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# Co-operation between Gdańsk and Vilnius Universities in Pleistocene geochronology investigations

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The thermoluminescence (TL) dating of aquatic sand'y sediments, carried out as a co-operation between Gdańsk and Vilnius Universities, provided a more accurate chronology of the Middle-Upper Pleistocene in Lithuania. Based on TL dating, Middle and Upper Pleistocene fine-grained sands of aquatic origin have been attributed to the Butėnai (Holsteinian) Interglacial (Tartokai outcrop), Snaigupėlė (Drenthe–Wartha) Interglacial (Tartokai and Valakampiai (Valakupiai) outcrops), Merkinė (Eemian) Interglacial (Tartokai and Netiesos outcrops) and Nemunas (Vistulian) Glacial (Tartokai, Netiesos and Rokai outcrops). The dating of samples from the outcrops studied show the age of the Butėnai Interglacial to be 430.2 to 280.3 ka years BP, of the Snaigupėlė Interglacial 239.4 to 179.3 ka years BP and the Merkinė Interglacial 135.9 to 103.2 ka years BP. The Early Nemunas and the Middle Nemunas non-glacial sediments accumulated between 67.2–30.6 ka years BP. Tills in the upper part of the Tartokai and Rokai outcrops are younger than 30,000 BP and belong to the Late Nemunas glacial maximum in Lithuania. Different dosimetric (TL, OSL) ages of granular fractions of the same sample indicate different parametres predetermined by the distribution of grain size fractions during aquatic sedimentation of quartz sand. The granulometry of sand or the grain size distribution of quartz particles in samples reflect the state of the hydrodynamic sedimentation space.

**Key words:** thermoluminescence (TL) dating, aquatic sediments, Pleistocene, Lithuania, sedimentological interpretation

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## INTRODUCTION

The co-operation between the universities of Gdańsk and Vilnius started early in this century as a common research on samples from the TL dating of the Vilkiškes profile. The first publication appeared in 2002 (Gaigalas, Fedorowicz, 2002). In 2002, a conference was held in Vilnius where the first presentation of our results took place. The co-operation included also the $^{137}$CS datings method (Gaigalas et al., 2003). In 2003, an article presenting researches in Gdańsk appeared in *Geologija* (Fedorowicz, 2003), followed papers concerning studies on loess dating (Lanczont, Fedorowicz, 2004; Fedorowicz et al., 2005). Gaigalas and Fedorowicz presented their results at international conferences in Vilnius, Gliwice, Gdańsk, Lublin. Samples were taken from Lithuanian profiles: Vilkiškės, Tartokai, Netiesos, Rokai, Jonionys (Fig. 1). The common researches contributed to ST. Fedorowicz's habilitation (2006).

## DOSIMETRIC DATING AGE (TL. OSL) OF MIDDLE-UPPER PLEISTOCENE AQUATIC SANDY SEDIMENTS IN LITHUANIA

The dosimetric methods (TL, OSL) of dating aquatic sandy sediments enabled compiling the Middle-Upper Pleistocene geochronology in Lithuania (Gaigalas et al., 1994; Gaigalas, Hütt, 1996; Satkūnas, Hütt, 1999; Gaigalas, 2000; Gaigalas, Fe-

Prof. S. Fedorowicz during habilitation at Lublin University

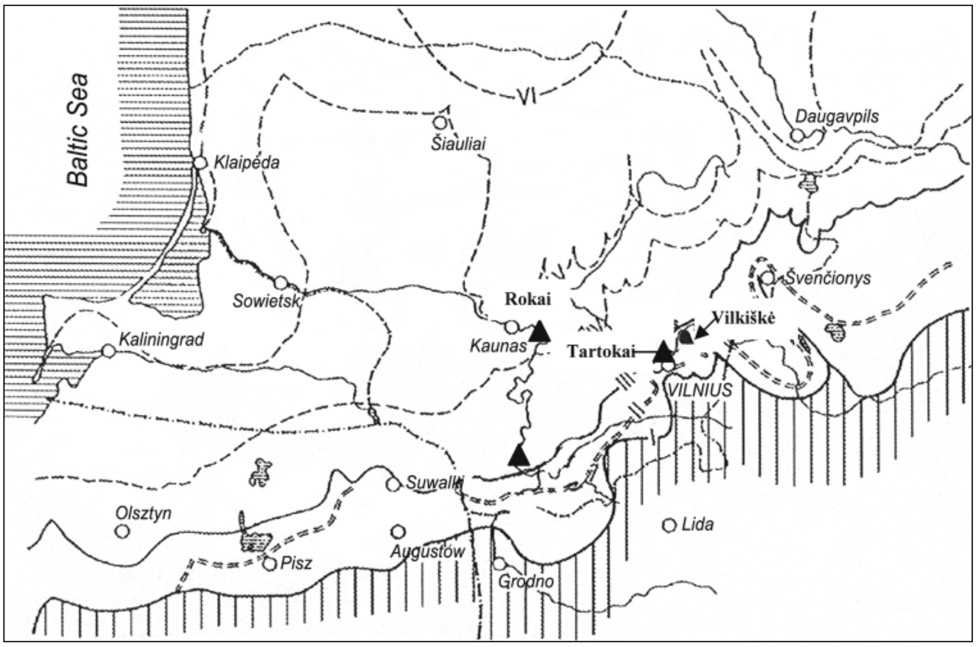



**Fig. 1.** Location of the sections studied
**1 pav.** Tirtų pjūvių padėtis žemėlapyje

dorowicz, 2002; Fedorowicz, 2003; Gaigalas et al., 2005, 2005; Fedorowicz, 2006a, 2006b, and others). The geochronology of the warm and cold climate of the Middle and Late Pleistocene of Lithuania (Gaigalas, 2004) – the absolute age of Interglacials of the Butėnai (Holsteinian) 450000–280000 years BP, Snaigupėlė (Drenthe-Wartha) 212000–180000 years, Merkinė (Eemian) 130000–75000 years BP and thermomers of Middle Nemunas (Weichselian) 55000–30000 BP were determined by the radiochronometric and dosimetric methods (Gaigalas et al., 1994, 1994a; Gaigalas, 2000; Gaigalas, Hütt, 1996; Gaigalas, Molodkov, 2002; Gaigalas, Pazdur, Fedorowicz, 2005; Gaigalas et al., 2005, and others).

By TL dating, the geochronological features of the last glaciation (Nemunas = Weichselian = Vistulian = Valdaian) were identified by us in the Rokai section (Fig. 2.) and of the last interglacial (Merkinė = Mikulian = Eemian) in the Netiesos section. Based on TL dating of Mid- and Late Pleistocene sediments, fine-grained sands of aquatic origin were attributed to the Butėnai (Holsteinian = Lichvian) and Snaigupėlė (Drenthian = Warthian) Interglacial of the Middle Pleistocene in the lowermost part of the Vilkiškės exposure (Fig. 3). TL dates of sediments in the uppermost part of the section allowed to determine the age of the Merkinė (Eemian) Interglacial and the Nemunas (Weichselian = Vistulian = Valdaian) glacial of the Late Pleistocene. Seven sedimentation complexes of sand deposits in the chronostratigraphic units were distinguished in the section of the Tartokai outcrop (Fig. 4). The TL age was obtained for the Butėnai (Holsteinian) Interglacial (430.2 ka and 280.3 ka years BP), Snaigupėlė (Drenthian = Warthian) Interglacial (188.8 ka and 183.3 ka years BP for the Late Interstadial and 239.4 ka, 246.3 ka and 223.8 ka years BP for the Early stadial), Merkinė (Eemian) Interglacial (130.1 ka, 129.8 ka, >126.3 ka, 107.2 ka, 112.9 ka and 109.7 ka years BP), the Early Nemunas (Vistulian) Glacial (67 ka years BP), the Middle Nemunas (Vistulian) (47.8 ka, 58.2 ka and 34.9 ka years BP), the Late Nemunas (Vistulian) Glacial (>44.2 ka,

