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Results of uranium-thorium isochron dating of Netiesos section peat-bog in South Lithuania

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The Merkinë (Muravian, Mikulian, Eemian) Interglacial peat bog was dated first by the uranium-thorium isochron method in the Netiesos parastratotype section, South Lithuania. The age of the Netiesos section ranges within 80.6 ± 4.1 ka and 108.8 ± 8.7 ka years BP. These dates correspond to the second part of climatic optimum of the Interglacial (palynosubzone M_{3c} and palynozone M_4) and confirm the ESR dates (101.5 ± 11.5 ka) of the same layer in the Netiesos section.

Key words: peat, uranium-thorium dating, Merkinë Interglacial, Netiesos section, South Lithuania

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INTRODUCTION

Relatively recently it has been established that thick peat horizons are favorable material for dating by the uranium-thorium method (Vogel, Krenfeld, 1980; Heijnis, 1992; Geyh, 2001). This method allows to date peat bogs up to 300 ka, which is much above the limit of radiocarbon method (55–60 ka). We successfully use this method for dating stratotypical sections of Mikulino, Murava and Kazantsevo (Eemian) Interglacial on the Russian plain, in Belarus and Siberia (Кузнецов и др., 2003, Арсланов и др., 2004; Arslanov et al., 2004, Sanko et al, 2004). The obtained dates of the Last Interglacial agree with the Interglacial substage 5e chronology of marine isotopic-oxygen stages showing that the ^{230}Th/U isochron method is appropriate and important for dating interglacial and interstadial peat horizons.

The Netiesos outcrop is located on the right bank of the Nemunas River about 6 km downstream from Merkinë, a small town in South Lithuania. This outcrop is about 1 km downstream from the Netiesos village and the mouth of the Netiesë River (Fig. 1).

The Interglacial organogenic sediments of lacustrine–palustrine origin occur in the basement of a 19-meter terrace of the Nemunas River. They are dated as sediments of the Last (Merkinë, Muravian, Mikulian, Eemian) Interglacial by palaeontologic and geochronologic methods. The Merkinë continental deposits are composed mostly of gyttja and peat with rare mollusk shells and sandy sediments of lake origin on the top. This outcrop (sediments at a depth of 12–18 m) is a parastratotype section of the Merkinë Interglacial in Lithuania (Lithuanian Stratigraphic Units, 1999). The Netiesos outcrop is situated at a distance of 3 km from the Merkinë Interglacial

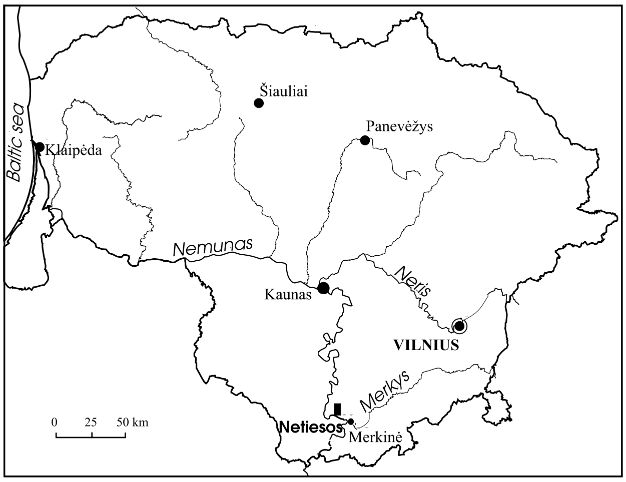

Fig. 1. Location of the Netiesos section studied.
Coordinates (longitude, latitude): 54°02'20''; 24°05'02''
1 pav. Netiesø pjûvio vieta.
Geografinës koordinatës (platuma, ilguma) – 54°02'20''; 24°05'02''

stratotype on the left (Jonionys outcrop) and right (Maksimonys outcrop) sides of the Nemunas River. The stratotype deposits lie in outcrops at a depth of 5.75–7.35 m and the Jonionys-3 boring at a depth of 11.95–13.75 m.

PREVIOUS INVESTIGATIONS

The interglacial deposits in the Netiesos locality are always well cropped out and available for investigations by different methods (palynological, palaeocarpological, palaeozoological, sedimentological, geochronological) for a long time. N. N. Sobolev (Соболев, 1910) mentioned the first peaty deposits of the Netiesos outcrop. Later, palaeobotanic investigations were carried out (Brenówna, Sobolevska, 1950; Borówka-Dùuêakowa, Halicki, 1957; Кондратене, 1965; 1996; Ришкене, 1978; Riðkienë, 1979; Литвинюк, 1981; Величкевич, 1982; Velichkevich, Kondratienë, Kiselienë, 1999). The interglacial lacustrine-palustrine deposits are rich in diverse fossil remains of plants (pollen and spores, seeds, fruits, megaspores, cones of conifers, wood and moss) and animals (mollusks, ostracods, little animals and insects). The most complete last information on the Netiesos seed flora is presented by Velichkevich, Kondratienë, Kiselienë (1999). The flora from the Netiesos section is the richest among all floras of the Merkinë (Muravian, Mikulian, Eemian) Interglacial in Lithuania and may be considered as a standard for the whole group of floras of this Interglacial in the East and Middle European region.

J. Urbanski (Brenówna, Sobolevska, 1950), P. Šivickis (Кондратене, 1966) and A. Sanko (Sanko, Gaigalas, 2004) restored a rich freshwater malacofauna from mollusk shells found in calcareous gyttja under peat in Netiesos section. Mollusks of lakes and other constant reservoirs of various sizes prevail in the fauna. The temperature of the water was rather high. The rodent fauna was studied by A. Motuzko and P. Kalinovski (Калиновский, 1984). The palaeontological data allow to conclude that in the Merkinë Interglacial forest-tundra with steppe elements prevailed. In the lower part of Interglacial sediments the rodent fauna remains were found at two intervals: 17–18 m and 16.8–17.1 m.

The different sediments from the Netiesos section were estimated geochronologically by the optically Stimulated Luminescence (OSL), Termoluminescence (TL) and Electron Spin Resonance (ESR) methods. The age of freshwater mollusk shells from lake and bog deposits (pollen zones M_1–M_4 in the Merkinë Interglacial) in the Netiesos outcrop was determined as 112.1 ± 25.9 and 101.5 ± 11.5 ka years BP (for samples from lower and upper units, respectively) by the ESR method (Gaigalas et al., 1994; Gaigalas, Molodkov, 1997; 2002). Last year, the TL age for sands under gyttja was determined as 196.9 ± 27.5 ka years BP and for the sand interlayer in the basal part of gyttja as 145.9 ± 20.3 ka years BP (Gaigalas, Fedorowicz, Meleðytë, 2004). These deposits belong to the next-to-last glaciation according to TL dates. Four samples of lake sands above the organogenic sediments of Merkinë (Muravian, Mikulian, Eemian) Interglacial were dated first by OSL (Gaigalas, Hütt, 1997). Two samples from the lower horizon of lake sand were determined as 98000 ± 12000 and 86000 ± 700, and two samples from the upper part of the Netiesos section were indicated as 70000 ± 3000 and 70800 ± 8000 years BP. These dates correlate well with new TL results (Gaigalas, Fedorowicz, Meleðytë, 2004) obtained in 2003 for the Netiesos outcrop of the same lake sand (118.4 ± 14.2 ka, 104 ± 13.5 ka, > 110.6 ka, 135.9 ± 17.7 ka, 103.2 ± 13.4 ka years BP). Their deposition probably took place just before the Last (Nemunas, Poozerian, Valdaian, Vistulian) Glaciation.

