Thermoluminescence dates of Mid- and Late Pleistocene sediments in Vilkiškės exposure, Eastern Lithuania

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Based on thermoluminescence (TL) datings of Mid- and Late Pleistocene sediments, fine-grained sands of aquatic origin have been attributed to the Snaigupėlė (Drenthian-Warthian) Interglacial of Middle Pleistocene in the lowermost part of Vilkiškės exposure. TL dates of sediments in the uppermost part of the section allowed to determine the age of Merkinė (Eemian) Interglacial and Nemunas (Weichselian, Vistulian, Valdaian) glacial of Late Pleistocene.

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INTRODUCTION

Most glacigenic sediments, which are dominant Quaternary deposits in Lithuania, are barren of datable organic matter. We have studied the optically stimulated luminescence (OSL) of limno-alluvial sandy-gravel and sandy deposits with interbeds of soil and silts of Late Pleistocene which has a rich set of ^{14}C dates (Gaigalas and Hütt, 1995). Most deposits from the palaeolake with broad, low-gradient floor are inferred to be more favourable to accurate TL and OSL dating. The lacustrine, glaciolacustrine, aeolian, soil and fluvial sediments of Pleistocene in Lithuania are a rather good object for a correct both TL and OSL dating techniques and for receiving correct dates of absolute age (Gaigalas, 2000).

A different conclusion was drawn about the age and origin of Pleistocene deposits in the Neris River valley between the Belarus border and the Vilnius city. The present study is focused on the Vilkiškės exposure (25°22' 35" NL; 54°50'16" EL). Sandy sediments in this section have been studied in the last century. Their stratigraphical position and genesis were a subject of controversy among the researchers. After Z. Malinauskas (1991), the Vilkiškės outcrop sediments were accumulated by saltation of alluvial sand in a fluvial stream in the Merkinė (Eemian) Interglacial time. In J. Satkūnas' (1993) opinion, the sandy sediments were accumulated at the beginning of the Butėnai (Holsteinian) Interglacial in the lacustrine basin. A detailed structural, textural and compositional research of the Vilkiškės and Tartokai outcrops was carried out by a group of authors (Bardžiuvienė, Šinkūnas, Jurgaitis, Satkūnas, 2000). They proposed a relation of older lacustrine sediments with the Butėnai (Holsteinian)

and of the younger ones with the Merkinė (Eemian) Interglacials.

The objective of our present investigation was the chronostratigraphical subdivision of the Vilkiškės section, using the methods of thermoluminescence dating. This section comprises some different lithocomplexes of the Mid- and Late Pleistocene. The bed form, composition and structure of the deposit are a result of deposition during different phases of sedimentation of two glacial–interglacial cycles (Bardžiuvienė et al., 2000).

HISTORICAL BACKGROUND OF THE MID- AND LATE PLEISTOCENE STUDY

The Mid- and Late Pleistocene in Lithuania are probably more intensely studied than the other subdivisions of the Pleistocene. Several periods can be distinguished in the development of views on the defining and stratigraphic division of the Nemunas glaciation and Merkinė interglaciation (Gudelis, 1961; Vaitiekūnas, 1968, 1969; Kondratienė, 1960, 1965, 1996; Vonsavičius, 1967, 1984; Gaigalas, 1979, 1984, 1988, 1994, 1995; Gaigalas and Satkūnas, 1994, 1996; Satkūnas, 1996; Gaigalas and Hütt, 1996 et al.).

Mid- and Late Pleistocene deposits in Lithuania became known from the middle of the 19th century. Lately a number of exposures with interglacial formations have been discovered and examined in Lithuania. Most of them are situated in the south-eastern part of Lithuania within the limits of the Baltic Highlands, which belong to the belt of marginal-accumulative and periglacial deposits of the last Nemunas glaciation.

In 1935 Č. Pakuckas was the first to find some outcrops of buried peat and gyttja in the Nemunas River valley near the Merkinė town in Jonionys, Netiesos, Maksimonys, and others. In 1941–1943, after examination of the outcrops in the Nemunas River and Neris River valleys, B. Halicki and A. Jaroszewicz-Halicka discovered several new localities with interglacial deposits. They gathered samples for palynological investigations of interglacial sections known before in Jonionys, Maksimonys and Netiesos. The palynological data, together with some palaeogeographical and stratigraphical conclusions concerning these sections, were published in 1948 by B. Halicki and in 1950 by M. Bremówna and M. Sobołewska.

A regular work on detailed geological survey in Lithuania was started after the second world war. Much valuable information and materials were supplied by geological mapping. The rapid development of studies on the Quaternary and its stratigraphy started after a regional congress on the Quaternary of the Baltic countries and Belarus in 1955 which was held in Vilnius. The conference worked out a regional stratigraphical scheme of the Quaternary of the Baltic countries and Belarus, which was published in the works of this congress and opened a new period in the elaboration of the stratigraphy of the Lithuanian Quaternary deposits (Gaigalas, Satkūnas, 1994).

All stratigraphic units of the Quaternary of Lithuania received their proper local names. The regional stratigraphic scheme of Lithuania, obligatory for geological mapping, was approved by the State Board of Geology in 1961. This scheme was improved in 1965. The Regional Quaternary Stratigraphic Scheme for the Baltic Republics was presented at the conference held in Leningrad in 1963. This scheme was included into the unified scheme of the Russian plain.

