GEOCHRONOMETRIA 35 (2010), pp 75-83
DOI 10.2478/v10003-010-0003-7

Available online at
versita.metapress.com and www.geochronometria.pl

GEOCHRONOLOGICAL AND SEDIMENTOLOGICAL INTERPRETATION OF INTERGLACIAL AQUATIC SEDIMENTS BASED ON TL DATING

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Received 31 August 2009 Accepted 24 November 2009

Abstract: For the first time sedimentological interpretation of absolute ages obtained by thermoluminescence method on aquatic interglacial sediments was made. The analyzed size fractions of quartz grains were 160-250, 125-160, 100-125, 80-100 and 63-80 µm. The youngest and most reliable ages from 22 analyzed samples were obtained from the following quartz grain size granulometric fractions: 160-250 µm – 3 cases, 125-160 µm – 7, 100-125 µm – 6, 80-100 µm – 3 and 63-80 µm – 2 cases. Therefore, it may be concluded that the most suitable fractions for thermoluminescence dating are 125-160 µm and 100-125 µm. While evaluating the results of thermoluminescence dating it is necessary to take into account the procedure of sampling from layers of interest, their lithological composition, first of all granulometric, sedimentary environment, including sources of material, the material getting to the load flows, transportation mode and basin differentiation. From all the granulometric fractions of a sample, age of fine-grained fraction (63-80 µm) may be explained by the input of aeolian dust to a basin and sedimentation along with clasts brought to a lake by water flows. Aeolian sand storms performed precise multigenetic sedimentation that was active during that time. Bimodality of granulometric composition is defined by input of material from various sources of different composition. Older ages were obtained in the case of positive granulometric asymmetry. After sedimentological interpretation of thermoluminescence (TL) dating we can state that formation of aquatic fine-grained sands occurred 83.6±10 – 116.1±13 and 130.2±15 – 276.4±32 thousand years (ky) ago. Those geochronological zones coincide with interg lacial periods of Merkine (75.5-114 ky) and Snaigupele (180-280 ky) in Lithuania.

Keywords: aquatic interglacial sediments, Interglacials: Snaigupele (Drenthe-Warthe) and Merkine (eem), Lithuania, thermoluminescence (TL) dating

1. INTRODUCTION

For the dating of the Pleistocene interglacial aquatic mineral deposits dosimetric methods of thermoluminescence (TL) and optical stimulated thermoluminescence (OSL) are used. The results from different laboratories, however, are not always in a good agreement. Therefore, doubtfulness regarding reliability of obtained dates arises amongst researches. We encountered such a phenomenon while investigating the Vilkiškiai outcrop in the surroundings of Bireliai village, Lithuania (Satkunas and Molodkov, 2005; Gaigalas and Pazdur, 2004). It was earlier noticed that ages determined by these methods (TL and OSL) depend on accumulated relic energy in mineral grains that may not completely be removed and remains during sedimentation of aquatic deposits. This is defined by the properties of sedimentary environment: duration and mode of material transportation, water clearness and depth of a basin, mantles of quartz grains, intensity of solar radiation, etc (Gaigalas, 2000). Encountering such phenomena, we noticed that TL and OSL ages depend on fraction size of analyzed grains. This is straightforward because probability for relic energy to remain is higher in larger grains. In order to precisely determine dosimetric age of the same samples a low zero-point signal is needed. Relic effect depends on the sedimentation environment and conditions of transportation (Gaigalas and Fedorowicz, 2007).

Therefore, we aim to make sedimentological interpretation of geochronologic data, taking into account grain size fractions that reflect dynamic conditions of sedimentary environment. For this purpose we selected the above

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ISSN 1897-1695 (online), 1733-8387 (print)

mentioned Bireliai (Tartokai) and Sakiškiai (Vilkiškiai) village outcrops on the right and left banks of the Neris River between Vilnius and Nemenčine (**Fig. 1**). These outcrops contain interglacial aquatic sandy deposits which were dated with the use of thermoluminescence method (Gaigalas and Fedorowicz, 2002; Fedorowicz, 2003; Gaigalas *et al.*, 2005; Fedorowicz 2006b). Sometimes the same sand samples have different thermoluminescence ages. The sediments in these outcrops were studied earlier, which led to establishing common age of all grain-sized quartz, i.e. irrespective their grain sizes (**Fig. 2**).