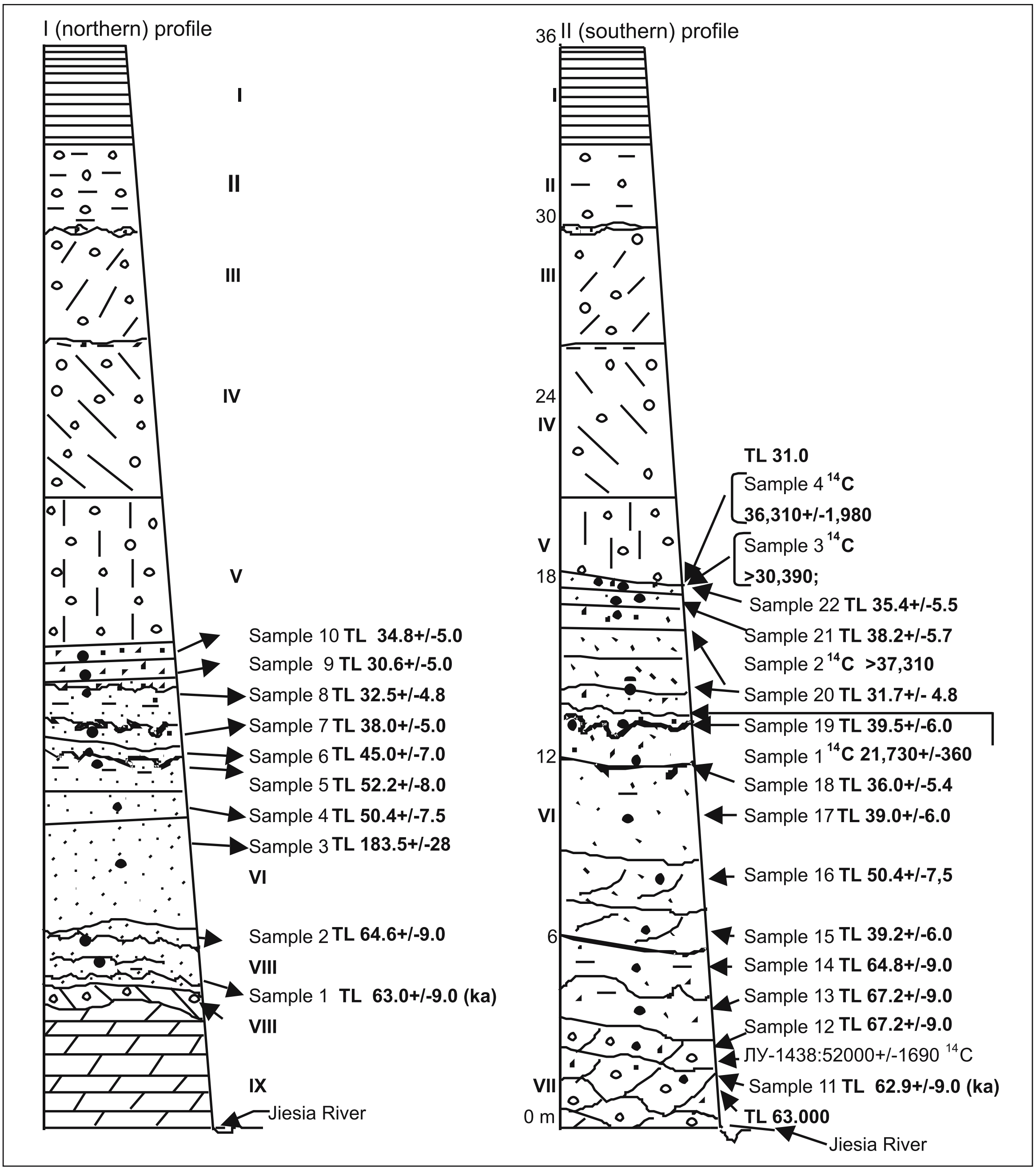



**Fig. 2.** TL (ka) and $^{14}C$ dates of sediments from Rokai section. Coordinates (longitude, latitude): 54°50′57″, 23°46′20″

Layers: I – glaciolacustrine varved clay, II – till of South Lithuanian phasial of Baltija stadial, III – till of East Lithuanian phasial of Baltija stadial, IV – till of Žiogeliai phasial of Grūda stadial, V – till of Grūda stadial of Nemunas glaciation, VI – silt, sand and gravel of Rokai mega interstadial, VII – sand, gravel and pebble of Lower Nemunas periglacial, VIII – till of Medininkai glaciation, IX – chalk marls in glaciodislocation.