The working regional stratigraphic scheme of the Baltic Republics was accepted at the session of the Baltic Quaternary Committee in Vilnius in 1970. The Regional Stratigraphic Scheme of the Quaternary was compiled on the basis of local stratigraphic schemes. The regional Baltic stratigraphic scheme of the Quaternary was unified during the stratigraphic conference held in Vilnius in 1976. This scheme was partly changed while preparing the Quaternary stratigraphic schemes of the East European superregion. Local stratigraphic schemes were used as a background for Regional Schemes. At the second Baltic Stratigraphic Conference held in Vilnius, 1993 our new stratigraphic subdivision of the Quaternary in Lithuania was proposed (Gaigalas, Satkūnas, 1994).

The general stratigraphic subdivision of the Pleistocene in Eastern Europe differs somewhat from that of Western Europe. In Eastern Europe the Quaternary begins with the Eopleistocene followed by the Lower, Middle and Upper Pleistocene. In Western Europe only three main subdivisions exist: Lower (Early), Middle and Upper (Late) Pleistocene. In addition, the boundary between the Lower (Early) and the Middle Pleistocene was fixed differently. In the stratigraphic schemes of Lithuania the Middle Pleistocene begins with the Butėnai (Holsteinian) interglacial. The beginning of the Late Pleistocene is fixed with the Merkinė (Eemian, Mikulian) interglacial.

The geochronological and geological features of the last interglaciation (Eemian, Mikulian, Merkinė) and glaciation (Weichselian, Vistulian, Valdaian, Nemunas) were identified in many countries in north-west and north-east Europe. Opinions differ as to where to draw the time boundary between the last interglacial and the succeeding glaciation, how to correlate it with the oceanic oxygen isotope stages and substages. The probable interglacial/periglacial transition is marked by an abrupt cooling and drying of the climate. Two alternatives are prefered in

Europe for the interglacial/periglacial transition: 1) at about 105 ka BP and at about 70–75 ka. 2) the Eemian interglaciation corresponds to a relatively short time interval (approximately 10,000 years only) and is correlated with the isotope substage 5e about 122,000–132,000 years ago. This opinion is reflected in our scheme of the evolution of the last glaciation in Lithuania (Gaigalas, 1994; 2000). However, the introduction of optically stimulated luminescence (OSL), radiocarbon (^{14}C) and electron spin resonance (ESR) dating has provided a more accurate chronology for the Merkinė interglaciation and Nemunas glaciation deposits in Lithuania (Gaigalas, 1994; 2000).

The views on the stratigraphy of Late Pleistocene in Lithuania were extended by V. Gudelis (1958, 1961, 1973), O. Kondratienė (1960, 1965, 1996), P. Vaitiekūnas (1960, 1969), V. Vonsavičius (1967, 1984) and others. The materials of O. Kondratienė's research into the palynology of interglaciations in Lithuania were summarized in 1996 (Kondratienė, 1996). The existence of only one Late Pleistocene interglaciation (the Merkinė) has been unambigously established in Lithuania. The formation of Late Pleistocene interglaciation deposits was contemporary with the Eemian transgression in Western Europe and the Boreal transgression in the northwestern part of the East European Plain. All the other Late Pleistocene interglaciations proposed earlier have proved to be invalid (Liivrand, 1991). The beginning of the Late Pleistocene with Merkinė interglaciation has been acknowledged by most investigators in Lithuania. The Merkinė interglaciation deposits serve as an important marker horizon in Pleistocene stratigraphy.

Palaeocarpological analyses of some sections of the Upper Pleistocene in Lithuania were carried out by M. Riškienė (1972, 1979), O. Kondratienė, M. Riškienė (1983) and F. Velichkevich (1982). E. I. Loseva (1981) studied diatoms of the stratotypical section of the Merkinė interglaciation. An