2. OBJECT OF THE STUDY.

At Tartokai, 22 samples from interglacial aquatic sand deposits were collected and divided into seven size fractions: >250, 160-250, 125-160, 100-125, 80-100, 63-80,and <63 μm. In the cross-section of the outcrop, sampling sites within interglacial sand beds are shown. In the studied sands, different fractions prevail, except the fraction of <63 μm which has the smallest percentage share (**Table 1**).

After establishing granulometric composition of samples T-2, T-3, T-7, T-8, T-12 to T-16, T-20 to T-22, grain-size fraction distribution plots were made (**Figs. 3 to 6**). As may be seen from the granulometric curves, deposits in the same sample have different parameters. They are defined by quartz grain size fraction distribution in the granulometric plots. Quantitative distribution of quartz sand grain size fractions is reflected in the granulometric curves. Relic age signal in different

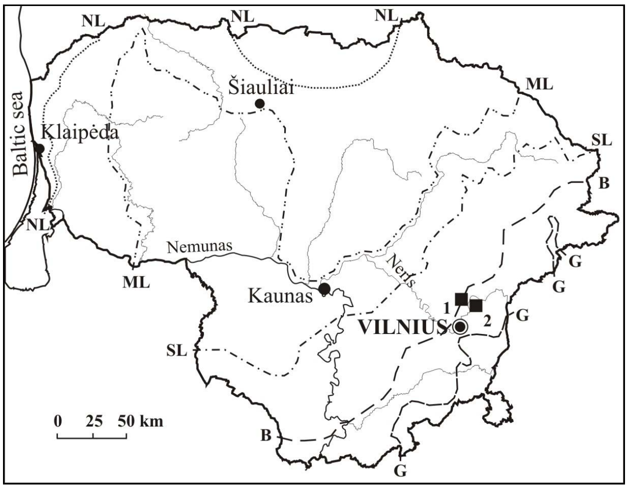
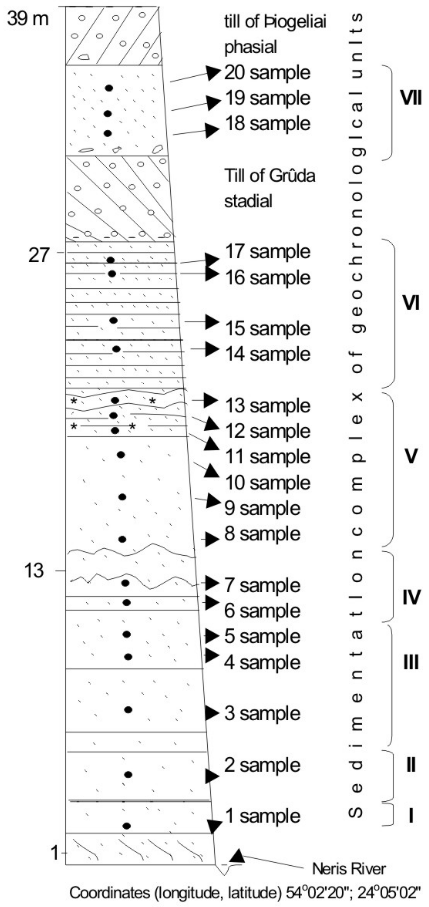


Fig. 1. *Location of the investigated sections 1-Tartokai, 2-Vilkiškės, Grūda (maximal) Stage, – Iogeliai Phase, B(EL) – East Lithuanian (maximum) Phase of the Baltija Stage, SL – South Lithuanian Phase, ML– Middle Lithuanian Phase, NL– North Lithuanian Phase.*



Sample No	Above the water line	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	
T -15	23.6	5592	0.03	1.17	0.48	1.68	80.3	47.8	VI
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	
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	V
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

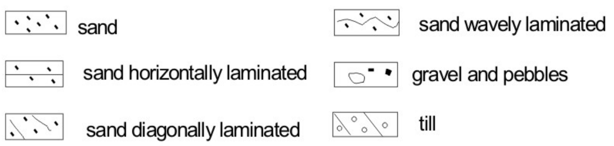


Fig. 2. *Tartokai section with TL dates (Gaigalas et al., 2005).*

Table 1. *Results of grain-size sieve analysis of samples from the Tartokai profiles.*

