Landscapes: 38–75. Minneapolis.

OLSEN L. (1997) — Rapid shifts in glacial extension characterise a new conceptual model for glacial variations during the Mid and Late Weichselian in Norway. NGU-BULL, 433: 54–55.

PIRRUS R., PUNNING J.-M., RAUKAS A., SEREBRYANNY L. (1967) — Absolute age and stratigraphic position of the Ula (South-East Lithuania) Interstadial deposits (in Russian with English summary). Proc. Estonian Acad. Sc., Chem. Geol., 16 (2): 156–161.

SAVVAITOV A. S., STRAUME J. A. (1963) — On question of stratigraphic subdivision of till of Valdaj glaciation in the area of lower reaches of the rivers Daugava and Gauja (in Russian). Proc. Inst. Geol. Acad. Sc. Latvian SSR, 2: 71–86. Riga.

SATKUNAS J. (1993) — The Vilnia–Neris glacial depression as a stratotype region of the Upper Pleistocene deposits (in Russian with English summary). Geologija, 14 (2d): 252–266.

SATKUNAS J. (1997*a*) — The Buivydziai outcrop: Upper Pleistocene sequence and conditions of occurrence of the Snaigupele Interglacial gyttja. In: The Late Pleistocene in Eastern Europe: stratigraphy, palaeoenvironment and climate. Abstract Volume and Excursion Guide of the INQUA-SEQS Symposium: 96–100. Lithuania.

SATKUNAS J. (1997*b*) — Stadials and interstadials of the Late Weichselian in Lithuania — a climatostratigraphical aspect. In: The Late Pleistocene in Eastern Europe: stratigraphy, palaeoenvironment and climate. Abstract Volume and Excursion Guide of the INQUA-SEQS Symposium: 51–52. Lithuania.

SEIBUTIS A. (1974) — Ulos interstadialiniu sluoksniu susidarymo misle. Geografinis Metrastis, 13: 23–36.

VAITIEKUNAS P. (1969) — On stratigraphie subdivision of the Neoplcistocene in glaciated area (in Russian). In: Continental glaciation and glacial morphogenesis: 227–271. Vilnius.

VAITIEKUNAS P. (1971) — On periodisation and geochronology of the Late Pleistocene in Baltic area. Proc. Symp. "Problems of periodisation of Pleistocene" (in Russian): 170–174. Leningrad.

STANOWISKO ANTAVILIAI WE WSCHODNIEJ LITWIE I JEGO ZNACZENIE DLA KLIMATOSTRATYGRAFII MŁODSZEJ CZĘŚCI ZLODOWACENIA WISŁY

Streszczenie

Profil Antaviliai we wschodniej Litwie (fig. 1) jest znany od dawna jako stanowisko z osadami interstadiału antaviliai, umieszczanego między stadiałami gruda (brandenburskim) i ziogeliai (frankfurckim) (P. Vaitickunas, 1969). Został on zbadany przez autorów w latach 1989–1991. Wykonano wówczas 6 otworów wiertniczych, przeprowadzono badania struktnralne i teksturalne, w tym analizy litostratygraficzne podścielających i przykrywających glin zwałowych, oraz datowano metodą termolumincscencji osady jezionie w górnej części odsłonięcia. Na podstawie sytuacji geologicznej (fig. 1), badań palinologicznych oraz datowań metodą termoluminescencji skorelowano interstadiał antaviliai z interstadiałem drenthe–warthe.

Podobnie jak w innych państwach bałtyckich, na Litwie brak dotychczas stanowiska, w którym wiarygodnie stwierdzono by obecność osadów interstadialnych lub interfazalnych z młodszej części zlodowacenia wisły. Z tego powodu nie ma obecnie przesłanek klimatostratygraficznych do wyróżniania stadiałów, faz i interstadiałów w krajach bałtyckich, zaś młodsza część zlodowacenia wisły może być podzielona wyłącznie na jednostki litostratygraficznc.