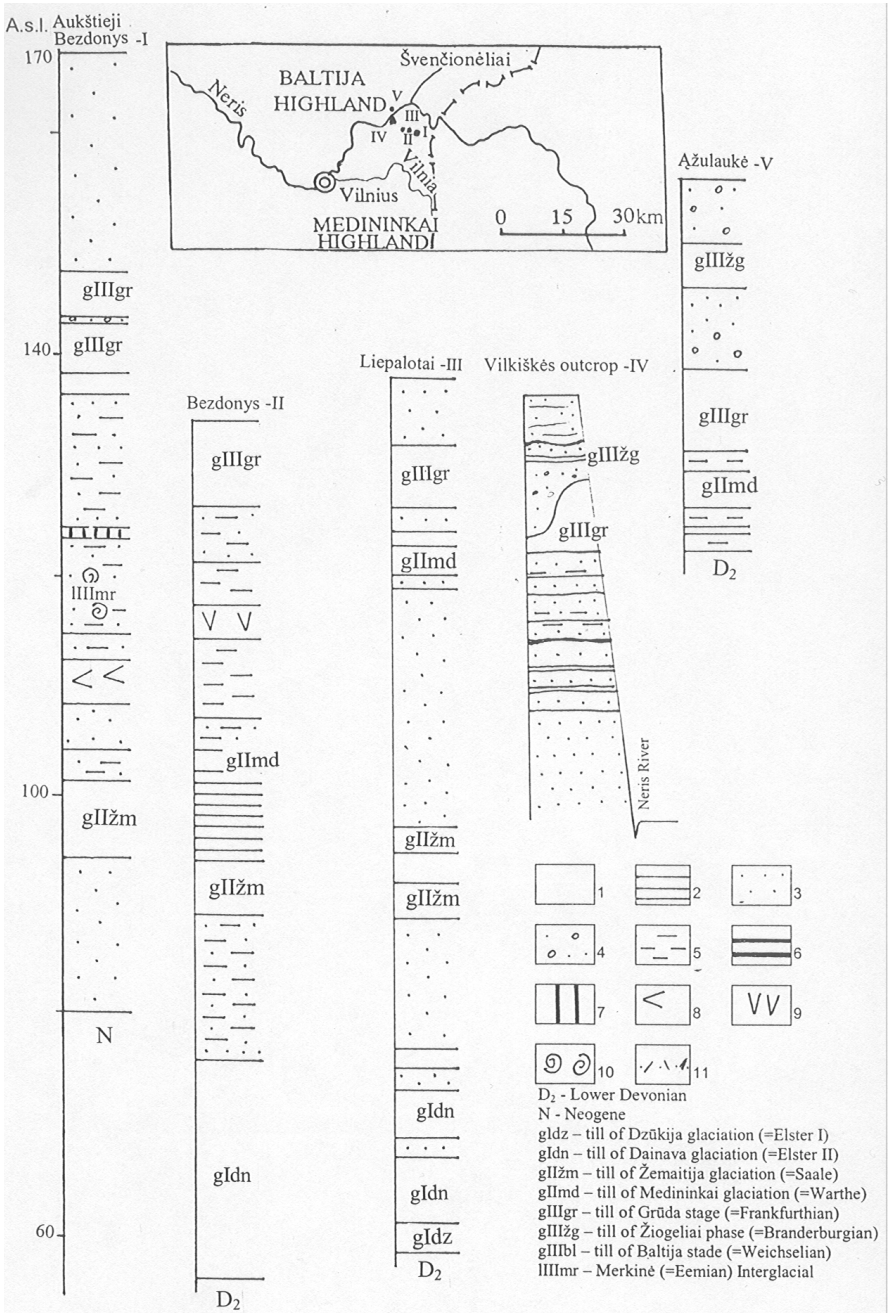

Fig. 1. Location sketch and sections: boreholes Aukštieji Bezdonys-I, Bezdonys-II, Liepalotai-III, Ąžulaukė-V and outcrop Vilkiškės-IV. *1* – till, *2* – clay, *3* – sand, *4* – gravel, *5* – silt, *6* – sand with organic, *7* – peat, *8* – lacustrine marls, *9* – carbonates tuffs, *10* – molluscs, *11* – soil

1 pav. Apžvalginė kartoschema ir geologiniai pjūviai. Gręžiniai: Aukštieji Bezdonys-I, Bezdonys-II, Liepalotai-III, Ąžulaukė-V ir Vilkiškės atodanga-IV. *1* – morena, *2* – molis, *3* – smėlis, *4* – žvirgždas, *5* – aleuritas, *6* – durpžemis, *7* – durpė, *8* – ežerinis mergelis, *9* – karbonatinis tufas, *10* – moliuskų kiauteliai, *11* – dirvožemis

abundant diatom complex characteristic of a small shallow lake has been established. The diatoms have been studied in detail by V. Šeirienė (1996) in sediments of the Merkinė interglaciation and Early Nemunas glacial.

The lithostratigraphy of the till sequence of the Pleistocene (Gaigalas, 1979) as well as the sedimentation, environment and geochronology of Rokai and Jonionys sections (Gaigalas, 1984, 1988, 1994; Gaigalas and Hütt, 1996; Gaigalas et al., 1986 and others) were studied.

LOCATION OF SITE AND ITS POSITION IN THE QUATERNARY COVER

The Vilkiškės outcrop is located in a near northern suburb of the Vilnius city (East Lithuania) in a valley of the Neris River (Fig. 1). The section Vilkiškės is exposed in the left slope of the valley at the absolute high of 136–98 m. The area of Eastern Lithuania is favourable for investigation of the Mid- and Upper Pleistocene. The maximum limit of the Nemunas (Weichselian or Vistulian or Valdaian) Glaciation has been traced in this area. The examined exposure is set in the peripheral part of the last glaciation. Similar sedimentations are found in some outcrops (Buivydžiai, Antaviliai, etc.) of the Neris River in the upper flow between the Belarus border and the Vilnius city. The general structure and stratigraphy of Pleistocene deposits in the basin of the Neris River situated between Vilnius and Nemenčinė was discussed by O. Kondratienė and A. Kučas (1973).

The thickness of the Quaternary cover makes up 60 m in Vilkiškės area. The Pleistocene deposits in East Lithuania are related to the advance and decay of ice sheets of Dzūkija and Dainava (Lower Pleistocene), Žemaitija and Medininkai (Middle Pleistocene) and Nemunas (Upper Pleistocene) Glaciations. The latter (Nemunas) glaciation contains two stadials: Grūda (with Žiogeliai phasial) and Baltija (with South-, Middle- and North-Lithuanian recessional phasials of the retreat of ice cover) (Fig. 2).