Fraction (µm) Samples	> 250	160-250	125-160	100-125	80-100	63-80	<63
T-1	**59.4**	**29.0**	6.2	1.6	1.4	1.9	0.5
T-2	2.6	**49.2**	**27.2**	5.8	**8.0**	5.6	1.5
T-3	**22.1**	**54.0**	**16.0**	2.8	1.4	3.2	0.3
T-4	**81.4**	**11.6**	2.6	1.3	1.0	1.6	0.6
T-5	**30.2**	**37.6**	**19.1**	3.3	4.0	4.7	1.1
T-6	**39.8**	**31.3**	5.4	4.0	5.1	**13.5**	0.9
T-7	3.7	**36.2**	**30.3**	9.2	**10.0**	8.6	1.9
T-8	**13.9**	**54.3**	**17.4**	2.3	2.3	8.9	0.9
T-9	5.9	**45.2**	**26.0**	5.4	**10.5**	5.6	1.4
T-10	0.8	2.5	8.8	**10.6**	**10.2**	**51.4**	15.8
T-11	**50.5**	**26.0**	**11.3**	4.0	3.0	3.9	0.9
T-12	0.4	7.0	**31.4**	**19.7**	**19.7**	19.2	2.6
T-13	1.0	**16.7**	**28.8**	14.5	**20.0**	14.6	4.3
T-14	1.0	**18.8**	**28.8**	15.0	15.3	**17.8**	3.3
T-15	6.5	**58.9**	**25.5**	3.8	3.0	1.9	0.4
T-16	**19.9**	**59.2**	**13.9**	2.4	2.0	1.8	0.4
T-17	**42.1**	**45.7**	8.0	2.0	1.1	0.8	0.2
T-18	**8.0**	**61.2**	**19.0**	4.4	4.2	3.0	0.3
T-19	**10.3**	**56.8**	**18.3**	5.0	5.2	3.7	0.6
T-20	4.4	**32.4**	**29.2**	10.0	9.2	**12.4**	2.3
T-21	**21.8**	**54.1**	**16.2**	1.5	2.5	3.7	0.3
T-22	3.1	**66.3**	**22.5**	2.4	3.5	1.9	0.3

The numbers in bold mean dominant fraction in the samples

quartz sand grain size fractions of the same sample is defined by grain size distribution. Graphical and statistical methods for thermoluminescence age interpretation in various size fractions allow for determining certain regularity in aquatic sand deposits. Granulometric coefficients (sorting, median diameter, modal diameter, skewness or asymmetry, etc.) are useful to highlight conditions of sedimentation. The character of granular curves reflects grain size distribution in the sample (**Fig. 3**). Grain size distribution in granulometric spectrum may be unimodal,