**2 pav.** Rokų atodangos pjūviai su nuosėdų TL (ka) ir $^{14}C$ datomis

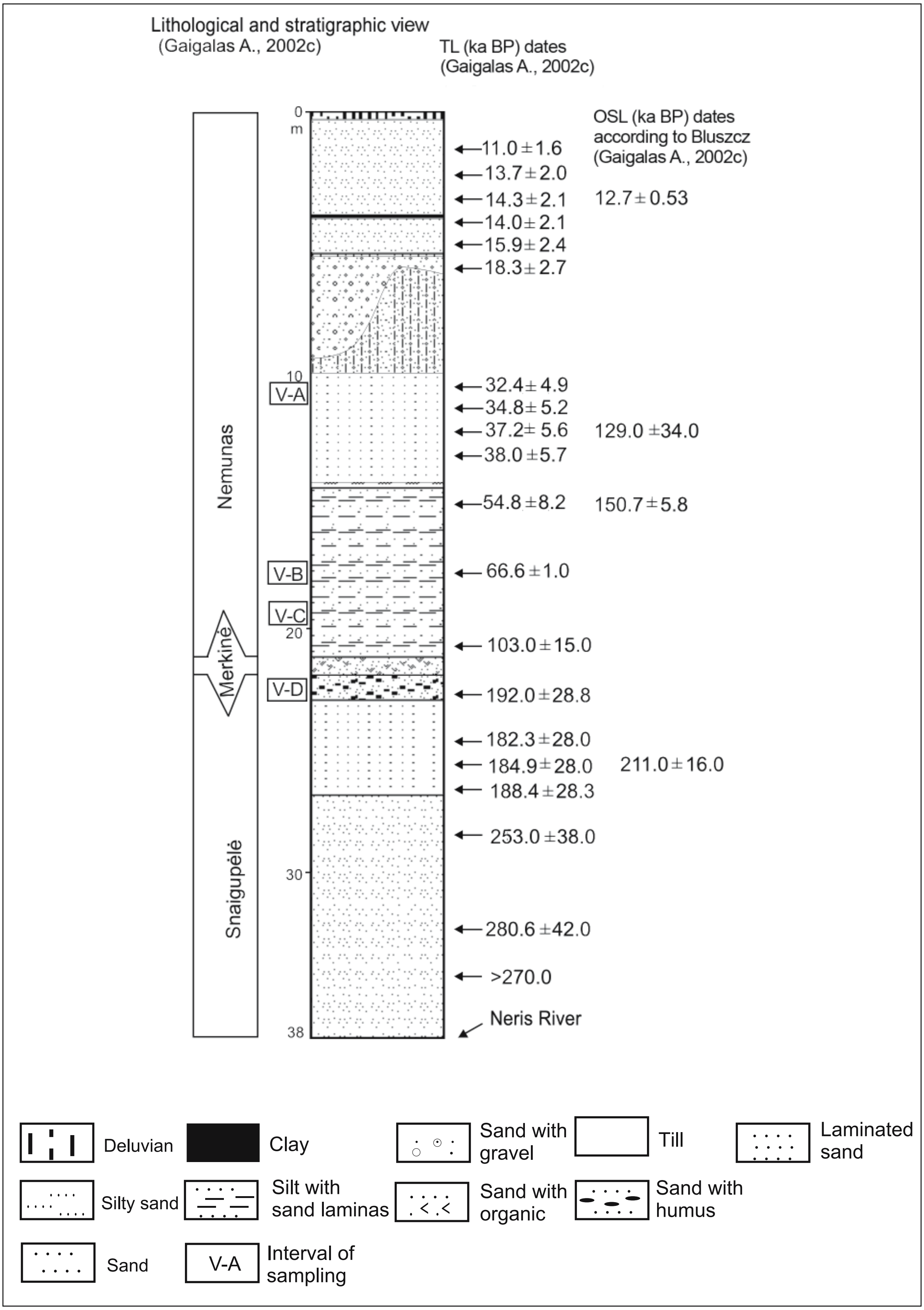
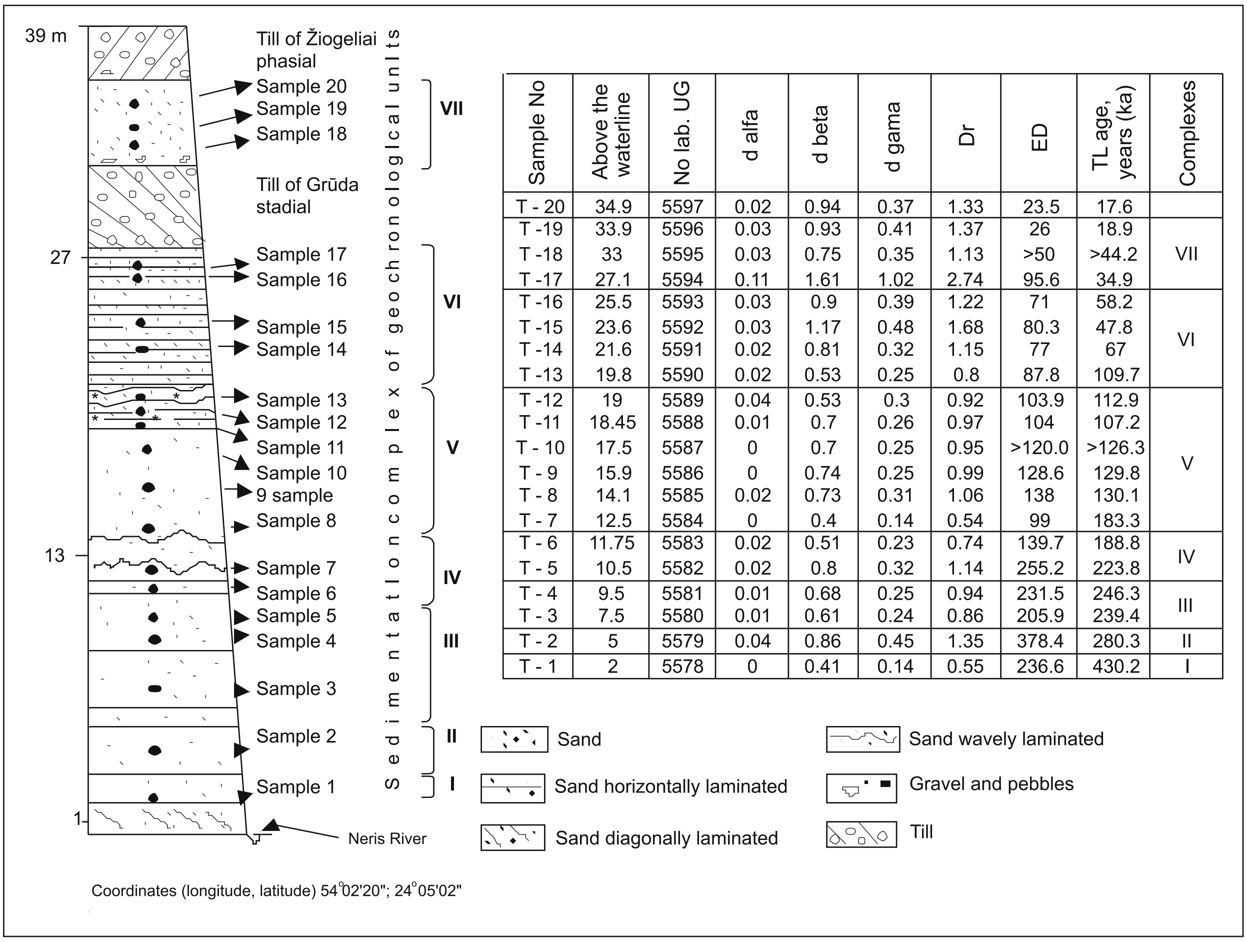



**Fig. 3.** Vilkiškės section and stratigraphical subdivision

**3 pav.** Vilkiškių atodangos nuogulų stratigrafinis suskirstymas




| Sample No | Above the waterline | No lab. UG | d alfa | d beta | d gama | Dr | ED | TL age, years (ka) | Complexes |
|---|---|---|---|---|---|---|---|---|---|
| T - 20 | 34.9 | 5597 | 0.02 | 0.94 | 0.37 | 1.33 | 23.5 | 17.6 | |
| T -19 | 33.9 | 5596 | 0.03 | 0.93 | 0.41 | 1.37 | 26 | 18.9 | VII |
| T -18 | 33 | 5595 | 0.03 | 0.75 | 0.35 | 1.13 | >50 | >44.2 | |
| T -17 | 27.1 | 5594 | 0.11 | 1.61 | 1.02 | 2.74 | 95.6 | 34.9 | |
| T -16 | 25.5 | 5593 | 0.03 | 0.9 | 0.39 | 1.22 | 71 | 58.2 | VI |
| T -15 | 23.6 | 5592 | 0.03 | 1.17 | 0.48 | 1.68 | 80.3 | 47.8 | |
| T -14 | 21.6 | 5591 | 0.02 | 0.81 | 0.32 | 1.15 | 77 | 67 | |
| T -13 | 19.8 | 5590 | 0.02 | 0.53 | 0.25 | 0.8 | 87.8 | 109.7 | |
| T -12 | 19 | 5589 | 0.04 | 0.53 | 0.3 | 0.92 | 103.9 | 112.9 | V |
| T -11 | 18.45 | 5588 | 0.01 | 0.7 | 0.26 | 0.97 | 104 | 107.2 | |
| T - 10 | 17.5 | 5587 | 0 | 0.7 | 0.25 | 0.95 | >120.0 | >126.3 | |
| T - 9 | 15.9 | 5586 | 0 | 0.74 | 0.25 | 0.99 | 128.6 | 129.8 | |
| T - 8 | 14.1 | 5585 | 0.02 | 0.73 | 0.31 | 1.06 | 138 | 130.1 | |
| T - 7 | 12.5 | 5584 | 0 | 0.4 | 0.14 | 0.54 | 99 | 183.3 | |
| T - 6 | 11.75 | 5583 | 0.02 | 0.51 | 0.23 | 0.74 | 139.7 | 188.8 | IV |
| T - 5 | 10.5 | 5582 | 0.02 | 0.8 | 0.32 | 1.14 | 255.2 | 223.8 | |
| T - 4 | 9.5 | 5581 | 0.01 | 0.68 | 0.25 | 0.94 | 231.5 | 246.3 | III |
| T - 3 | 7.5 | 5580 | 0.01 | 0.61 | 0.24 | 0.86 | 205.9 | 239.4 | |
| T - 2 | 5 | 5579 | 0.04 | 0.86 | 0.45 | 1.35 | 378.4 | 280.3 | II |
| T - 1 | 2 | 5578 | 0 | 0.41 | 0.14 | 0.55 | 236.6 | 430.2 | I |