The glacial deposits (tills), glaciofluvial and glaciolacustrine sediments are separated by normal aquatic (fluvial and lacustrine) sediments deposited during different (Turgeliai, Butėnai, Snaigupėlė and Merkinė) interglaciations, as well as the interstadials of the last (Nemunas) glaciation.

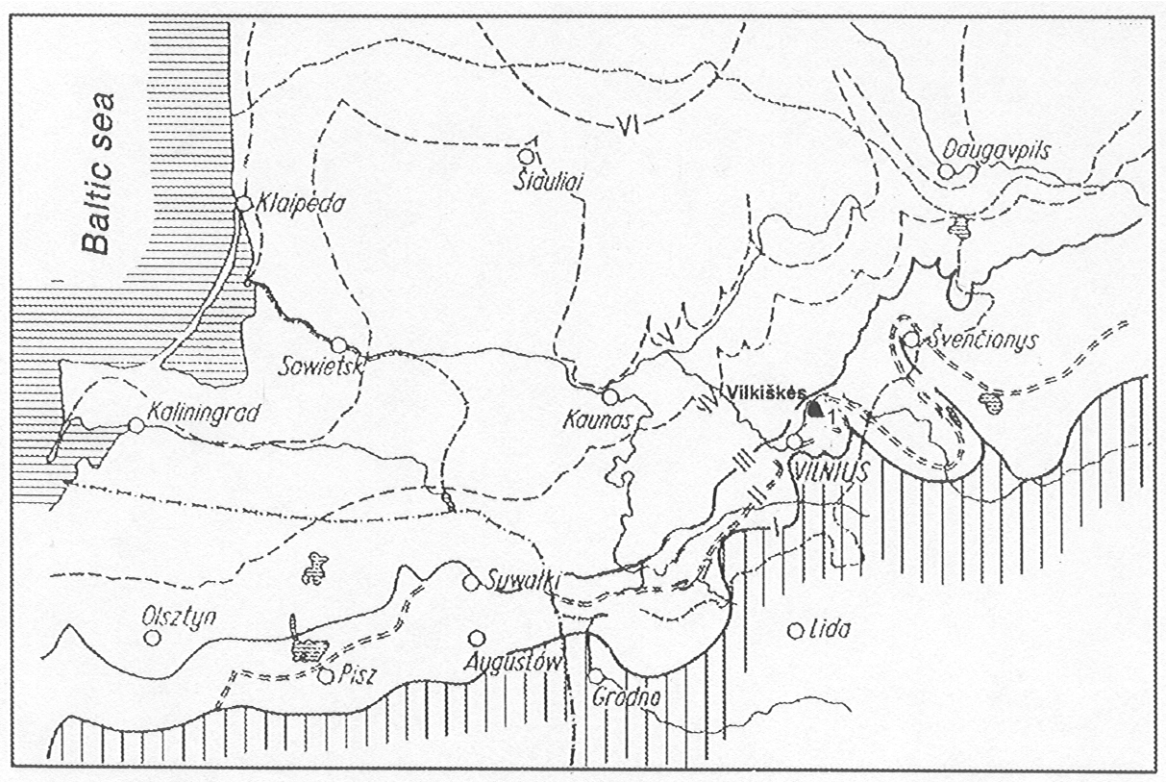

Fig. 2. Location of the Vilkiškės outcrop and boundaries stages and phases of the Last glaciation in Lithuania (after P. Vaitiekūnas, 1968). I – Grūda Stadial, II – Žiogeliai phasial, III – Baltija stadial, IV – South-Lithuanian phasial, V – Middle-Lithuanian phasial, VI – North-Lithuanian phasial

2 pav. Vilkiškės atodangos vieta ir paskutiniojo apledėjimo stadijų ir fazių ribos Lietuvoje (pagal P. Vaitiekūną, 1968). I – Grūdos stadijos, II – Žiogelių fazės, III – Baltijos stadijos, IV – Pietų Lietuvos fazės, V – Vidurio Lietuvos fazės, VI – Šiaurės Lietuvos fazės

All pre-Quaternary rocks are covered by Pleistocene deposits formed in the period 800,000–10,000 years BP. The outcrops of the deep valley of the Neris River are composed of a different sequence of Pleistocene deposits.

TL METHOD

The TL dating was carried out in the TL Laboratory of the Department of Geomorphology and Quaternary Geology, Gdansk University, by Stanisław Fedorowicz (1994). The samples were about 1 kg in weight and 0.5 dm^3 in volume each.

The annual radiation doses (Dr) were determined by taking the potassium, radium and thorium counts with a gamma spectrometer. A preliminary procedure preceded determination of the equivalent dose (ED) and involved the removal of the external shells of quartz grains (grain size 88–102 micrometers – samples No. 5, 6, 13 and grain size 40–60 micrometers – samples No. 1–4, 7–12, 14–20).

The purified fraction was then treated with 10% HCl for 60 minutes. ED was assessed using the reproduction method. The fraction under test was exposed to UV radiation for 24 hours, after which the residual TL level was measured. The sample was then exposed to radiation from a Co-60 cobalt bulb of such an intensity that the values of the TL induced by this dose would between the residual and natural TL levels. The increase in TL was found to be linearly dependent on the size of the dose and ED was then obtained by extrapolation. The occurrence of TL saturation was noted. The accuracy of dating, taking into account laboratory factors, was estimated at around 15% of the assigned age values.