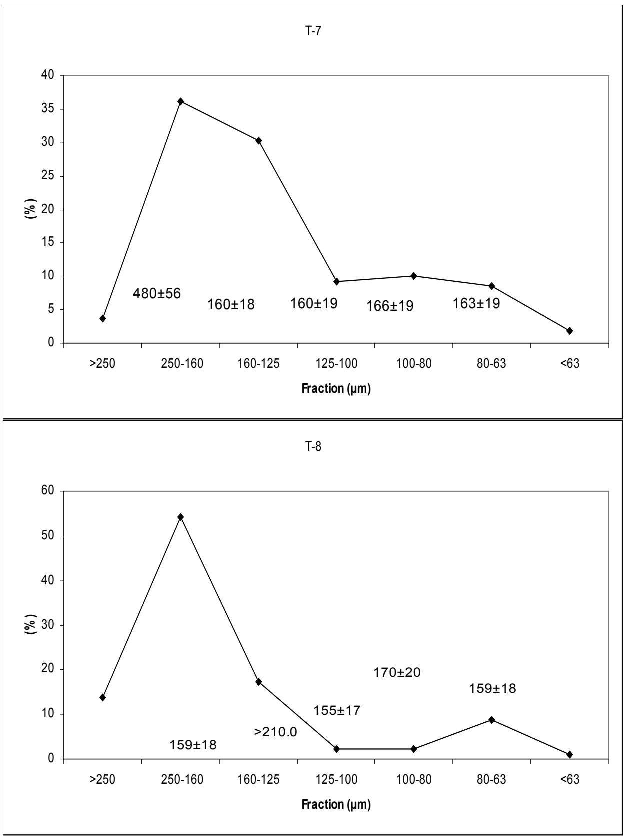


Fig. 3. *Granular composition's of sample's T-7, T-8 with TL date.*

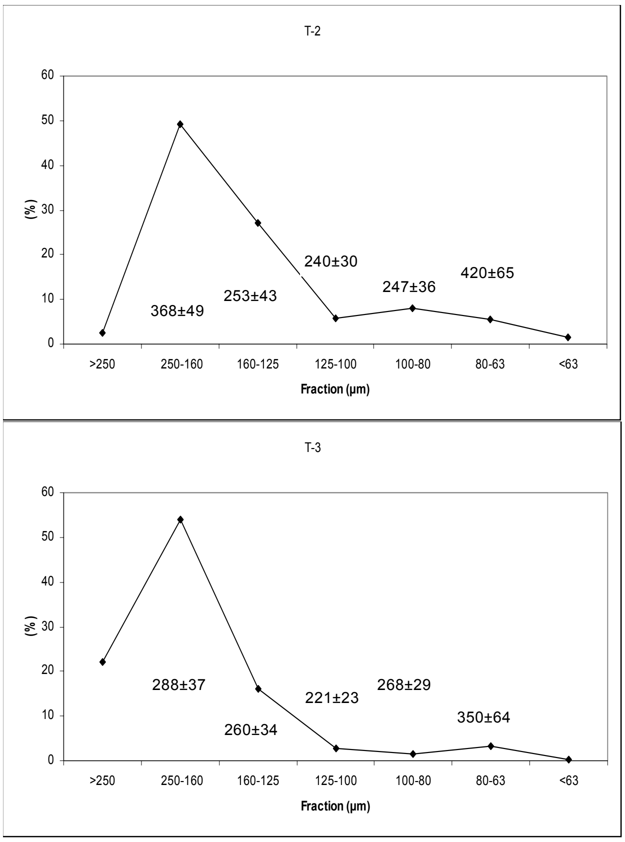


Fig. 4. *Granular composition's T-2, T-3 sample's with TL date.*

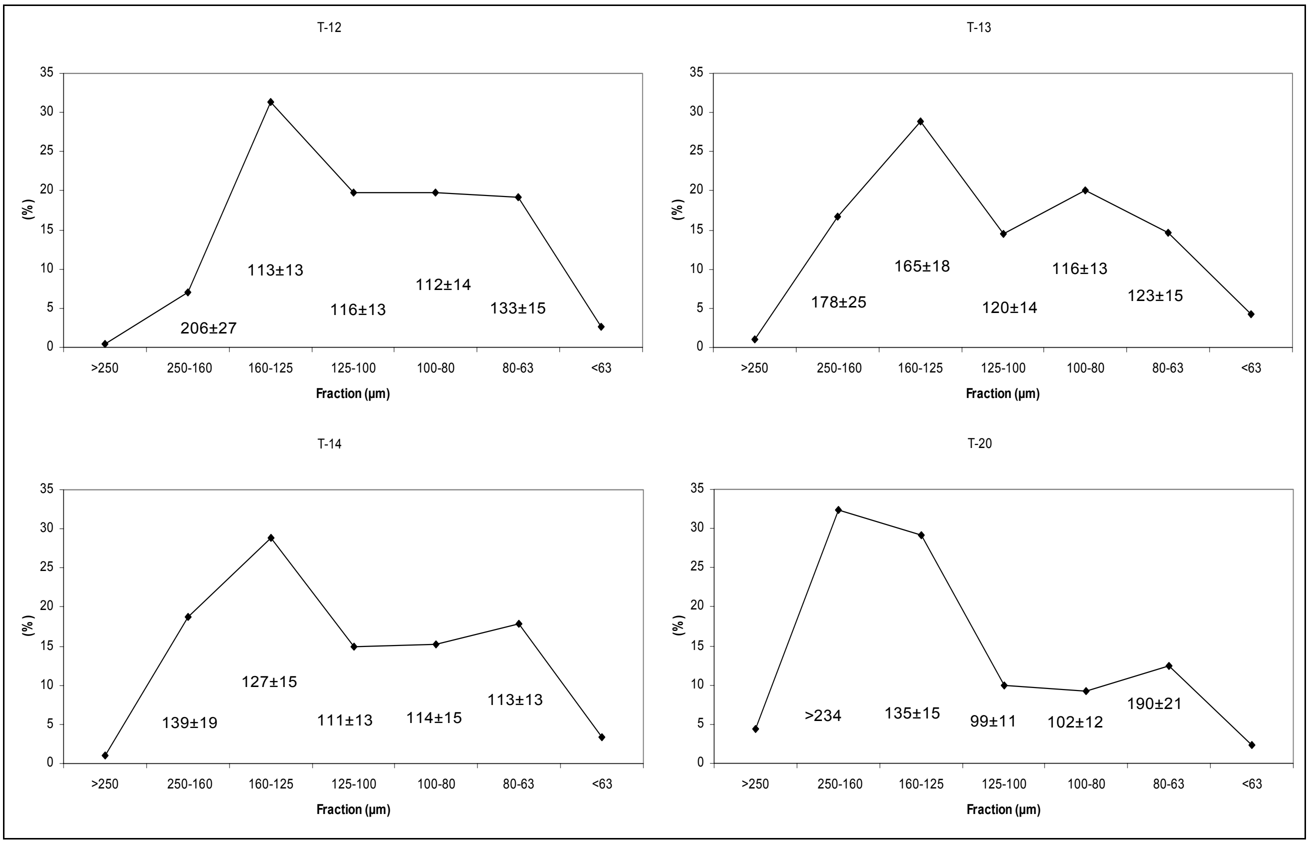


Fig. 5. *Granular composition's of sample's T-12, T-13, T-14, T-20 with TL date.*

bimodal and multimodal. In the case of unimodal distribution of grain sizes, granulometric curve show one maximum (peak) i.e. one mode (dominant fraction). When two fractions are dominant we have bimodal distribution, when even more modes are present – multimodal. The character of granular curves, which is defined by distribution of grain size fractions, reflects heterogeneity of material, i.e. probably coming from several sites of origin. In our case, the material could come from water destructed tills, fluvioglacial or river deposits, eolian dunes, beach, etc.

Sorting degree of sample's is reflected in the steepness of the grain size fractions curve (**Fig. 3**). The steeper the curve, the better a sample is sorted. There is one dominant granular fraction in such a sample. This indicates the existence of a long period of materials differentiation during which the quartz grains could reach zero relic effect. Inclination or steepness of the granulometric curve is estimated by kurtosis or excess coefficient. The excess value of a gently inclined curve is less than zero, while the excess value of steeply inclined one is more than zero. The material from the sample with gently inclined curve could be quickly accumulated, but other geological processes could also be responsible for it.