**Fig. 4.** Tartokai section with TL dates
**4 pav.** Tartokų atodangos pjūvis su TL datomis

Table 1. **New results of TL dating of samples from Nemunas (Weichselian) aquatic sediments covering the Merkinė (Eemian) Interglacial lake sediments in Jonionys stratotype section**
1 lentelė. **Nemuno (Vyslio) akvalinių nuosėdų, dengiančių Merkinės (Eemio) tarpledynmečio ežerines nuosėdas Jonionių stratotipiniame pjūvyje, termoliuminescencinio datavimo nauji rezultatai**

| Samples | Depth m | Lab. UG No. | Dose rate Gy / ka | ED (Gy) | TL age (ka BP) |
|---|---|---|---|---|---|
| Jonionys 1 | 5.40 | UG-6106 | 2.25 ± 0.1 | 199.8 ± 20 | 88.8 ± 9.8 |
| Jonionys 2 | 5.20 | UG-6107 | 2.31 ± 0.1 | >100 | >43.3 |
| Jonionys 3 | 5.05 | UG-6108 | 2.27 ± 0.1 | 175.5 ± 17 | 76.0 ± 8.5 |
| Jonionys 4 | 4.80 | UG-6109 | 1.67 ± 0.1 | 66.2 ± 6.4 | 39.6 ± 4.0 |
| Jonionys 5 | 3.80 | UG-6110 | 1.16 ± 0.06 | 40.9 ± 4.3 | 35.3 ± 4.5 |
| Jonionys 6 | 2.90 | UG-6111 | 1.21 ± 0.05 | 41.6 ± 4.0 | 34.4 ± 4.5 |

18.9 ka and 17.6 ka years BP) (Gaigalas et al., 2005). The 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 in 2009 from the study of the Jonionys section confirm the absence of an ice sheet during the Early Nemunas and Middle Nemunas time (Table 1). The Early and Middle Nemunas periglacial deposits were presented by silty and sandy aquatic sediments.

Data on the TL age of aquatic sandy sediments of the Middle–Upper Pleistocene from the Vilkiškės (V), Tartokai (T) and Rokai (R) sections in Lithuania correspond to the geochronological division of the Lithuanian Pleistocene (Table 2).

## SEDIMENTOLOGICAL INTERPRETATION OF TL DATES

Sometimes the obtained data showed the different dosimetric ages of the same samples of aquatic sandy sediments. The relict effect depends on the stability of sedimentation

Table 2. **Geochronological division of the Lithuanian Pleistocene**
2 lentelė. **Lietuvos pleistoceno geochronologiniai padaliniai**

| Main subdivision | Stage | Suppositional age kyrs | Climatic events | Samples of TL and OSL investigations |
|---|---|---|---|---|
| Upper Pleistocene | Nemunas | | Ice | V-3 |
| | | | sheet | T-19 |
| | or | | of main | |
| | Vistulian | | glacial | |
| | or | | advance | |
| | Weichselian | | | R-10 |
| | | | | R-7 |
| | | | | V-9 |
| | or | 30 | Non-glacial | R-20 |
| | | | | R-18 |
| | Valdaian | 60 | | T-15 |
| | | | | V-11 |
| | Glacial | | conditions | R-14 |
| | | 70 | | R-12 |
| | Merkinė | 105 | | |
| | or | | Interglacial | T-13 |
| | Eemian Interglacial | | warming | |
| | | 130 | | |
| Middle Pleistocene | Medininkai | | | |
| | or | | Glacial | |
| | Warthian | | cover | |
| | Glacial | | | |
| | Snaigupėlė | 180 | | V-16 |
| | or | | Interglacial | T-6 |
| | Drenthian– | | warming | |
| | Warthian | | | |
| | Interglacial | 212 | | V-19 |
| | Žemaitija | | | |
| | or | | Glacial | |
| | Saale | | cover | |
| | Glacial | | | |
| | Butėnai | 280 | | |
| | or | | Interglacial | |
| | Holsteinian | | warming | |
| | Interglacial | | | |

conditions in the sedimentary environment (Gaigalas, 2000; Gaigalas, Fedorowicz, 2006).

The exact TL and OSL dating requires a small zero-point signal and a long well-sorting, which remains in most deposits (Gaigalas, 2000). Procedures and sedimentation processes critically affected the accuracy of TL and OSL ages. Most deposits from palaeolakes with broad, low-gradient floors are inferred to be more favourable for an accurate TL dating; as examples, Middle Nemunas sediments in the Rokai section (Central Lithuania) may be considered.

The residual TL and OSL level is a function of the spectrum and the duration of light exposure during sediment transport and accumulation.

Relict effects depend on climate fluctuations and sedimentary environment: the frequency of sunny and cloudy days, relation between winter and summer seasons, occurrence of sedimentation in ice-covered basins, etc. Deep sedimentation basins, a muddy water column, a short transport distance, water velocity, steep walls of lakes and a high input of sediments, as well as a coarse grain size of minerals and coverage with iron oxides or other plates do not favour accurate TL and OSL dating. Larger and heavier quartz grains go down faster than smaller and lighter grains. As admited by Raukas and Stankowski (2005), it also depends on the incorporation of older, unbleached particles.

For this reason, grains of a larger diameter have had a shorter exposition to solar radiation which reduces the energy stored in them. Thus, the age of larger-size grains may be longer than that of smaller grains. According to S. Fedorowicz (2006), a sieve analysis should be the first action in luminescence dating; of great importance are also the methods (additive, regeneration, RΓ) used for measurements. The possibility of an accurate dosimetric dating (Gaigalas, 2000) is provided by a long transport distance and a low relief, a clean water column, silty clay and clay interlayers a few centimetres thick, a low deposition rate (a few milimetres), fine-grained water-laid sediments, soil and the occurrence of aeolian, rain-out processes. The main factor is the homogenity of sediments, which indicated a long sorting in the natural process.

Sieve analyses of samples collected from stratified sands show a variation of grain size, with the domination of different fractions in different samples (Fig. 5). In Quaternary sediments we observed a heterogenity of the granulometric composition. The sedimentological composition reflects the grain-size distribution in samples and influences the data. The relative entropy of the age of quartz grains of different granular fractions (>250, 250–160, 160–125, 125–100, 100–80, 80–63, <63 μm) in the same sample is different. Four aliquots of grains of the same diameter were selected from each sample for the further research by the additive, regeneration and RΓ methods (Table 3). Different dosimetric (TL, OSL) ages of granular fractions of the same sample indicate the different parameters (Figures 6–9) predetermined by the distribution of grain size fractions during the aquatic sedimentation of quartz sand. The granulometry of sand or grain size distribution in the quartz particles of samples reflect the state of the hydrodynamic sedimentation space. The accumulation of sediments depends on the mechanics of particle movement load: in suspensions, bouncing (saltation), rolling. The relict age signal in different grain-size fractions of the same quartz sand sample is preserved due to the relative entropy of sedimentation environments (aspects of genesis, facies, uneven assimilation of source rocks or deposits, hydrodynamics, transportation mode, post-sedimentation and other processes). Both graphic and statistical methods of interpretation of particle size analyses and granulometric diagrams have been used for determining the entropy of TL ages of different grain-size fractions in aquatic sand samples. We have found some kinds of grain size distribution