TL DATES OF SEDIMENTS AND THEIR INTERPRETATION

Twenty samples for TL dating were collected from the Vilkiškės outcrop (Fig. 3) by Algirdas Gaigalas and Monika Melešytė in the autumn of 2001. The research results are given in Table 1. The introduction of TL dating provides a more accurate chronology for the aquatic and aeolian sediments of the Vilkiškės section (Table 2). The section starts from the bottom with white fine-grained sand which at present is partly mantled with slope debris due to the diminished erosion capacity of the river in the recent time.

SNAIGUPĖLĖ INTERGLACIATION PROBLEM

During the Middle and Late Pleistocene the deposits of two interglaciations: Butėnai (Holsteinian) and Merkinė (Eemian) are firmly singled out in Lithuania. Some researchers single out one more interglaciation between Butėnai (Holsteinian) and Merkinė (Eemian). This interglaciation, consistent with MIS 7 (Marine Oxygen Isotope Stage), is dated approximately between 240–190 ka. It corresponds with deposits of the Snaigupėlė (Drenthian–Warthian) interglaciation in Lithuania.

The bed of organogenous deposits, attributed to penultimate Snaigupėlė (Drenthian–Warthian) interglaciation is very problematic for Baltic countries.

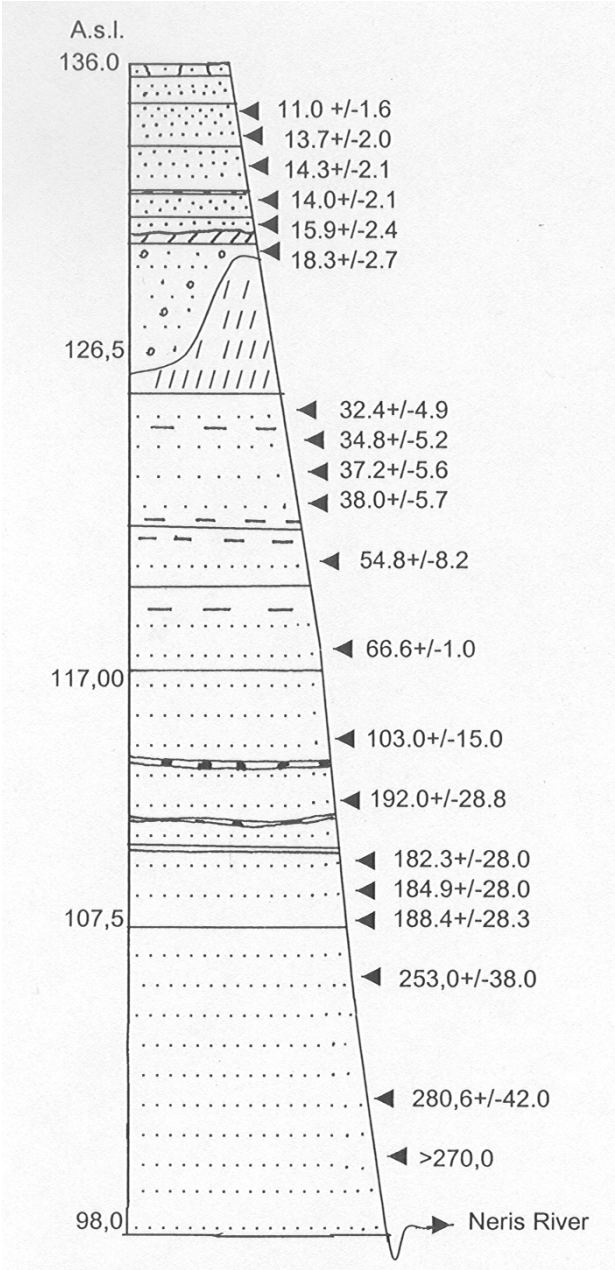

Fig. 3. Vilkiškės outcrop with results of thermoluminescence dating. Legend as in Fig. 1.
3 pav. Termoliuminescencinės datos Vilkiškių atodangoje. Sutartinius ženklus žr. 1 paveiksle