Another feature of granulometric curve is its asymmetry (**Fig. 3**) or unevenness (curvature). It shows the dominance of larger or smaller grains in the sample. When more coarse grains prevail we have positive asymmetry, while predominance of fine grains indicates negative asymmetry. From the asymmetry of grain size distribution it is possible to assess the transportation mode in the water flow (suspension, rolling, saltation, etc.). Transportation mode depends on the flow velocity. In the case of positive asymmetry the obtained thermoluminescence dates are older than the ages of the sedimentation period due to the relic effect.

Thus, the usage of the granulometric method and data of grain size fraction distribution in a sample are important for geological interpretation of thermoluminescence ages. It is important for evaluation of reliability and accuracy of age estimation.

3. THERMOLUMINESCENCE DATA

The ages obtained using TL method in the thermoluminescence laboratory at Gdansk University are different for different fractions in the same sample (**Table 2**). The preparatory process and measurement method are described in the work by Fedorowicz and Zieliński (2009) and Fedorowicz (2006a) Granulometric sieve analysis confirmed that fractions of >250 µm and 160-250 µm are predominant (**Table 1**). They comprise 70% in most of the samples. From all fractions which were separated during granulometric analysis, the fraction 125-160 µm may also be distinguished since its amount is also significant in the samples. From all 22 samples, the amount of this fraction was less than 10% only in five cases (**Table 1**).

Standard procedure of TL dating at Gdansk laboratory is based on quartz grains of fraction 80-100 µm. Unfortunately, this fraction is not dominant in the 22 samples. Therefore, the age determination by this method is not