A palaeomagnetical study of the Merkinë (Eemian) Interglacial deposits in the Netiesos section was carried out (Gaigalas et al., 2002). The geomagnetic Blake event sometimes recorded in Eemian deposits was not found in the Netiesos profile of the Merkinë Interglacial.

The Nemunas (Poozerian, Valdaian, Vistulian) glacial sandy deposits in the cover of Interglacial sediments were dated by TL in the Netiesos section, too (Gaigalas, Fedorowicz, Meleðytë, 2004): Early Nemunas periglacial (72 ± 8.7 ka, 82.0 ± 10.7 ka, 73.3 ± 9.5 ka, 70.4 ± 5 ka years BP), Middle Nemunas Interstadial (48.2 ± 7.5 ka, 41.2 ± 5.0 ka, 40.6 ± 4.9 ka, 37.9 ± 4.5 ka, 38.8 ± 4.6 ka, 31.9 ± 4.4 ka, 35.2 ± 4.2 ka, 34.2 ± 4 ka years BP) and Late Nemunas glacial time (23.1 ± 2.8 ka, 18.2 ± 2.3 ka, 79.7 ± 11.9 ka, 18.8 ± 2.3 ka years BP). The upper part of the Netiesos outcrop represents glaciofluvial sediments of the Grûda (Bologovskian, Brandenburgian) stadial of Nemunas (Valdaian, Poozerian, Vistulian) Glaciation. Twenty-three TL dates obtained last year (Gaigalas, Fedorowicz, Meleðytë, 2004) characterized the Last Interglacial/Glacial macroclimatic cycle of the Pleistocene in Lithuania.

According to the results of Optically Stimulated (OSL) analysis, the deposits of the Merkinë Interglacial in the stratotypic section at Jonionys are 120000–70000 years old (Gaigalas, Hütt, 1995). Two samples of freshwater gastropod shell remains from the lower part of Jonionys section were taken for ESR analyses (Molodkov, Gaigalas, 1994). The samples gave ages of 101 ± 12 ka and 118 ± 12 ka, mean about 110 ± 9 ka BP.

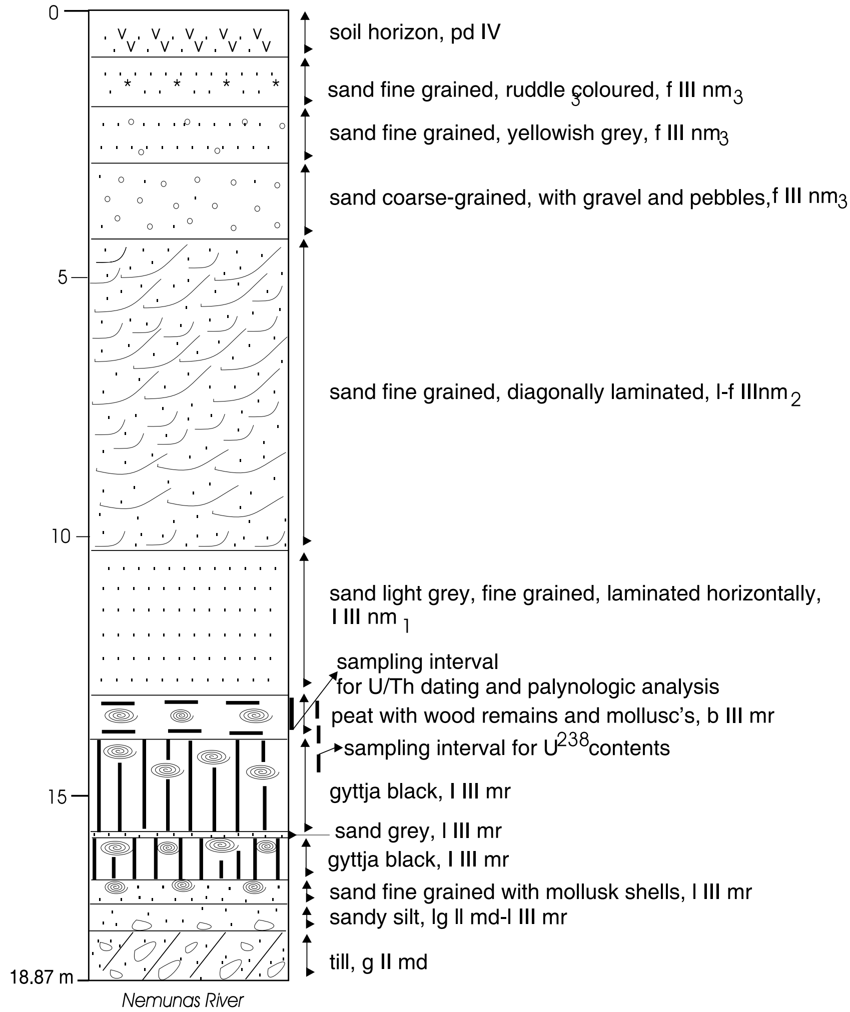

Fig. 2. Netiesos outcrop with sampling intervals below the sand layer for U/Th dating: 30–35, 35–40, 40–45, 45–50, 50–55 and 55–60 cm

2 pav. Netiesø atodanga su mëginiø U/Th datavimui ëmimo intervalais þemiau smëlio sluoksnio: 30–35, 35–40, 40–45, 45–50, 50–55 ir 55–60 cm

METHOD

In summer 2002, CR2 team members of the INTAS project Kh. A. Arslanov, V. Yu Kuznetsov and F. E. Maksimov participated in field works in Lithuania together with the leader of CR1 team Prof. A. Gaigalas and his colleagues and collected samples for ^{230}Th/U dating from stratotypical Late and Middle Pleistocene sections. Now we give ^{230}Th/U ages of the Netiesos section – key ones of the Merkinë (Eemian) Interglacial in Lithuania. We selected six peat samples (5 cm thick each) from the middle part of a brown peat horizon (66 cm thick). For dating we used the same analytical method as had been used for the dating of Murava sections in Belarus (Sanko et al., 2004).

For ^{230}Th/U dating, peat samples were dried at 110 °C up to constant weight. The ground samples (10–20g) were burned in a muffle oven at 700 °C. We used both well known Leach Alone (L/L) (Schwarcz, Latham, 1989; Heijnis, 1992) and total sample dissolution (TSD) (Luo, Ku, 1991) models for extraction of U and Th isotopes from the samples. In the former case (L/L model), calcined samples were leached with 7 M HNO_3 for 6 h. After centrifuging (residue was discarded), spikes of ^{232}U and ^{234}Th were added to the solutions. In the second case (TSD model), the calcined samples were dissolved in concentrated HNO_3, HF and HCl solutions. Then F^- was removed by treatment with concentrated $HClO_4$, and U and Th isotopes were co-precipitated on iron hydroxide by carbonate-free ammonia after introduction of ^{232}U and ^{234}Th spikes. For separation of uranium and thorium we used anion exchange resin AB-17 (Кузнецов и др., 2000). Then U and Th isotopes were deposited on platinum disks, and the alpha-activity of ^{234}U, ^{238}U, ^{232}U, ^{230}Th and ^{232}Th was measured with a silicon detector and pulse analyzer. The chemical yield of U and Th isotopes was calculated from the activity of ^{232}U and ^{234}Th spikes. The counting efficiency for uranium and thorium isotopes was checked with a trans-uranium (^{239}Pu and ^{241}Am) standard of known activity.