Table 1. **The Vilkiškės section**
1 lentelė. **Vilkiškės pjūvis**

Depth (m)	Lithology	Chronostratigraphy		Sample No	Depth (m)	Dr (Gy/ka)	ED (Gy)	TL age (ka BP)
0.00–4.6	Sand eolian	Nemunas= Weichselian Glacial	Late	1	2.15	2.10 ± 0.08	23.1 ± 2.3	11.0 ± 1.6
				2	3.20	2.12 ± 0.06	29.0 ± 3.0	13.7 ± 2.0
				3	4.40	2.04 ± 0.05	29.1 ± 3.0	14.3 ± 2.1
				4	4 50	2.03 ± 0.06	28.4 ± 2.6	14.0 ± 2.1
4.6–4.76	Sand			5	4.70	2.07 ± 0.06	32.9 ± 3.3	15.9 ± 2.4
4.76–4.82	Till, brown							
4.82–6.0	Sand with gravel			6	5.20	2.26 ± 0.08	41.3 ± 4.2	18.3 ± 2.7
6.0–11.8	Till, reddish brown							
11.8–16.1	Lacustrine sand, laminated		Middle	7	12.45	1.16 ± 0.08	37.6 ± 3.6	32.4 ± 4.9
				8	13.50	1,12 ± 0.06	38.9 ± 3.6	34.8 ± 5.2
				9	14.50	1,17 ± 0.06	43.7 ± 4.0	37.2 ± 5.6
				10	15.50	1,19 ± 0.04	45.2 ± 4.5	38.0 ± 5.7
16.1–16.5	Silt							
16.5–20.7	Silty sand with interlayers of silt		Early	11	17.80	2.26 ± 0.06	123.8 ± 12.2	54.8 ± 8.2
				12	19.50	2.32 ± 0.08	154.5 ± 15.4	66.6 ± 10.0
20.7–21.0	Silty sand							
21.0–21.65	Sand							
21.65–22.10	Sand fine grained with organic	Merkinė=Eem Interglacial		13	21.05	3.70 ± 0.11	381.1 ± 38.2	103.0 ± 15.0
22.10–22.60	Sand fine grained with humic	Late Snaigupėlė= Drenthian–Warthian Interglacial		14	22.40	1.12 ± 0.08	215.0 ± 21.5	192.0 ± 28.8
22.60–23.9	Sand, laminated							
23.9–27.4	Sand, laminated			15	24.10	1.18 ± 0.010	215.1 ± 20.8	182.3 ± 28.0
				16	25.70	1.13 ± 0.08	208.9 ± 20.3	184.9 ± 28.0
				17	27.00	1.19 ± 0.06	224.2 ± 22.4	188.4 ± 28.3
27.4–37.1	Sand	Early Snaigupėlė= Drenthian–Warthian Interglacial		18	28.60	1.16 ± 0.08	293.5 ± 30.0	253.0 ± 38.0
				19	33.00	2.84 ± 0.08	796.9 ± 80.0	280.6 ± 42.0
				20	33.75	2.80 ± 0.10	>750.0	>270.0

The stratotypical sediments of the Snaigupėlė palaeobasin have been studied near the Druskininkai town in South Lithuania. The Valakampiai site, Buivydžiai and Mardasavas outcrops are parastratotypical sections of the Snaigupėlė interglaciation. The outcrop of interglaciation deposits at the Valakampiai site is located in the northern part of the city of Vilnius on the left side of the Neris River not far from the Vilkiškės outcrop.

The age and stratigraphical position of Snaigupėlė interglaciation sediments at the Valakampiai site is uncertain. The age of this interglaciation sediments has been determined on two samples of mollusc shell material composed of calcite displaying typical multicomponent ESR spectra (Gaigalas, Molodkov, 2001). Shell analysis yielded mutually consistent dates of 116.0 ± ± 10.8 and 110.0 ± 12.1 ka BP with an average age of about 113.0 ka years BP. The numerical data obtained allow to link the interglaciation layer studied with Merkinė (Eemian) age. The presence of the Snaigupėlė (Drenthian–Warthian) interglaciation in the Valakampiai site is open to debate.

In the lowermost part (23.9–37.1 m from the top) of the Vilkiškės outcrop, interglacial lacustrine fine-grained sands with lamination and interlayers of silt occur. This part of section comprises two chronostratigraphical units: the lower – 253.0 ± 38.0 – 280.6 ± ± 42.0 ka and the upper – 182.3 ± 28.0 – 192.0 ± ± 28.8 ka BP. They belong to Lower and Upper Snaigupėlė interglaciation units, respectively (Table 1).

The analogous optically stimulated luminescence (OSL) dating of lacustrine sediments of the lower unit was made in 2000 by G. Hütt in the Institute of Geology (Tallinn) (Gaigalas, Hütt, Melešytė,

Table 2. **Geochronological division of Vilkiškės outcrop**
2 lentelė. **Vilkiškės atodangos geochronologinis suskirstymas**

Main subdivision	Stage	Substage	Age kyrs	Stadial		Age kyrs	Interstadial
Upper Pleistocene	Nemunas or Vistulian or Weichselian or Valdaian Glacial	Late Middle Early	30 60 70	Ice sheet of main glacial advance	Baltija Žiogeliai (phasial) Grūda	15,8 16 17 18 22 45 60	Pavytė Krikštonys (interphasial) Biržai Rokai Jonionys II Jonionys I
	Merkinė or Eemian Interglacial		105 130				
Middle Pleistocene	Medininkai or Warthian Glacial	*Hiatus*	–	sediments absent			
	Snaigupėlė or Drenthian – – Warthian Interglacial		180 280				

2000). The OSL age (250,000 ± 17 400 and >250,000 for three samples) was determined.

The sand of lacustrine origin at the Vilkiškės outcrop is presently attributed to the Snaigupėlė interglaciation. A similar thermoluminescence age (>250 ka BP and 175 ± 18 years BP) of the Snaigupėlė interglaciation lake sands at the Antaviliai outcrop in the valley of the Neris River, suburbs of Vilnius, was published by J. Satkūnas and G. Hütt (1999).

The thermoluminescence age (250.000 ± 20 and 248.000 ± 25 years BP) of the Snaigupėlė interglaciation was determined in to samples, collected from fine-grained light grey lacustrine sands (depth 3.0 m and 9 m) in the Gvildžiai outcrop near Klaipėda in West Lithuania (Gaigalas, Hütt, Melešytė, 2001).