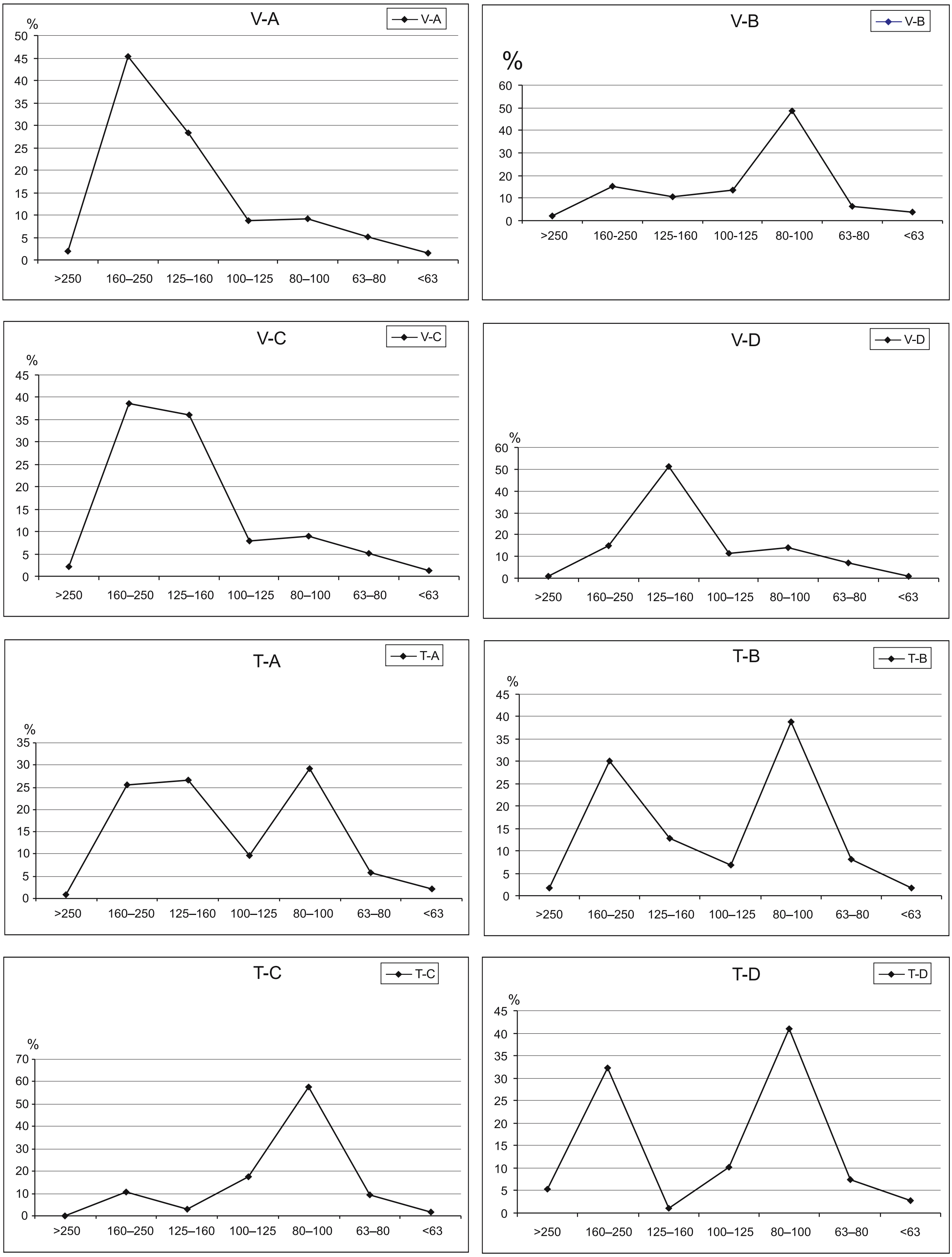



**Fig. 5.** Grain size distribution of aquatic sediments from Vilkiškės (V) and Tartokai (T) profiles. V–A, V–C, V–D – positive grain size distribution, V–B, V–C – negative grain size distribution, T–A, T–B, T–D – bimodal grain size distribution

**5 pav.** Akvalinių nuosėdų grūdelių dydžių pasiskirstymas Vilkiškės (V) ir Tartokų (T) profiliuose: teigiamas (V–A, V–C, V–D), neigiamas (V–B, V–C) ir bimodalinis (T–A, T–B, T–D)

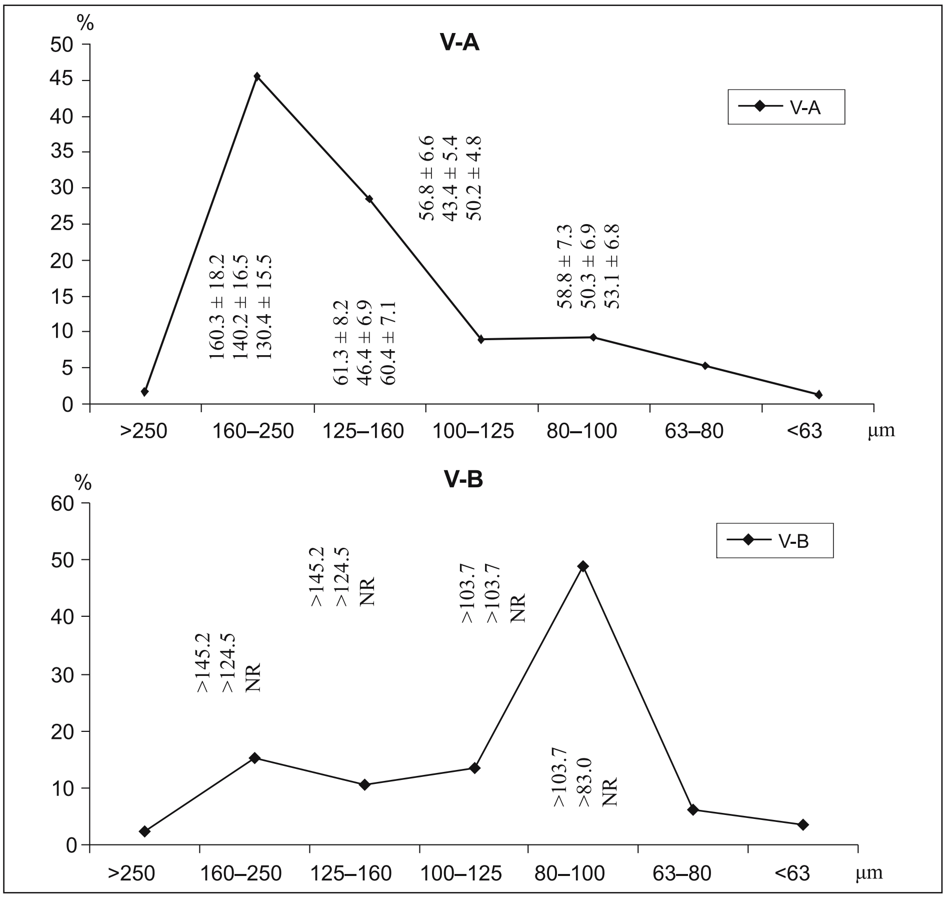



**Fig. 6.** Positive of coarse (V–A) and negative of fine (V–B) skew of grain size distribution with TL dates of different fractions, using additive (A), regeneration (R) and partial bleach (RΓ) methods. NR – no results

**6 pav.** Teigiamas, arba stambus (V–A), ir neigiamas, arba smulkus (V–B), grūdelių pasiskirstymas su skirtingų frakcijų termoliuminescencijos datomis, datuotomis adityviniu (A), regeneracijos (R) ir dalinio apšvietimo (RΓ) metodais