DESCRIPTION OF RESEARCH PROFILE

Sands, clays, peat and gyttja were present in deposits of the Netiesos profile. The basement of the glaciofluvial terrace outcrop is open in the Netiesos outcrop (Fig. 2). The following layers are exposed (from bottom to top):

1 – g II md – till (boulder loam) of the Medininkai glaciation, brown colour , 1.15 m;

2 – lg ll md–l III mr – sandy silt of the end of the Medininkai glaciation and beginning of the Merkinë interglacial, 0.75 m;

3 – l III mr – sand fine-grained, lightly grey-coloured, peaty, with mollusk shells and wood remains, 0.25 m;

4 – l III mr – sand yellowish grey, 0.15 m;

5 – l III mr – gyttja dark colour, distinctly fissile and with interlayers of sand 0.93 m;

6 – l III mr – sand grey, fine grain, 0.03 m;

7 – l III mr – gyttja dark colour, with peat interlayers and wood remains, sandy in the lower part, with mollusk shells, 1.70 m;

8 – III mr – peat with wood remains, dark brown colour, with mollusk shells in the lower part, the top of layer is rewashed and serves as non-conductor of groundwater, 0.85 m;

9 – l III nm_1– sand light grey, fine-grained, laminated horizontally, quartz-feldspar, sole shows sedimentation hiatus, 2.85 m;

10 – l III nm_2 – sand fine-grained, lightly grey, diagonally laminated, carbonaceous, quartz-feldspar, 6.05 m;

11 – f III nm_3 – sand coarse-grained, with gravel and pebbles, carbonaceous, quartz-feldspar, yellowish-grey, 1.45 m;

12 – f III nm_3 – sand fine-grained, yellowish grey, 1.1 m;

13 – f III nm_3 – sand fine-grained, ruddle coloured, quartz-feldspar, 0.91 m;

14 – pd IV – soil horizon, 0.7 m.

SEDIMENTATION ENVIRONMENTS

Sediments of lacustrine, boggy and alluvial origin are represented in the Netiesos outcrop. Grain size distribution, structure and texture were investigated in these deposits sedimentologically. Different sedimentation environments were distinguished for Merkinë Interglacial and Nemunas Glaciation after sedimentological investigation of the Netiesos outcrop in South Lithuania (Table 1). After the next to last Medininkai glaciation, arctic climatic conditions started. Lake littoral and deep sedimentation environments existed during the most part of Merkinë Interglacial. The bog formation started in the second part of the Interglacial under the dry but warm climatic conditions. After Merkinë Interglacial, periglacial conditions existed during the Early Nemunas time. A threefold time environmental division (Early Middle and Late) of the Nemunas glacial stage in Lithuania is based on climatic fluctuations (Gaigalas, 2000). The layer of sands covering the organic deposits of Merkinë Interglacial was interpreted as deposited by in stagnant water basin during the early Nemunas time. The sole of the sand layer shows a clear rewash and sedimentations. The initial phase of the Early Nemunas was characterized by the spread of cryophilous and hydrophilous vegetation (plants that can survive in a cold and moist climate) (Кондратене, 1965). The peat bog of Merkinë Interglacial was open for the action of outward processes in the end of Merkinë Interglacial and the beginning of Early Nemunas in Netiesos. Weathered till of Middle Pleistocene is observed in the left side

Table 1. **Sedimentation environments and climatic changes during formation of deposits exposed in Netiesos outcrop**
1 lentelë. **Nuogulø, slûgsanèiø Netiesø atodangoje, formavimosi sedimentacinës aplinkos ir klimato sàlygos**

Chronostratigraphic division		Sedimentation environments	Climatic conditions
Nemunas Glaciation	Late Nemunas	Glaciofluvial	Arctic Humidic peri-Glacial
	Middle Nemunas	Lake sublitoralic	Subarctic stadial
		Lake	Subboreal interstadial
	Early Nemunas	Lake sublitoralic	Subarctic stadial
Merkin Interglacial		Lake litoralic	Colder humid interglacial
		Bog	Dry Warm interglacial
		Lake deap	Humid
		Lake litoralic	
Medininkai glacial		Glacigenic	Arctic glacial

of the outcrop. The investigated area remained ice-free during the Early and Middle Nemunas time. The data already obtained in the Netiesos outcrop confirm the absence of an ice sheet in this area during the Middle Nemunas time, as well as in Early Nemunas. The sedimentation of sandy sediments took place in lake environments. The ice cover of Nemunas Glaciation reached its maximum in Lithuania about 22000–18000 years BP. The duration of the Late Nemunas glaciation was short, certainly less than 10 000 years in South Lithuania (Gaigalas, 1994). In the upper part of the Netiesos section there lie glaciofluvial sediments of last glacial melt waters. Glaciofluvial sediments are connected with a melting ice cover tending to the end of Nemunas Glaciation.