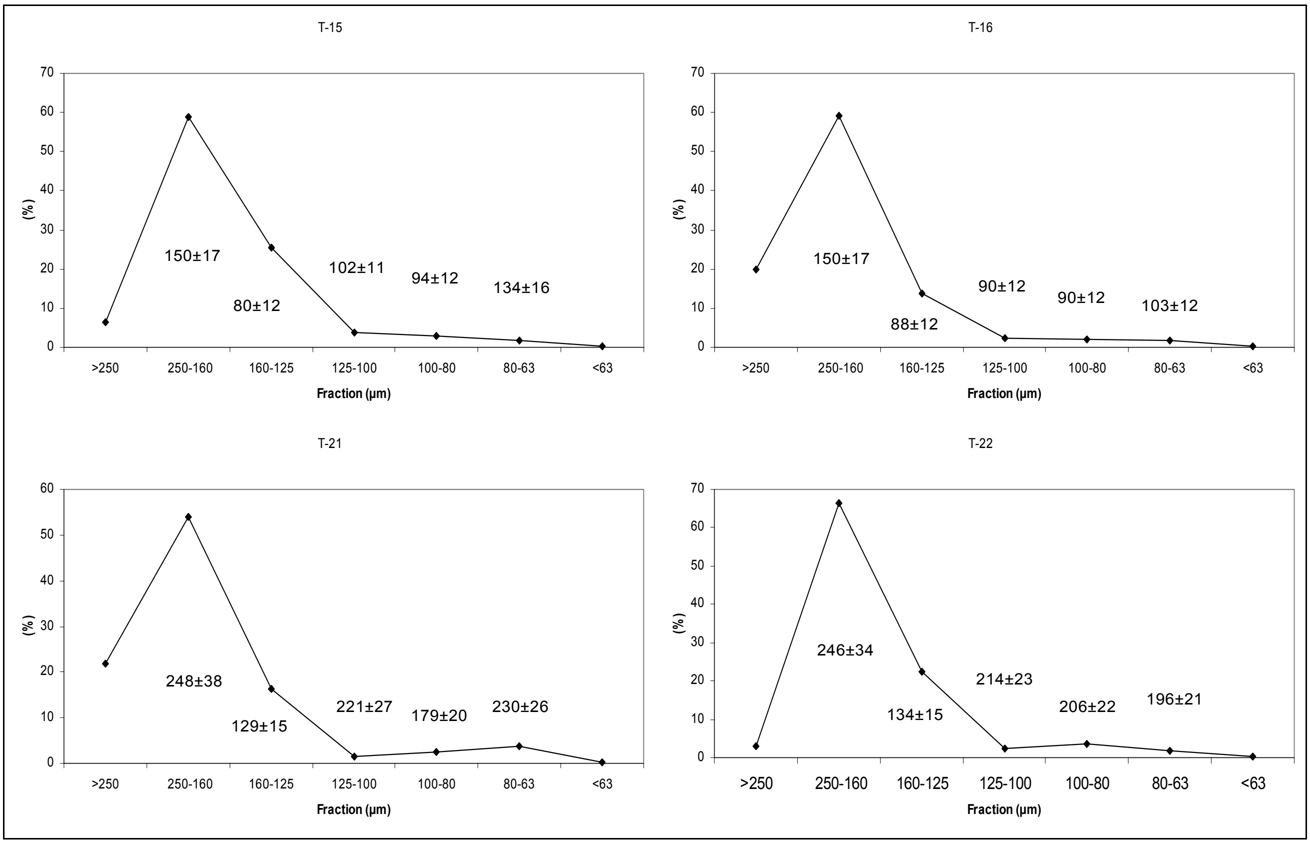


Fig. 6. *Granular compositions of samples T-15, T-16, T-21, T-22 with TL date.*

justified in sedimentological sense. Only in six samples amounts of that fraction exceeded 10% (**Table 1**). Percentage share of fractions 80-100 µm and 100-125 µm are similar. The magnitude of a thermoluminescence dose depends on the results of the granulometric composition. Large doses are typical for large quartz grain size fractions while smaller doses are characteristic for smaller fractions.

In comparison to other fractions, the samples with the highest levels in the profile have only few percents of grains that are larger than 125 µm. Measurements of

Table 2. *TL dates of samples from the Tartokai (T) profile obtained with the following regeneration method for various diameters of quartz grains.*