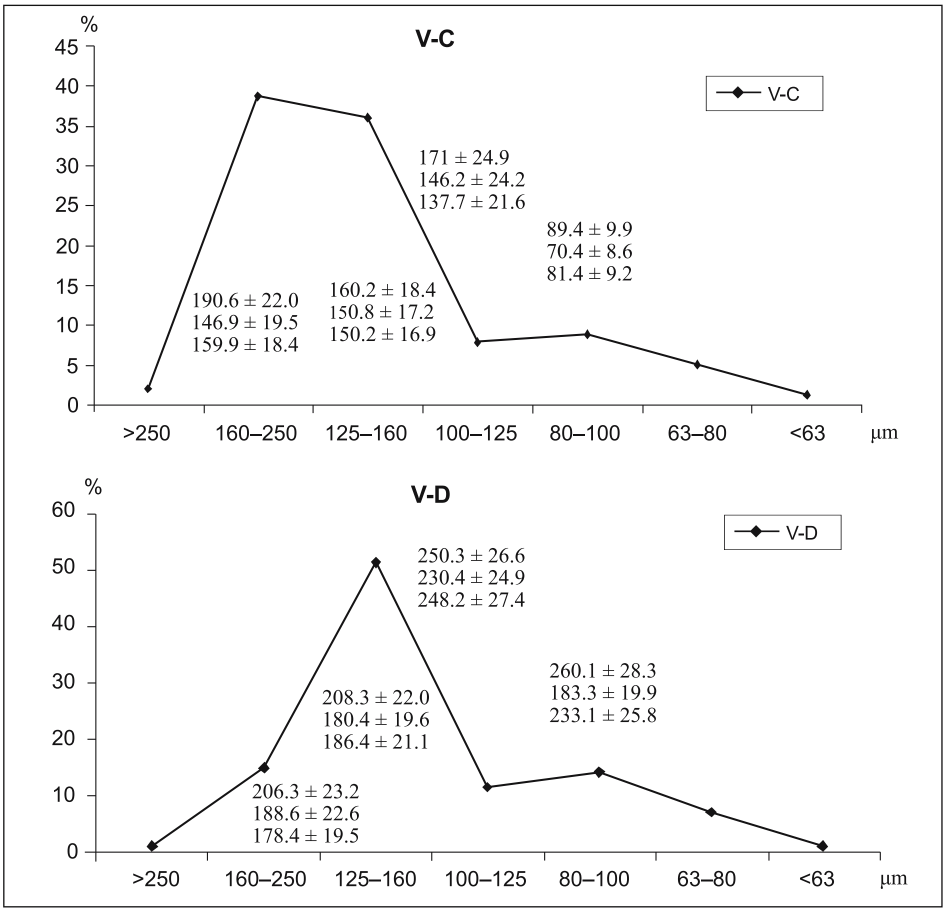



**Fig. 7.** Positive of coarse (V–C and V–D) skew of grain size distribution with TL dates of different fractions, using additive (A), regeneration (R) and partial bleach (RΓ) methods

**7 pav.** Teigiamas, arba stambus, grūdelių dydžių pasiskirstymas su skirtingų frakcijų termoliuminescencijos datomis, gautomis adityviniu (A), regeneraciniu (R) ir dalinio apšvietimo (RΓ) metodais

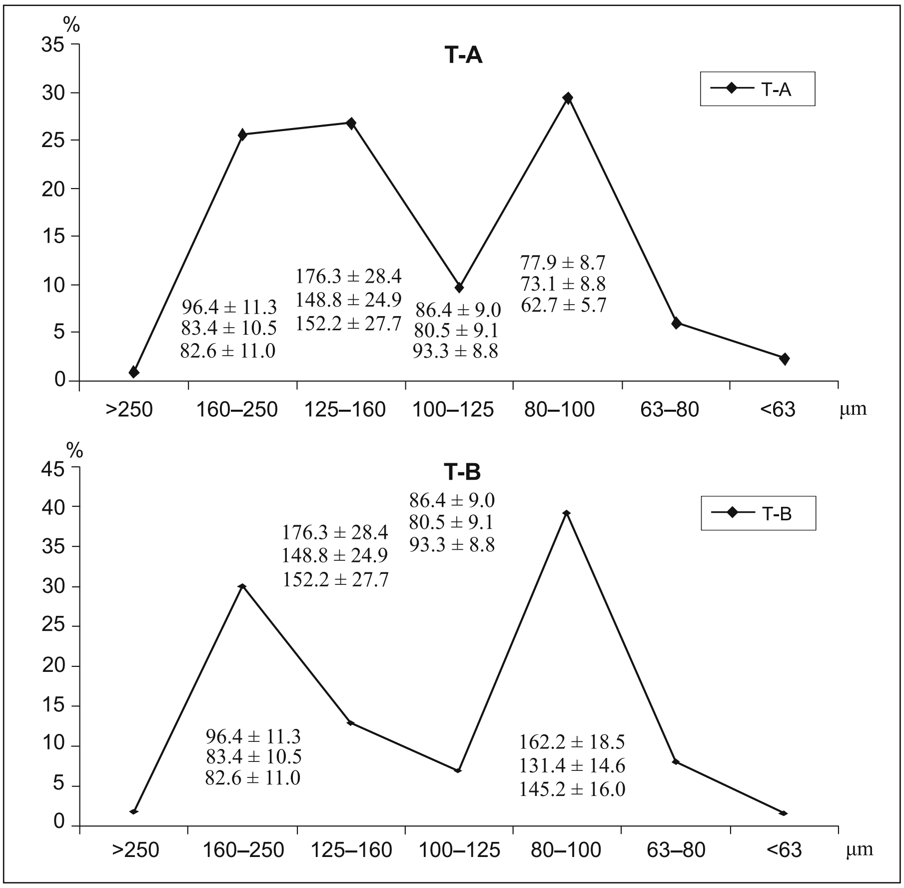



**Fig. 8.** Bimodal grain size distribution (T–A and T–B) in deposits from different sources with TL dates of different fractions, using additive (A), regeneration (R) and partial bleach (RΓ) methods

**8 pav.** Bimodalinis (T–A, T–B) grūdelių dydžių pasiskirstymas nuogulose iš skirtingų šaltinių su skirtingų frakcijų termoliuminescencijos datomis, gautomis adityviniu (A), regeneracijos (R) ir dalinio apšvietimo metodais

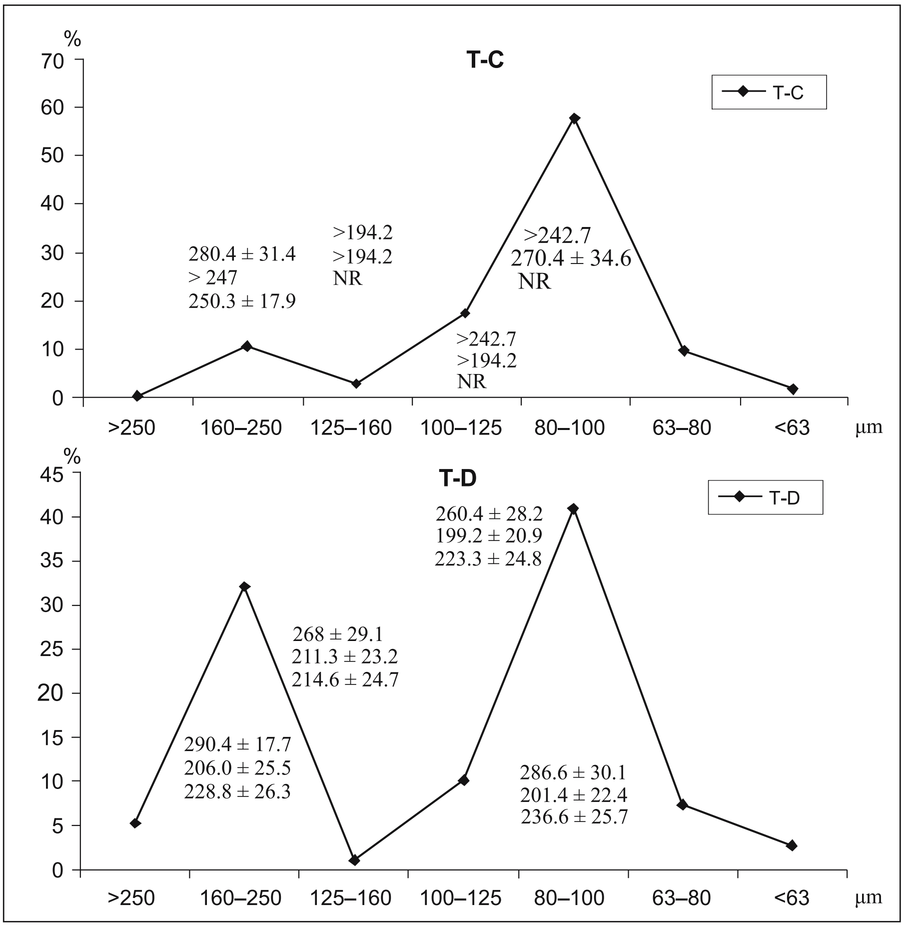



**Fig. 9.** Negative or fine (T–C) and bimodal (T–D) grain size distribution from different sources with TL dates of different fractions, using additive (A), regenration (R) and partial bleach (RΓ) methods