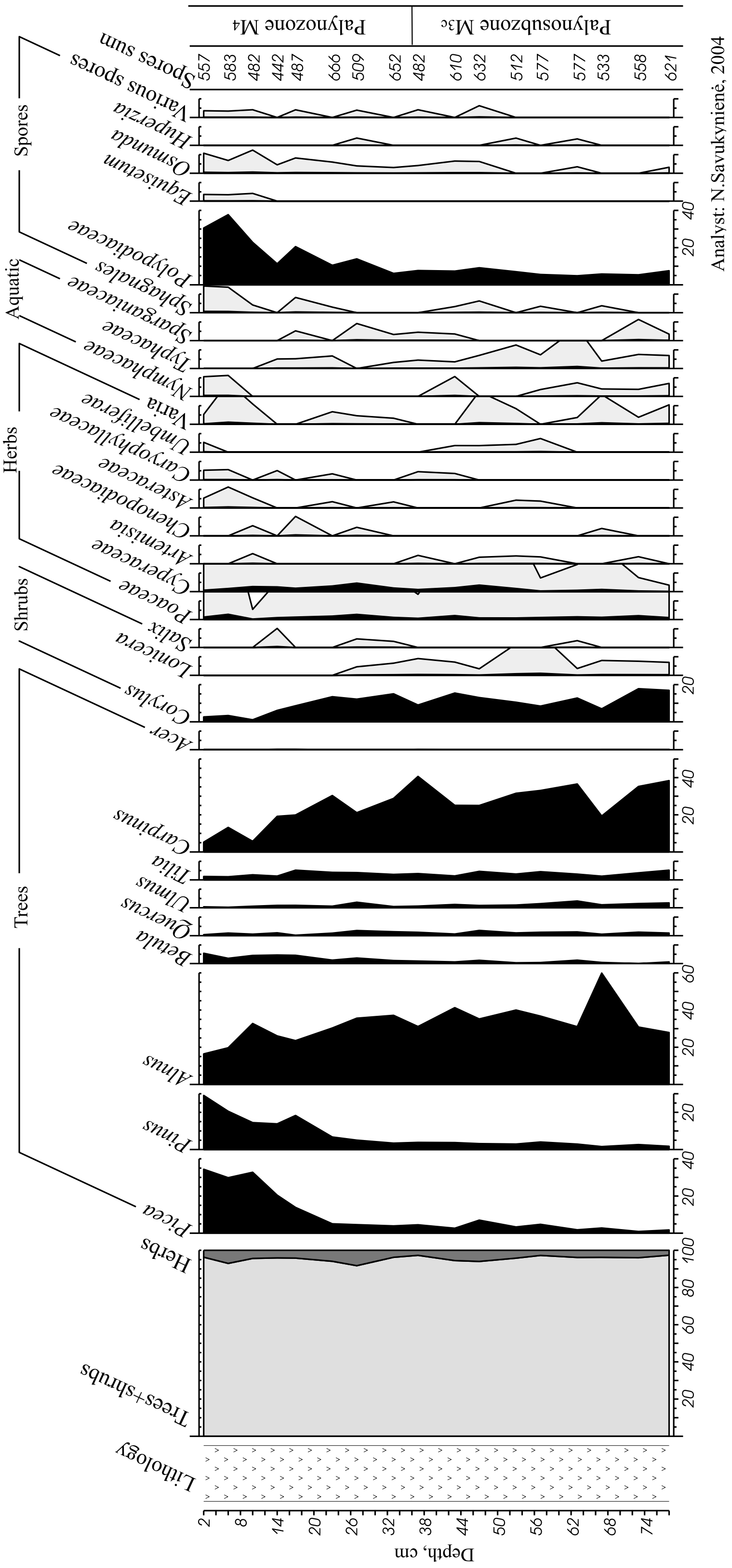

Fig. 3. Palynological diagram of peat layer in Netiesos section
3 pav. Netiesø pjûvio durpiø sluoksnio palinologinë diagrama

PALYNOLOGY OF THE PEAT BOG

Palynological analyses of peat and gyttja samples from the Netiesos outcrop were carried out by O. Kondratienë and resulted in a diagram (Кондратене, 1996). She found spore-and-pollen zones from M_1 to M_4. The zone M_5 is absent in the upper part of this outcrop. We realize palynological analysis of the peat horizon for determination what part of the interglacial period (onset optimum or final stage) was dated (Fig. 3). In general, the pollen diagram shows a monofloristic vegetation sequence typical of Merkinë Interglacial. The end of palynozone M_3 and the beginning of zone M_4 of Merkinë Interglacial in the pollen diagram display presence of the section studied. The presence of hornbeam (up to 45%) and alder (up to 60%) in the pollen diagram (pollen subzone M_{3c}) is attributed to the second half of the climate spell of Merkinë Interglacial in the Netiesos section (Fig. 3). Later they were supplanted by fir-trees. The interglacial was warmer and probably also damper than at present. The weather exceed the present by the number of cloudy clays.

RESULTS OF U/TH ISOCHRON DATING

In order to assess the distribution of uranium in the vertical profile of the peat bog and to assess the validity of the peat bog section for ^{230}Th/U dating we determined uranium content in peat layers from

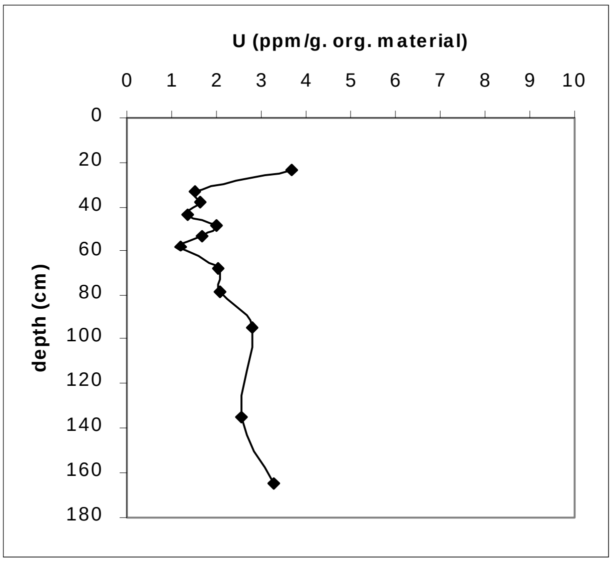

Fig. 4. Distribution of ^{238}U contents of deposit samples in vertical profile of Netiesos section

4 pav. Netiesø pjûvio organogeniniø nuogulø mëginiø ^{238}U kiekis

top to bottom (Fig. 4). Data of Fig. 4 illustrate that uranium content in the upper and lower layers of peat bog sediments is more considerable than U content in layers at a depth of 35–55 cm. This means that dissolved U with groundwater penetrates into the peat bog, but it was absorbed in the upper and lower peat layers, which act as a geochemical barrier. Layers from the depth 35–55 cm are favorable for ^{230}Th/U dating.

We determined the content of U and Th isotopes and their activity ratios in samples from the depth of 35–60 cm. Results are given in Tables 2 and 3.

In order to account for detrital U and Th isotopes and determine the present day ^{230}Th/^{234}U and corrected ^{234}U/^{238}U ratios inorganic fraction of coeval samples (depth 35–55 cm), we constructed isochron plots of U and Th isotopes for both L/L and TSD models (Figs. 5, 6).

The tangent of the isochron slope reflects the ^{230}Th /U and ^{234}U/^{238}U activity ratios in organic fraction. Substituting these values into the formula (Schwartz, Latham, 1989) we have determined the age of coeval peat samples. We have also calculated the ages using M. Geyh's (2001) approach for determining the present value of ^{230}Th/^{232}Th activity ratio (Th-index for TSD model and index of detrital correction). With the L/L model we obtained an isochron age of 105.7 ± 10.0 ka, and the "isochron-derived" age according to M. Geyh's (2001) approach

Table 2. **Radiochemical and uncorrected age data obtained from total dissolution analysis of Netiesos peat samples**

2 lentelë. **Netiesø durpiø mëginiø radiocheminio ir nekoreguoto amþiaus duomenys, gauti atlikus viso tirpalo analizæ**

1	Depth, cm	Ash, %	^{238}U dpm/g	^{234}U dpm/g	^{230}U dpm/g	^{232}Th dpm/g	^{230}Th/^{234}U	^{234}U/^{238}U	Uncorrected Age
N-2a	35–40	51.94	1.582 ± 0.049	1.584 ± 0.049	1.305 ± 0.036	0.946 ± 0.031	0.824 ± 0.034	1.002 ± 0.029	188.3 +30.7 –22.6
N-3a	40–45	49.71	1.446 ± 0.034	1.466 ± 0.034	1.301 ± 0.018	1.049 ± 0.016	0.887 ± 0.024	1.014 ± 0.021	233.6 +35.1 –25.1
N-4a	45–50	49.33	2.009 ± 0.052	2.070 ± 0.053	1.674 ± 0.027	1.156 ± 0.022	0.808 ± 0.025	1.031 ± 0.023	176.3 +18.6 –15.3
N-5a	50–55	47.31	1.786 ± 0.039	1.837 ± 0.040	1.506 ± 0.032	1.114 ± 0.026	0.820 ± 0.025	1.028 ± 0.019	183.1 +19.5 –15.9