Sample index	No laboratory	Depth (m)	Dose rate* Dr(Gy/ka)	TL date for grain fraction (µm)				
				160-250	125-160	100-125	80-100*	63-80
T-1	UG-5919	14.50	1.16±0.06	**276±32**	283±47	396±54	388±55	460±78
T-2	UG-5920	13.60	1.34±0.06	368±49	253±43	**240±30**	247±36	420±65
T-3	UG-5921	12.80	1.33±0.05	288±37	260±34	**221±23**	268±29	350±64
T-4	UG-5922	12.40	1.14±0.05	**240±36**	>400.0	400±64	>200.0	376±62
T-5	UG-5923	12.00	1.27±0.06	230±36	**223±33**	>250.0	>350.0	431±67
T-6	UG-5924	11.70	1.36±0.06	170±24	390±56	196±24	210±25	**168±19**
T-7	UG-5925	10.50	1.42±0.06	480±56	**160±18**	160±19	166±19	163±19
T-8	UG-5926	8.80	1.43±0.05	159±18	>210.0	**155±17**	170±20	159±18
T-9	UG-5927	8.40	1.42±0.07	151±16	155±18	160±18	**147±16**	150±17
T-10	UG-5928	8.05	1.94±0.10	290±36	182±19	142±15	159±17	**140±16**
T-11	UG-5929	6.90	1.26±0.05	**130±15**	126±14	206±22	196±22	206±21
T-12	UG-5930	5.30	1.76±0.07	206±27	113±13	116±13	**112±14**	133±15
T-13	UG-5931	4.65	1.73±0.07	178±25	165±18	120±14	**116±13**	123±15
T-14	UG-5932	4.30	1.64±0.07	139±19	127±15	**111±13**	114±15	113±13
T-15	UG-5933	3.90	1.36±0.05	150±17	**80±12**	102±11	94±12	134±16
T-16	UG-5934	3.50	1.18±0.07	150±17	**88±12**	90±12	90±12	103±12
T-17	UG-5935	3.00	1.21±0.06	234±25	**84±11**	98±11	88±13	94±11
T-18	UG-5936	2.50	1.36±0.06	109±14	116±14	**108±13**	111±14	183±20
T-19	UG-5937	2.00	1.30±0.06	156±20	141±15	**83±10**	88±11	99±12
T-20	UG-5938	1.00	1.39±0.05	>234.0	135±15	**99±11**	102±12	190±21
T-21	UG-5939	0.50	1.36±0.06	248±38	**129±15**	221±27	179±20	230±26
T-22	UG-5940	0.45	1.34±0.05	246±34	**134±15**	214±23	206±22	196±21

The numbers in bold mean the youngest dates obtained for the sample natural thermoluminescence of the coarser quartz grains have larger values. This influences the factor of reliability if total age of all granulometric fractions is calculated. Sometimes it exceeds 15% (**Table 2**).

Only one sample (T-2) revealed ages that are similar to all analyzed quartz grain granulometric fractions, except fraction 160-250 µm (**Table 2**). Two samples (T-4 and T-5) showed finite ages only for extreme size fractions (160-250 µm and 63-80 µm). The ages for finer-grained fractions are older than for coarser fractions (**Table 2**). This we explain later sedimentologically. The ages obtained for the samples (T-1 to T-5) collected at the lower part of the cross-section (**Table 2**) require sedimentological interpretation. The finest fractions in these samples yielded older ages than those in coarser grained quartz fractions. Percentage of the fine-grained fractions which revealed unreliable results is small.

From 22 studied samples, the youngest ages are obtained for the following quartz grain size granulometric fractions:

160-250 µm – 3 cases,
125-160 µm – 7 cases,
100-125 µm – 6 cases,
80-100 µm – 3 cases,
63-80 µm – 2 cases.

Therefore, it is possible to state that fractions 125-160 µm and 100-125 µm are the best for dating aquatic sandy deposits with the use of thermoluminescence method. The grains from the 80-100 µm fraction are less reliable for age determination conducted with the use of thermoluminescence method (**Table 3**). The TL dates often show inversion in all grain fractions.

As we demonstrated, the results of thermoluminescence dating depend on grain size fractions, however, not only on them but also on the method used to establish their TL ages. For this purpose, we selected eight samples, four from each outcrop, the granulometric composition of which is presented in **Table 4**.