The research of the Snaigupėlė interglaciation sections allowed to conclude that the lake sediments recognized in East and West Lithuania ought to be attributed most likely to the Drenthian–Warthian ice free time interval of isotope stage 7.

In the Vilkiškės section studied, the Snaigupėlė interglaciation sediments are not overlain with Medininkai (Warthian) glaciation till, but such till has been noted at the other outcrops of the Neris River. This till was impacted by denudation during Merkinė interglaciation deposition of the overlying sandy sediments of the next lithostratigraphic complex.

MERKINĖ (EEMIAN) INTERGLACIATION

One sample of fine-grained sand with organic matter is TL-dated at 103.0 ± 15.0 ka (Table 1) Merkinė interglacial. The Merkinė interglaciation deposits are most widely spread. Most section have been examined in South-Eastern Lithuania. There they are presented by lake-bog deposits (gyttja, peat, clay, mud, loam, sand). The Merkinė interglaciation stratotype deposits are located in the Jonionys-Maksimonys site near the Merkinė town in South Lithuania. Jonionys site has been dated by methods of

optically stimulated luminescence (OSL), radiocarbon and electron spin resonance (ESR) (Gaigalas, Hütt, 1995; Gaigalas, Pazdur, Pawlyta, 2001). At the Jonionys stratotype the sandy deposits of the Merkinė (Eemian) interglaciation lake beach produced an optically stimulated luminescence (OSL) age of 114,000–70,000 BP.

The dated layers were deposited during the *Quercus* pollen zone – 114.000 BP, the *Tilia* pollen zone – 83,000 BP and the *Carpinus* pollen zone – 70,000 BP. The layer of sand of the Merkinė (Eemian) interglacial in the Vilkiškės outcrop according to the TL date (103.0 ka) (Table 1) corresponds to the first time interval in the stratotype section at Jonionys.

The Nemunas (Weichselian, Vistulian, Valdaian) ice-free sandy and silty deposits overlie the deposits of the Merkinė (Eemian) interglaciation.

NEMUNAS GLACIAL

Thermoluminescence dating was applied to twelve samples of deposits of the Nemunas glacial in the Vilkiškės section (Table 1). Three chronostratigraphic units of the Nemunas (Weichselian, Vistulian, Valdaian) glacial are distinguished in the Vilkiškės section according to the TL dating and sedimentation complexes (Table 2). The first unit corresponds to Early Nemunas (Weichselian, Vistulian, Valdaian) silty sands, with frozen involutions formed about 66.6 ± ± 10.0 – 54.8 ± 8.2 ka BP, the second unit of the laminated lacustrine sand is attributed to the Middle Nemunas (Weichselian, Vistulian, Valdaian) time formed about 38.0 ± 5.7 – 32.4 ± 4.9 ka BP, and the third unit of glacial deposits covered by glaciolacustrine and aeolian sands with soil layers to the Late Nemunas time (about 18.3 ± 2.7 – 11.0 ± ± 2.7 ka).

Two reddish-brown (lower) and brown (upper) till layers in the section studied are younger than 30,000 BP and older than 15.900 BP (Table 1). Radiocarbon dating of analogous glacigenic sediments in the Jonionys section (Gaigalas, Pazdur and Pawlyta, 2001) as well as in the Rokai section (Gaigalas and Hütt, 1995) are younger than 30,000 BP. The till stratum at the Vilkiškės section belongs to the Grūda (Branderburgian, Lesznian) stadial and the Žiogeliai (Frankfurtian, Poznanian) phasial of the maximum of the Late Nemunas glaciation (Table 2).

Sand under the soil layer (0.16 m thick) was TL-dated to 15.9 ± 2.4 ka. The TL dating of a sand sample from under the soil layer suggests that it represents the Pavytė (Branderburgian with Frankfurtian–Pomeranian) interstadial (Table 2).

Glaciolacustrine and aeolian sediments from the upper part of the sequence were TL-dated to 14.000 ± ± 2.100 – 11.000 ± 1.600 (Table 1). Their deposition took place in the periglacial conditions of the maximum and retreat of the glacial cover of the Baltija (Pomeranian, Pomorzian) stadial of the Late Nemunas time (Table 2). Recessions of the diminishing ice sheet of the Baltija (Pomeranian, Pomorzian) stadial were marked in the northern relief by several well-shaped terminal formations of the East-Lithuanian, South-Lithuanian, Middle-Lithuanian and North-Lithuanian phasials 16,000–13,000 years ago.

The uppermost part of the section is composed of aeolian sand with the TL date younger than 11,000 ± 1,600 years and belongs to the Late Dryas time of Late Glacial (Gotiglacial). The regular succession of Gotiglacial climatic and sedimentation changes was conditioned by recession of the ice sheet of the Baltija (Pomeranian, Pomorzian) stadial (Gaigalas et al., 2001).

Lacustrine sediments 13 m thick have been discovered under the Late Nemunas till complex in a palaeokarst depression at Biržai, Northern Lithuania (Gaigalas et al., 1992). Wood fragments from silty layers in the basal part of this section were ^{14}C dated to 34,400 ± 1,500 and 33,460 ± 1,060 years BP. The comparable sediments in the Rokai section in Central Lithuania have the OSL age of 32,000 ± ± 4,000 – 31,000 ± 3,000 BP (Gaigalas and Hütt, 1995). The Middle Nemunas deposits at Rokai are covered by four layers of Late Nemunas tills.