Table 3. **Radiochemical and uncorrected age data obtained from leachate analysis of Netiesos peat samples**

3 lentelë. **Netiesø durpiø mëginiø tirpiniø radiocheminio ir nekoreguoto amþiaus duomenys**

1	Depth, cm	Ash, %	^{230}Th dpm/g	^{230}Th dpm/g	^{230}Th dpm/g	^{230}Th dpm/g	^{230}Th/^{234}U	^{234}U/^{238}U	Uncorrected Age
N-1b	30–35	50.41	0.537 ± 0.022	0.641 ± 0.025	0.352 ± 0.009	0.193 ± 0.007	0.549 ± 0.026	1.194 ± 0.059	84 +6.8 –6.2
N-2b	35–40	51.94	0.572 ± 0.018	0.617 ± 0.019	0.353 ± 0.006	0.227 ± 0.005	0.572 ± 0.020	1.080 ± 0.041	90.8 +5.9 –5.5
N-3b	40–45	49.71	0.494 ± 0.017	0.553 ± 0.018	0.329 ± 0.009	0.229 ± 0.007	0.595 ± 0.025	1.118 ± 0.045	96.1 +7.5 –6.8
N-4b	45–50	49.33	0.728 ± 0.022	0.792 ± 0.023	0.478 ± 0.016	0.267 ± 0.012	0.604 ± 0.027	1.088 ± 0.037	98.8 +8.4 –7.5
N-5b	50–55	47.31	0.640 ± 0.018	0.727 ± 0.019	0.430 ± 0.016	0.246 ± 0.012	0.592 ± 0.027	1.135 ± 0.035	95.0 +7.8 –7.2
N-6b	55–60	45.81	0.477 ± 0.008	0.527 ± 0.009	0.360 ± 0.008	0.233 ± 0.006	0.682 ± 0.019	1.106 ± 0.020	121 +6.9 –6.4

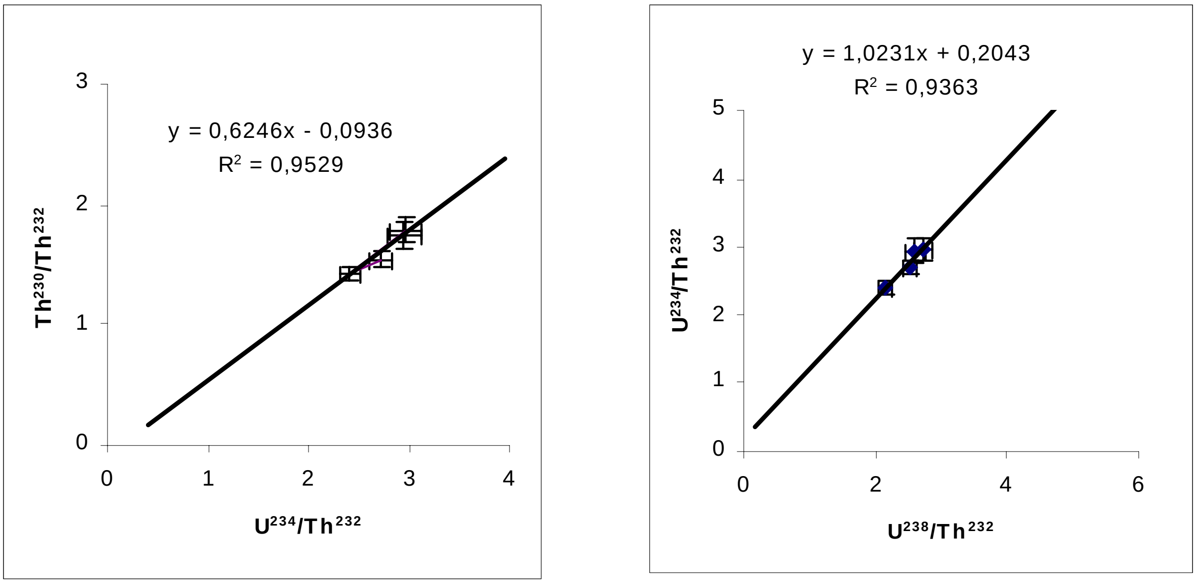

Fig. 5. Isochron plots of ^{230}Th/^{232}Th–^{234}U/^{232}Th and ^{234}U/^{232}Th–^{238}U/^{232}Th for leachates from peat samples (depth 35–55 cm) of Netiesos section

5 pav. Netiesø pjûvio durpiø mëginiø (35–55 cm gylyje) tirpiniø ^{230}Th/^{232}Th–^{234}U/^{232}Th ir ^{234}U/^{232}Th–^{238}U/^{232}Th izochroninë diagrama

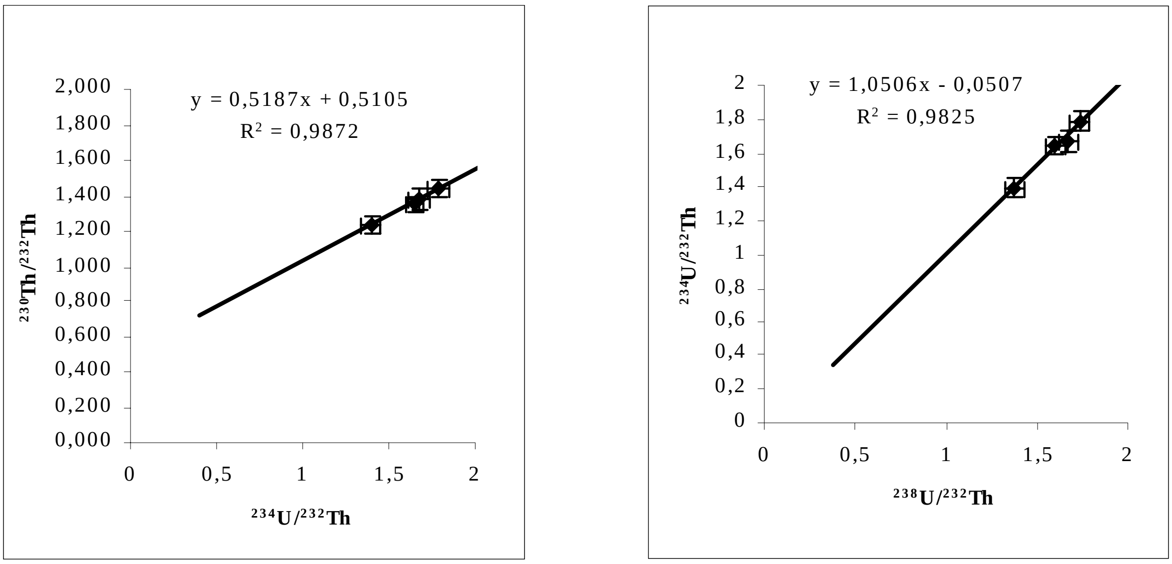

Fig. 6. Isochron plots of ^{230}Th/^{232}Th–^{234}U/^{232}Th and ^{234}U/^{232}Th–^{238}U/^{232}Th for total dissolved samples (depth 35–55 cm) of Netiesos section

6 pav. Netiesø pjûvio visiðkai iðtirpintø durpiø mëginiø (35–55 cm gylyje) ^{230}Th/^{232}Th–^{234}U/^{232}Th ir ^{234}U/^{232}Th–^{238}U/^{232}Th izochroninë diagrama

was 108.8 ± 8.7 ka. With the TSD model we obtained an isochron age of 78.8 ± 7.0 ka and "isochron-derived" age 80.3 ± 5.9 ka.