**9 pav.** Neigiamas, arba smulkus (T–C), ir bimodalinis (T–D) grūdelių dydžių pasiskirstymas iš skirtingų šaltinių su skirtingų frakcijų termoliuminescencijos datomis, gautomis adityviniu (A), regeneraciniu (R) ir dalinio apšvietimo (RΓ) metodais

Table 3. **TL dates of samples from the Vilkiškės (V) and Tartokai (T) profiles obtained by the additive method (A), regeneration method (R) and partial bleach method (RΓ) for quartz grains of various diameter**

3 lentelė. **Skirtingo dydžio kvarco dalelių iš Vilkiškių ir Tartokų atodangų pavyzdžių TL datos, apskaičiuotos A (adityvinis), R (regeneracinis) ir D (dalinio apšvietimo) metodais**

| Sample index | Depth, m | Dose rate, gy/ka | | TL date for grain fraction (µm) | | | |
|---|---|---|---|---|---|---|---|
| | | | | 250–160 | 160–125 | 125–100 | 100–80 |
| V-A | 12.5 | 1.13 | A | 160.3 ± 18.2 | 61.3 ± 8.2 | 56.8 ± 6.6 | 58.8 ± 7.3 |
| | | | R | 140.2 ± 16.5 | 46.46.9 | 43.4 ± 5.4 | 50.3 ± 6.9 |
| | | | D | 130.4 ± 15.5 | 60.4 ± 7.1 | 50.2 ± 4.8 | 53.1 ± 6.8 |
| V-B | 17.7 | 2.41 | A | >145.2 | >145.2 | >103.7 | >103.7 |
| | | | R | >124.5 | >124.5 | >103.7 | >83.0 |
| | | | D | NR | NR | NR | NR |
| V-C | 19.6 | 1.86 | A | 190.6 ± 22.0 | 160.2 ± 18.4 | 171.1 ± 24.9 | 89.4 ± 9.9 |
| | | | R | 146.9 ± 19.5 | 150.8 ± 17.2 | 146.2 ± 24.2 | 70.4 ± 8.6 |
| | | | D | 159.9 ± 18.4 | 150.2 ± 16.9 | 137.7 ± 21.6 | 81.4 ± 9.2 |
| V-D | 22.5 | 1.21 | A | 206.3 ± 23.2 | 208.3 ± 22 | 250.3 ± 26.6 | 260.1 ± 28.3 |
| | | | R | 188.6 ± 22.6 | 180.4 ± 19.6 | 230.4 ± 24.9 | 183.3 ± 19.9 |
| | | | D | 178.4 ± 19.5 | 186.4 ± 21.1 | 248.2 ± 27.4 | 233.1 ± 25.8 |
| T-A | 13.5 | 1.34 | A | 96.4 ± 11.3 | 176.3 ± 28.4 | 86.4 ± 9.0 | 77.9 ± 8.7 |
| | | | R | 83.4 ± 10.5 | 148.8 ± 24.9 | 80.5 ± 9.1 | 73.1 ± 8.8 |
| | | | D | 82.6 ± 11.0 | 152.2 ± 27.7 | 93.3 ± 8.8 | 62.7 ± 5.7 |
| T-B | 17.5 | 1.21 | A | 201.4 ± 22.4 | >206.6 | 196.6 ± 21.3 | 162.2 ± 18.5 |
| | | | R | 149.6 ± 18.4 | >247.9 | 140.4 ± 15.1 | 131.4 ± 14.6 |
| | | | D | 154.4 ± 17.9 | NR | 163.6 ± 18.2 | 145.2 ± 16.0 |
| T-C | 22.8 | 1.03 | A | 280.4 ± 31.4 | >194.2 | >242.7 | >242.7 |
| | | | R | >242.7 | >194.2 | >194.2 | 270.4 ± 34.6 |
| | | | D | 250.3 ± 17.9 | NR | NR | NR |
| T-D | 27 | 0,96 | A | 290.4 ± 17.7 | 268.4 ± 29.1 | 260.4 ± 28.2 | 286.6 ± 30.1 |
| | | | R | 206.0 ± 25.5 | 211.3 ± 23.3 | 199.2 ± 20.9 | 201.4 ± 22.4 |
| | | | D | 228.8 ± 26.3 | 214.6 ± 24.7 | 223.3 ± 24.8 | 236.6 ± 25.7 |

NR – no result (nėra rezultato).

in aquatic sediments: poorly sorted and well sorted, bimodal distribution, a positive or coarse skew, a negative or fine skew, positive symmetrical distribution. Smoothed frequency distribution curves show the types of sorting and skew.

There are four statistical coefficients which are commonly calculated for a granulometric analysis. In summary, they consist of the central tendency measure (including median, mode and mean); the degree of scatter or sorting; kurtosis, the degree of peakedness; and skewness, the curve lop-sidedness. The sedimentology and granulometry methods for interpretation of different ages of grain size fractions of aquatic quartz sand were used by us in case of Lithuanian TL-dated sections. We consider the value of the sedimentological approach, its interpretation and application.

Based on grain-size analysis results, we have the right to maintain that well-sorted aquatic sediments show an exact final age in TL dating (Fig. 10) and serve for establishing an accurate chronology of sandy sediments. Dates obtained by the TL method (Gaigalas et al., 2005) confirm the Snaigupėlė Interglacial age of sands in the Valakupiai outcrop.

Variations in the relative entropy of dates of the same samples were assessed from the average data on grain-size sedimentation conditions. Sometimes the older dates depend on the resedimentation sand portion of rewashed glacial deposits.

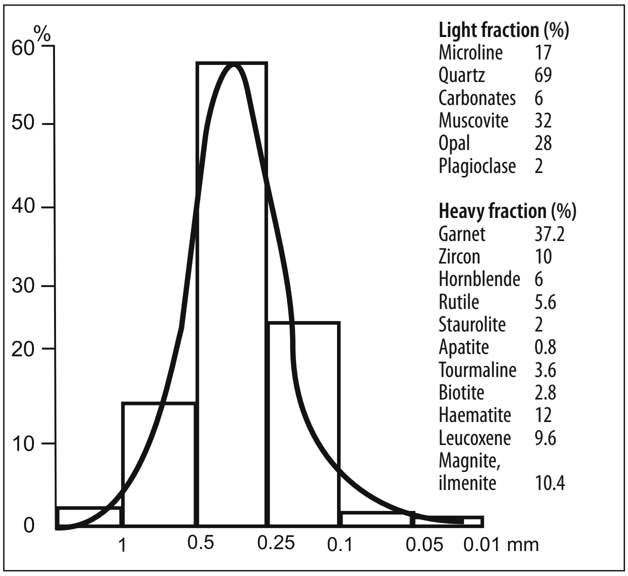



**Fig. 10.** Well-sorted grain-size distribution in beach sand of Snaigupėlė Interglacial palaeolake in Valakupiai section (Gaigalas et al., 2005).

TL age:229.7 ± 36 ka BP. Good long-time sorting – exact TL age (reflected in the sorting curve and mineral composition)

**10 pav.** Labai geras smėlio dalelių iš Snaigupėlės interglacialo paleoežero paplūdimio išrūšiavimas Valakupių pjūvyje (Gaigalas ir kt., 2005).

TL amžius: 229,7 ± 36 ka BP. Ilgas rūšiavimo laiko tarpas – tikslus TL amžius (atsispindi išrūšiavimo kreivėje ir mineralinėje sudėtyje)

## PERSPECTIVES FOR THE FUTURE

This sedimentological interpretation was inspired by a cooperation between a physicist (Fedorowicz) from the Gdańsk University and a geologist (Gaigalas) from the Vilnius University. The physicist conducted the dating and prepared the results. The geologist will determine their value. The grain-size analysis and geochemical analysis were already conducted for the aquatic sandy sediments of specific origin. As a result, lithocomplexes were distinguished, which allowed for the geochronological correlation. Maybe future interdisciplinary discussions will generate new ideas. The authors believe that the development of luminescence methods will stem in future from the collaboration between naturalists and physicists.