CONCLUSIONS

TL dating of Pleistocene sediments from the Vilkiškės section allows to draw some conclusions. The fine-grained sands at the lowermost part of the section previously correlated with the Butėnai (Holsteinian) or Merkinė (Eemian) interglaciation seems to be of the Snaigupėlė (Drenthian–Warthian) interglaciation age of the Middle Pleistocene.

The Merkinė (Eemian) interglaciation lake bog sediments in the study sections showed a TL age of 103,000 years BP.

TL dating of samples from the section studied suggests that there were three stages of the Nemunas (Weichselian, Vistulian, Valdaian) glaciation: Early, Middle and Late. The glacier covered South-eastern Lithuania in the Late Nemunas time. Periglacial conditions existed in the Early Nemunas time.

The TL dates obtained from the study of the Vilkiškės section confirm the absence of an ice sheet during the Early Nemunas and Middle Nemunas time. The Early and Middle Nemunas periglacial deposits are presented by silty and sandy aquatic sediments.

The Snaigupėlė interglaciation section allowed to conclude that the lake sediments recognized in Vil-

kiškės ought to be attributed most likely to the Drenthian–Warthian ice-free time interval of Marine Oxygen Isotope Stage 7.

Results of TL dating in the Vilkiškės section call for a broad discussion of the extent and correlation of the Snaigupėlė (Drenthian–Warthian) interglaciation in Lithuania.

On the grounds of thermoluminescence (TL) dating of Middle and Late Pleistocene sediments, fine-grained sands of aquatic origin are attributed to the Snaigupėlė (Drenthian–Warthian) interglaciation of the Middle Pleistocene in the lowermost part of the Vilkiškės exposure. TL dates of sediments in the upper part of the section provided the basis for determining the age of the Merkinė (Eemian) interglaciation and the Nemunas (Weichselian, Vistulian, Valdaian) glaciation of the Late Pleistocene.

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VILKIŠKĖS ATODANGOS RYTŲ LIETUVOJE VIDURINIO IR VĖLYVOJO PLEISTOCENO NUOGULŲ TERMOLIUMINESCENCINĖS DATOS

S a n t r a u k a

Vilkiškės atodangoje Neries kairiajame krante, Vilniaus šiauriniame pakraštyje, smulkiagrūdis smėlis, nusėdęs akvalinėje aplinkoje, anksčiau buvo priskirtas Butėnų (Holšteino, Lichvino) ir Merkinės (Eemio, Mikulino) tarpledynmečiui. Termoliuminescencinės (TL) datos (280,6–182,3 ka), gautos Gdansko universiteto laboratorijoje, leidžia jį priskirti Snaigupėlės (Drentės–Vartos, Odincovo) tarpledynmečiui. Virš minėto smėlio slūgso Merkinės tarpledynmečio smulkiagrūdis smėlis su aleurito tarpsluoksniais ir organika, kurio TL amžius – 103,0 ka. Viršutinės atodangos dalies sluoksniuotos smėlingos nuosėdos yra priskiriamos Nemuno (Vislos, Valdajaus) ledynmečiui. TL datos iš apačios į viršų yra pasiskirsčiusios nuo 66,6 iki 11,0 ka. Išskirti trys Nemuno laikotarpiai: ankstyvasis (66,6–54,8 ka), vidurinis (38,0–32,4 ka) ir vėlyvasis (18,3–11,0 ka). Viršutinėje pjūvio dalyje pastebėti moreninio priemolio sluoksniai yra jaunesni negu 30.000 ir senesni negu 15.900 metų.

Альгирдас Гайгалас, Станислав Федорович

ТЕРМОЛЮМИНЕСЦЕНТНЫЕ ДАТЫ ОТЛОЖЕНИЙ СРЕДНЕГО И ПОЗДНЕГО ПЛЕЙСТОЦЕНА В ОБНАЖЕНИИ ВИЛЬКИШКЕС, ВОСТОЧНАЯ ЛИТВА

Р е з ю м е

Мелкозернистые пески аквального происхождения в обнажении Вилькишкес на левом берегу р. Нярис возле северной границы г. Вильнюс раньше относились либо к бутенайскому (гольштейнскому, лихвинскому), либо к мяркинскому (эемскому, микулинскому) межледниковью. Термолюминесцентные (ТЛ) даты (280,6–182,3 ka), полученные в лаборатории Гданьского университета, позволяют их отнести к снайгупельскому (дренте–варта, одинцовскому) межледниковью. Над ними залегают мелкозернистые пески мяркинского межледниковья с прослоями алевритов и с органикой, ТЛ возраст которых – 103,0 ka. Залегающие в верхней части обнажения слоистые песчаные отложения относятся к нямунскому (вислинскому, валдайскому) ледниковью. Их ТЛ даты распределяются от 66,6 до 11,0 ka снизу вверх. Выделены три временных интервала нямунского ледниковья: ранний (66,6–54,8 ka), средний (38,0–32,4 ka) и поздний (18,3–11,0 ka). Обнаруженные в верхней части разреза слои моренных суглинков моложе 30 000 лет и старше 15 900 лет.