DISCUSSION ON THE INTERPRETATION OF DATES

The basic assumptions of the Th/U method allow introducing the correction for dethrital Th and U isotopes contained in the mineral fraction of peat samples. However, the content of the isotopes in the mineral part should be less than the content of organic fraction. From data presented in Tables 2 and 3 it follows that the mineral fraction (mostly silicates) insoluble in 7 M HNO_3 contains too much U and Th isotopes (^{238}U 64–66 % , ^{230}Th 71.4–75.0% and ^{232}Th 72.9–78.2%) from the total content in organic and mineral fractions. These isotopes get into the solution destined for dating when we use the total dissolution (TSD) model. Conversely, when we use the leachate (L/L) model, most of U and Th isotopes contained in the silicate structure do not

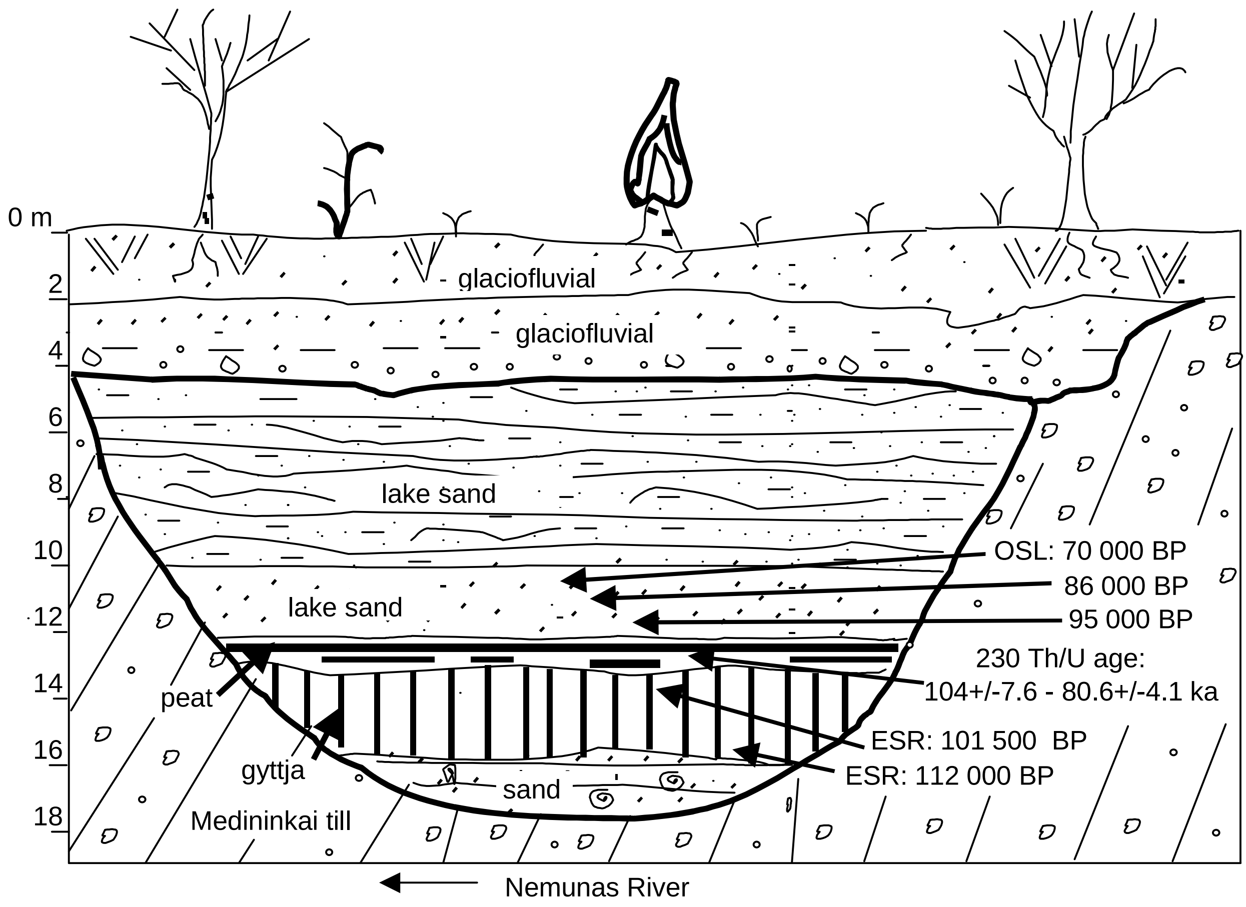

Fig. 7. The model of Netiesos outcrop
7 pav. Netiesø atodangos modelis

get into the solution. Leachate solution mostly contains U and Th isotopes from the organic fraction of peat samples. Thus, the advantage of the L/L method is that we avoid the necessity of dissolving the silicate residues containing the contaminant U and Th isotopes (Schwartz, Latham, 1989). So, in our view, the ^{230}Th/U ages obtained by the leachate model (105.7 ± 10.0 ka and 108.8 ± 8.7 ka) present the ages close to actual ones. These ages, considering the error of age determination, correspond to the ages of the Mikulino, Murava, Kazantsevo Interglacials (Кузнецов и др., 2003, Арсланов и др., 2004; Sanko et al., 2004) and of the 5e Interglacial substage of oxygen-isotope scale (114–127 ka) (Bassinet et al., 1994). The geological model of the Netiesos outcrop (Fig. 7) shows an open geochemical position of the peat bog in the late Merkinë Interglacial and early Nemunas Interglacial before and during lacustrine sedimentation.

CONCLUSIONS

We first determined the isochron ^{230}Th/U age of the parastratotypical section of the Last Interglacial in Lithuania (Netiesos outcrop). The ages of Interglacial peat in the Netiesos section obtained by the leachate model (105.7 ± 10.0 ka and 108.8 ± 8.7 ka) present the ages close to actual ones. These dates correspond to the second part of the climatic optimum of Merkinë (Muravian, Mikulian, Eemian) Interglacial in South Lithuania. These dates are slightly underestimated in comparison with the expected ages of Muravian (Belarus) and Merkinë (Lithuania) Interglacials (Eemian). The underestimation was probably caused by uranium uptake by peat deposits. Analogous results were obtained for Muravian Interglacial in Belarus (Murava section). These dates confirm the ESR date (101.5 ± 11.5 ka) of the same layer in the Netiesos section.

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References

Arslanov Kh., Laukhin S., Maksimov F., Kuznetsov V., Velichkevich F., Sanko A. 2004. Uranium-thorium isochron dating of Riss-Würm key section and palaeoclimatic reconstructions of Riss-Würm and Early Würm in Central parts of Middle Siberia. *Book of abstr. 8th International Conference "Methods of Absolute Chronology"*. 17–19 May 2004, Ustron, Poland, 8–9.