The mechanism of the formation of deposits requires the most accurate measurements of their TL properties. Each sample exhibits unique TL and dosimetric characteristics, and therefore the dating technique cannot be routinely applied. The further research should focus on comparing TL ages with an independent age control, which is easy to achieve for surficial sediments. Twenty-two new samples of sandy lacustrine deposits were collected from the Tartokai section for TL dating; we would like to present their sedimentological interpretation in the next article in more detail in the near future.

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### References

1. Fedorowicz S. 2003. Thermoluminescence method: outline of method history, foundations, principle, possibilities, perspectives, and limitations. *Geologija* 41: 28–35.
2. Fedorowicz S. 2003. Interlaboratory comparison of TL dating results on the Vilkiškės profile (Lithuania). *Geologija* 42: 40–44.
3. Fedorowicz S., Łanczont M., Muc A. 2005. Comparison of (TL and OSL) luminescence dating results from samples from selected loess profiles in SE Poland and the NW Ukraine. *Geologija* 50: 19–27.
4. Fedorowicz S. 2006. 9-oji visos Lenkijos mokslinė sesija „Uolienų ir mineralų datavimas“. *Mokslas ir gyvenimas* 11: 20.
5. Fedorowicz S. 2006. *Metodyczne aspekty luminescencyjnego oznaczanie wieku osadów neoplejstoceńskich Europy Środkowej*. Gdańsk: Wydawnictwo Uniwersytetu Gdańskiego. 156 s.
6. Gaigalas A., Fedorowicz S. 2002. Thermoluminescence dates of Mid- and Late Pleistocene sediments in Vilkiškės exposure, Eastern Lithuania. *Geologija* 38: 31–40.
7. Gaigalas A., Fedorowicz S., Melesyte M. 2002. TL age of Middle and Late Pleistocene deposits of Vilkiskes exposure in Eastern Lithuania. *Extended Abstracts "Baltic Stratigraphical Association – Basin Stratigraphy – Modern Methods and Problems". 22–27. IX. 2002, Vilnius, Lithuania*. 41–43.
8. Gaigalas A., Fedorowicz S., Račinskas A., Baužienė J. 2003. Radioaktyvaus cezio (Cs-137 izotopo) aktyvumas deliuvio dirvožemiuose Rytų Lietuvos Aukštumose. *Geologija* 42: 26–32.
9. Gaigalas A., Fedorowicz S., Melesyte M. 2004. New TL dates of aquatic sandy sediments of Middle–Upper Pleistocene in Lithuania. *Book of Abstracts of the 8th International Conference "Methods of Absolute Chronology". 17–19 May 2004, Ustroń*. 48–50.
10. Gaigalas A., Fedorowicz S., Melesyte M. 2005. TL dates of aquatic sandy sediments of Middle – Upper Pleistocene in Lithuania. *Geologija* 51: 39–50.
11. Gaigalas A., Fedorowicz S. 2006. Dosimetric age (TL, OSL) of aquatic sandy sediments of Middle – Upper Pleistocene in Lithuania. *Materiały konferencyjne "Datowanie minerałów i skał". 23–24 października, 2006, Gdańsk*. 33–36.
12. Gaigalas A., Fedorowicz S. 2007. Sedimentological interpretation thermoluminescence (TL) ages of Pleistocene aquatic sediments to follow Lithuanian example. *Abstracts and Programme 9th International Conference "Methods of Absolute Chronology". 25–27 April 2007, Gliwice, Poland*. 67.
13. Gaigalas A., Hütt G., Melešytė M. 1994. The OSL of the Merkinė (Mikulino) interglacial and the Nemunas (Valday) glacial period in Lithuania. *Conference of Geochronology and Dendrochronology of Old Town's and Radiocarbon Dating of Archaeological Findings. October 31–November 4, 1994. Vilnius, Lithuania*. P. 16.
14. Gaigalas A., Molodkov A., Melešytė M. 1994. The first EPR dating results of Butėnai (Likhvin) and Merkinė (Mikulino) interglacial deposits in Lithuania. *Conference of Geochronology and Dendrochronology of Old Town's and Radiocarbon Dating of Archaeological Findings. October 31–November 4, 1994. Vilnius, Lithuania*. P. 15.
15. Łanczont M., Fedorowicz S. 2004. The age of loess deposits at Dybawka, Tarnawce and Zarzecze (SE Poland) based on luminescence dating. *Geologija* 47: 8–15.
16. Raukas A., Stankowski W. 2005. Influence of sedimentological composition on OSL dating of glaciofluvial deposits: examples from Estonia. *Geological Quarterly* 49(4): 463–470.

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## GDANSKO IR VILNIAUS UNIVERSITETŲ BENDRADARBIAVIMAS TIRIANT PLEISTOCENO GEOCHRONOLOGIJĄ

*Santrauka*

Bendradarbiaujant Gdansko ir Vilniaus universitetams buvo sukurta Lietuvos vidurinio–viršutinio pleistoceno geochronologija, paremta akvalinio smulkiagrūdžio smėlio termoliuminescenciniu datavimu – Butėnų tarpledynmečio (Tartokų atodanga), Snaigupėlės tarpledynmečio (Tartokų ir Valakupių atodangos), Merkinės tarpledynmečio (Tartokų ir Netiesų atodangos) ir Nemuno ledynmečio (Tartokų, Netiesų ir Rokų atodangos). Butėnų tarpledynmečio amžius gautas nuo 430,2 iki 280,3 ka BP, Snaigupėlės interglacialo – nuo 239,4 iki 179,3 ka BP ir Merkinės interglacialo – 135,9–103,2 ka BP. Ankstyvojo Nemuno ir Vidurinio Nemuno neledyninės nuogulos klostėsi tarp 67,2–30,6 ka BP. Tartokų ir Rokų atodangų viršutinėse dalyse morenos yra jaunesnės negu 30 000 metų ir priklauso Vėlyvojo Nemuno ledyno maksimumui Lietuvoje. Skirtingų granuliarinių frakcijų to paties ėminio termoliuminescencinis ir optiškai stimuliuotos liuminescencijos amžius turi skirtingus parametrus, kurie buvo nulemti kvarcinio smėlio akvalinės sedimentacijos skirtingų sąlygų. Smėlio granuliometrija, arba kvarco grūdelių dydžių paplitimas, atspindi sedimentacinės erdvės hidrodinaminę būklę.

**Альгирдас Гайгалас, Станислав Федорович**

## СОТРУДНИЧЕСТВО МЕЖДУ ГДАНЬСКИМ И ВИЛЬНЮССКИМ УНИВЕРСИТЕТАМИ В ДЕЛЕ ИЗУЧЕНИЯ ГЕОХРОНОЛОГИИ ПЛЕЙСТОЦЕНА

*Резюме*

Благодаря сотрудничеству между Гданьским и Вильнюсским университетами было создано геохронологическое подразделение среднего и верхнего плейстоцена Литвы, которое обосновано результатами термолюминесцентного датирования бутенского (лихвинского) межледниковья (обнажение Тартокай), снайгупельского (Черепецкого) межледниковья (обнажения Тартокай и Валакупяй), мяркинского (микулинского) межледниковья (обнажения Тартокай и Нятесос) и нямунского (валдайского) ледниковья (обнажения Тартокай, Нятесос и Рокай). Возраст бутенского (лихвинского) межледниковья располагается в пределах 430,2–280,3 ka BP, снайгупельского (Черепецкого) межледниковья – 239,4–179,3 ka BP и мяркинского (микулинского) межледниковья – 135,9–103,2 ka BP. Неледниковые отложения раннего и среднего нямунского (валдайского) времени отлагались 37,2–30,6 ka BP. В верхних частях обнажений Тартокай и Рокай морены возрастои менее 30 000 лет и относятся ко времени максимального распространения ледника нямунского (валдайского) оледенения Литвы. Разные размерные фракции кварцевых зерен в одном и том же образце аквального песка имеют разные возрастные параметры. Гранулометрический состав кварцевого песка разных размерных фракций отражает гидродинамическое состояние седиментационной среды.