Bassinet F. C., Labeirie L. D., Vincet E. et al. 1994.The astronomical theory of climate and the age of the Brunhes–Matuyama magnetic reversal. *Earth and Planet. Sci. Lett*. ***126***. 91–108.

Borówko-Dùuêakowa Z., Halicki B. 1957. Interglacjaùy Suwalszyzny i terenów sàsiednich. *Acta Geologica Polonica*. ***7***. 361–403.

Bremówna M., Sobolewska M. 1950. Wyniki botanicznyh badañ osadów interglacjalnych w dorzeczu Niemna. *Acta Geologica Polonica*. ***1***(*4*). 335–360.

Gaigalas A. 1994. On palaeogeography the of Late Pleistocene in Lithuania. *Acta Universitatis Nicolai Copernici. Geografia XXVII – Nauki matematyczno-przyrodnicze*. Zeszyt ***92***. 183–194.

Gaigalas A. 2000. Correlation of ^{14}C and OSL dating of Late Pleistocene deposits in Lithuania. *Geochronometria. Volume **19***. Journal on methods and applications of absolute chronology. Gliwice. 7–11.

Gaigalas A., Molodkov, Meleðytë M., 1994. The first EPR dating results of Butënai (Likhvin) and Merkinë (Mikulino) Interglacial deposits in Lithuania. *Abstracts and papers. Conference on geochronology and dendrochronology of old town's and radiocarbon dating of archaeological findings Lithuania*. Vilnius, October 31 – November 4, 1994. Vilnius. P. 29.

Gaigalas A., Hütt G. 1995. OSL dating of the Merkinë (Eem) Interglacial (in Jonionys) and the Nemunas Glaciation (Rokai section) in Lithuania. *PACT **50***. Journal of the European Network of Scientific and Technical Cooperation for Cultural Heritage. P. 59–69.

Gaigalas A., and Hütt G. 1997. The OSL age of the lacustrine sand of Upper Pleistocene at the Netiesos outcrop. The Late Pleistocene in Eastern Europe: stratigraphy, palaeoenvironment and climate. *Abstract Volume and Excursion Guide of the INQUA-SEQS symposium*. Vilnius. 13.

Gaigalas A., Fedorowicz St., Meleðytë M., 2004. New TL dates of aquatic sandy sediments of Middle-Upper Pleistocene in Lithuania. *Book of Abstracts, 8th International conference "Methods of absolute chronology*". Gliwice. 48–50.

Gaigalas A., and Molodkov, 1997. New ESR dates of the Butënai and Merkinë Interglacial deposits in the Neravai and Netiesos exposures. The Late Pleistocene in Eastern Europe: stratigraphy, palaeoenvironment and climate. *Abstract Volume and Excursion Guide of the INQUA-SEQS symposium*. Vilnius. 15.

Gaigalas A., Molodkov A., 2002. ESR ages of three Lithuanian Mid-Late Pleistocene interglacials: methodical and stratigraphical approach. *Geochronometria. **21***. Journal on Methods of Absolute Chronology. Gliwice. 57–56.

Gaigalas A., Abrahamsen, Kazakauskas V., Meleðytë M. 2002. Palaeomagnetism of Lithuanian Upper Pleistocene sediments. *Geochronometria. **21***. Journal on Methods of Absolute Chronology. Gliwice. 65–72.

Heijnis H., 1992. Uranium/thorium dating of Late Pleistocene peat deposits in N. W. Europe. *Rijksuniversitet Groningen*. 149 p.

Geyh M. A. 2001. Reflections on the 230-Th/U dating of dirty material. *Geochronometria*. ***20***. 9–14.

Luo S. and Ku T.-L. 1991: U-series isochron dating: A generalized method employing total-sample dissolution. *Geochimica et Cosmochimica Acta*. ***55***. 555–564.

Molodkov A., Gaigalas A. 1994. The Last Interglacial site in Jonionys: evidence from the ESR dating of freshwater gastropod shells. *Abstracts and papers. Conference on geochronology and dendrochronology of old town and radiocarbon dating of archaeological findings*. Lithuania, Vilnius. October 31 – November 4, 1994. Vilnius. 29.

Riðkienë M. 1979. Merkinës tarpledynmeèio flora. *Geografinis metraštis*. ***16.*** 51–60.

Sanko A., Gaigalas A., 2004. Freshwater mollusc *Valvata sibirica* Middendorf in Butënai Interglacial of Lithuania. *Geologija **45***. 45–51.

Sanko A. F., Arslanov Kh. A., Elovicheva Ya. K., Velichkevich F., Kuznetsov V. Yu, Maksimov F. E., Chernov S. B. et al. 2004. The first U–Th dating of the Muravian Interglacial deposits in Belarus. *Book of abstracts – 8th International Conference "Methods of Absolute Chronology"*. 17–19 May, 2004. Ustron, Poland. 132–133.

Schwartz H. P., Latham A. G. 1989. Dirty calcites: 1. Uranium series dating of contaminated calcite using X. A. Leachate alone. *Chemical Geology*. ***80***. 35–43.

Vogel J. C., Krenfeld J. 1980. A new method for dating peat. *South African Journal of Science*. ***80.*** P. 557–558.

Velichkevich F., Kondratienë O., Kisielienë D. 1999. Paleocarpologic complexes of the Merkinë (Eemiam) Interglacial deposits in Netiesos outcrop (South Lithuania). *Geologija*. ***29***. Vilnius: 40–49.

Àðñëàíîâ Õ. À., Ëàóõèí Ñ. À., Ìàêñèìîâ Ô. Å., Êóçíåöîâ Â. Þ., Âåëè÷êåâè÷ Ô. Þ., Ñàíüêî À. Ô., Ã. Í. Øèëîâà À. Ô., ×åðíîâ Ñ. Á. 2004. Áåäîáà – îïîðíûé ðàçðåç êàçàíöåâñêîãî ãîðèçîíòà â Öåíòðàëüíîé Ñèáèðè. *Äîêëàäû Àêàäåìèè Íàóê*. ***396***(*6*). *796–788.*

Âåëè÷êåâè÷ Ô. Þ. 1982. Ïëåéñòîöåíîâûå ôëîðû ëåäíèêîâûõ îáëàñòåé Âîñòî÷íî-Åâðîïåéñêîé ðàâíèíû. Ìèíñê: Íàóêà è òåõíèêà. 208 ñ.

Êàëèíîâñêèé Ï. Ô. 1981. Î ïåðâûõ íàõîäêàõ ïëåéñòîöåíîâûõ ãðûçóíîâ òåððèòîðèè Ëèòâû. *Ãåîëîãè÷åñêèå èññëåäîâàíèÿ êàéíîçîÿ Áåëîðóññèè*. Ìèíñê. 135–136.

Êîíäðàòåíå Î. 1996. Ñòðàòèãðàôèÿ è ïàëåîãåîãðàôèÿ êâàðòåðà Ëèòâû ïî ïàëåîáîòàíè÷åñêèì äàííûì. Âèëüíþñ: Àñàdemia. 213 c.

Êîíäðàòåíå Î., 1965. Ñòðàòèãðàôè÷åñêîå ðàñ÷ëåíåíèå ïëåéñòîöåíîâûõ îòëîæåíèé þãî-âîñòî÷íîé ÷àñòè Ëèòâû íà îñíîâå ïàëèíîëîãè÷åñêèõ äàííûõ. *Ñòðàòèãðàôèÿ ÷åòâåðòè÷íûõ îòëîæåíèé è ïàëåîãåîãðàôèÿ àíòðîïîãåíà þãî-âîñòî÷íîé Ëèòâû*. Âèëüíþñ: Ìèíòèñ, 189–261.

Êóçíåöîâ Â. Þ., Àðñëàíîâ Õ. À., Øèëîâ Â. Â. è äð. 2000. Ðàñïðåäåëåíèå èçîòîïîâ óðàíà è òîðèÿ â ìàòåðèàëàõ îòëîæåíèÿõ ãëàäîòàðìàëüíîé çîíû Ñåâåðíîé Àòëàíòèêè. *Ðàäèîõèìèÿ*. ***6***. 565–568.

Êóçíåöîâ Â. Þ., Àðñëàíîâ Õ. À., Êîçëîâ Â. Á., Ìàêñèìîâ Ô. Å., Ñàâåëüåâà Ë. À., ×åðíîâ Ñ. Á., Áàðàíîâà Í. Ã. 2003. Ïåðñïåêòèâû ïðèìåíåíèÿ óðàí-òîðèåâîãî ìåòîäà íåðàâíîâåñíîé ãåîõðîíîëîãèè äëÿ äàòèðîâàíèÿ ìåæëåäíèêîâûõ êîíòèíåíòàëüíûõ îòëîæåíèé. *Âåñòíèê ÑÏáÃÓ. Ñåð 7, **2**(15)*. 40–51.

Ëèòâèíþê Ã. È. 1981. Íîâûå äàííûå î ñåìåííûõ ôëîðàõ Íÿòåñîñ è Ìàêñèìîíèñ íà Íåìàíå. *Ãåîëîãè÷åñêèå èññëåäîâàíèÿ êàéíîçîÿ Áåëîðóññèè*. Ìèíñê: Íàóêà è òåõíèêà. 75–84.

Ëîñeâà Ý. È. 1981. Ïîçäíåïëåéñòîöåíîâûé âîäîåì â áàññåéíå ðåêè Íåìàí (ïî äàííûì äèàòîìîâîãî àíàëèçà). *Ãåîëîãèÿ ïëåéñòîöåíà Ñåâåðî-çàïàäà ÑÑÑÐ.* Àïàòèòû. Ñ. 126–133.

Ðèøêåíå Ì. 1978. Íîâûé âèä *Pilea lithuanica* âî ôëîðå ìÿðêèíñêîãî ìåæëåäíèêîâüÿ â ðàçðåçå Íÿòåñîñ. *Äîñòèæåíèÿ è ïåðñïåêòèâû ãåîëîãè÷åñêîãî èçó÷åíèÿ Ëèòîâñêîé ÑÑÐ. Ìàòåð. 5-é íàó÷. êîíô. ãåîëîãîâ Ëèòâû*. Âèëüíþñ. 39–41.

Ñîáîëåâú Í. Í. 1910. Î ëåäíèêîâûõú îòëîæåíiÿõú âú Âiëåíñêîé, Êîâåíñêîé è Ãðîäíåíñêîé ãóá. (ïî ð. Íúìàíó). Êú ãåîëîãiè Ñúâåðî-Çàïàäíàãî êðàÿ Ðîññiè *(Èçú äîêëàäîâú Âiëåíñêàãî Îáùåñòâà Ëþáèòåëåé Åñòåñòâîçíàíiÿ).* Âiëüíà. 1–15.

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NETIESØ ATODANGOS PIETØ LIETUVOJE DURPIØ DATAVIMO URANO-TORIO IZOCHRONINIU METODU REZULTATAI

S a n t r a u k a

Merkinës (Emio, Muravos, Mikulino) tarpledynmeèio durpës ið Netiesø atodangos prie Nemuno pirmà kartà buvo datuotos ^{230}Th/U izochroniniu metodu. Netiesø parastratotipinëje atodangoje nustatytas Merkinës tarpledynmeèio durpiø amþius yra 105,7 ± 10,0 ir 108,8 ± 8,7 tûkst. metø. Ðios datos atitinka minëto tarpledynmeèio klimato maksimumo pabaigà (subpalinozona M_{3c} ir palinozona M_4) Pietø Lietuvoje. Galbût jos yra ðiek tiek pajaunintos dël urano vëlesnës asimiliacijos. Netiesø atodangos sedimentacinis modelis rodo, kad urano-torio metodu datuotos durpës Merkinës tarpledynmeèio pabaigoje ir Nemuno ledynmeèio pradþioje buvo atviroje geocheminëje aplinkoje.

Àëüãèðäàñ Ãàéãàëàñ, Õèêìàòóëëà À. Àðñëàíîâ, Ôåäîð Å. Ìàêñèìîâ, Âëàäèñëàâ Þ. Êóçíåöîâ, Ñåðãåé Á. ×åðíîâ, Ìîíèêà Ìåëåøèòå

ÐÅÇÓËÜÒÀÒÛ ÈÇÎÕÐÎÍÍÎÃÎ ÄÀÒÈÐÎÂÀÍÈß ÒÎÐÔÀ ÈÇ ÎÁÍÀÆÅÍÈß ÍßÒÅÑÎÑ Â ÞÆÍÎÉ ËÈÒÂÅ ÌÅÒÎÄÎÌ ÓÐÀÍ-ÒÎÐÈß

Ð å ç þ ì å

Òîðô ìÿðêèíñêîãî (ìèêóëèíñêîãî, ìóðàâèíñêîãî, ýåìñêîãî) ìåæëåäíèêîâüÿ èç ïàðàñòðàòîòèïíîãî îáíàæåíèÿ Íÿòåñîñ â Þæíîé Ëèòâå âïåðâûå äàòèðîâàí èçîõðîííûì ìåòîäîì ^{230}Th/U. Óñòàíîâëåí âîçðàñò: 105,7 ± 10,0 òûñ. ëåò è 108,8 ± 8,7 òûñ. ëåò. Ýòè äàòû ïîëó÷åíû äëÿ îáðàçöîâ òîðôà êîíöà êëèìàòè÷åñêîãî îïòèìóìà (ñóáïàëèíîçîíà Ì$_{3ñ}$ è ïàëèíîçîíà Ì$_4$) óêàçàííîãî ìåæëåäíèêîâüÿ. Âîçìîæíî, âîçðàñò çàíèæåí èççà áîëåå ïîçäíåé àññèìèëÿöèè óðàíà ìåæëåäíèêîâûì òîðôîì. Êàê âèäíî èç ñåäèìåíòàöèîííîé ìîäåëè îáíàæåíèÿ Íÿòåñîñ, èçó÷àåìûé òîðô íàõîäèëñÿ â îòêðûòîé ãåîõèìè÷åñêîé ñèñòåìå â êîíöå ìÿðêèíñêîãî ìåæëåäíèêîâüÿ è â íà÷àëå íÿìóíñêîãî (âàëäàéñêîãî, ïîîçåðñêîãî, âèñëèíñêîãî) ëåäíèêîâüÿ.