Table 3. *TL dates of 80-100 µm fraction smallest quartz size.*

Sample No	TL dates fraction 80-100 µm (ka BP)	TL dates smallest quartz grain in the sample (ka BP)
T-1	388±55	276±32
T-2	247±36	240±30
T-3	268±29	221±23
T-4	>200	240±36
T-5	>350	223±33
T-6	210±25	168±19
T-7	166±19	160±18
T-8	170±20	155±17
T-9	**147±16**	147±16
T-10	159±17	140±16
T-11	196±22	130±15
T-12	**112±14**	112±14
T-13	**116±13**	116±13
T-14	114±15	111±13
T-15	94±12	80±12
T-16	90±12	88±12
T-17	88±13	84±11
T-18	111±14	108±13
T-19	88±11	83±10
T-20	102±12	99±11
T-21	179±20	129±15
T-22	206±22	134±15

The numbers in bold mean the youngest dates obtained for the material of fraction 80-100 µm, which was used at Gdansk laboratory

Table 4. *TL age of samples from Vilkiškes (V) and Tartokai (T) profiles for quartz of different grain fractions. Explanation: (A) – additive method; (R) – regeneration method; (RΓ) – partial bleaching; (-) – age estimation impossible.*

Samples	Depth (m)	Dose rate (Gy/ka)*	Methods	TL date for grain fraction (µm) 160 -250	125-160	100- 125	80-100*
			A	160±18	61.3±8.2	56.8±6.6	58.8±7.3
			R	140±16	46.4±6.9	43.4±5.4	50.3±6.9
V –A	12.50	**1.13**	R-Γ	130±15	60.4±7.1	50.2±4.8	53.1±6.8
			A	>145.2	>145.2	>103.7	>103.7
			R	>124.5	>124.5	>103.7	>83.0
V –B	17.70	**2.41**	R-Γ	-	-	-	-
			A	190±22	160±18	171±25	89.1±9.9
			R	146±19	150±17	146±24	70.3±8.6
V –C	19.60	**1.86**	R-Γ	159±18	150±17	137±22	81.0±9.2
			A	206±23	208±22	250±27	260±31
			R	188±22	180±20	230±27	183±22
V –D	22.50	**1.21**	R-Γ	178±19	186±21	248±29	233±28
			A	96±11	176±28	86±15	77.9±8.7
			R	83±10	148±25	80±14	73.1±8.8
T –A	13.50	**1.34**	R-Γ	82±11	152±28	93±14	62.7±5.7
			A	201±22	>206	196±33	162±18
			R	149±18	>247	140±24	131±15
T –B	17.50	**1.21**	R-Γ	154±18	-	163±28	145±16
			A	280±31	>194	>242	>242.7
			R	>242	>194	>194	270±35
T –C	22.80	**1.03**	R-Γ	250±18	-	-	-
			A	290±18	268±29	260±31	286±30
			R	206±25	211±23	199±21	201±22
T –D	27.00	**0.96**	R-Γ	228±26	214±25	223±25	236±26

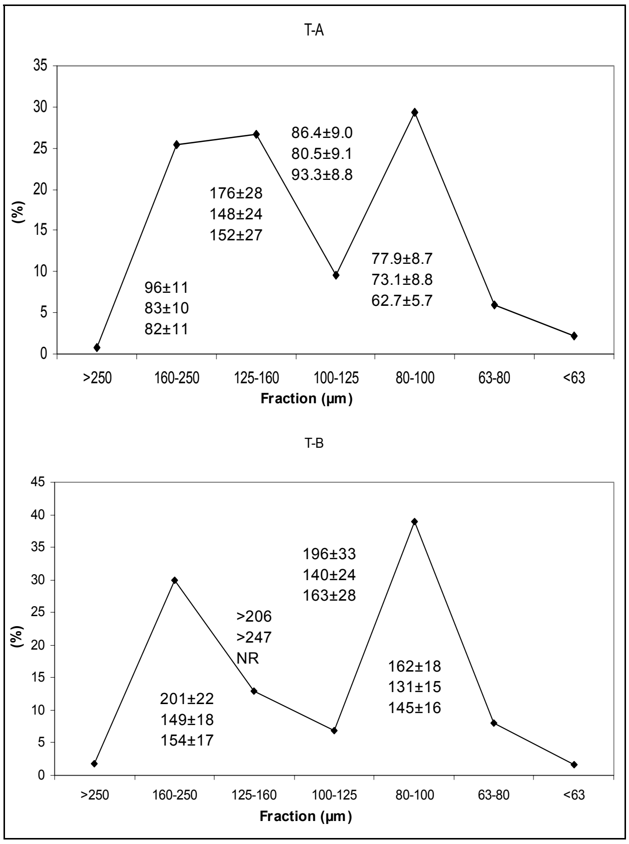


Fig. 7. *Bimodal distribution (T-A and T-B) of grain-size compositions from different sources with TL dates of different fractions using additive (A), regeneration (R) and partial bleach (RΓ) methods. T-A and T-B – samples (**Table 4**).*

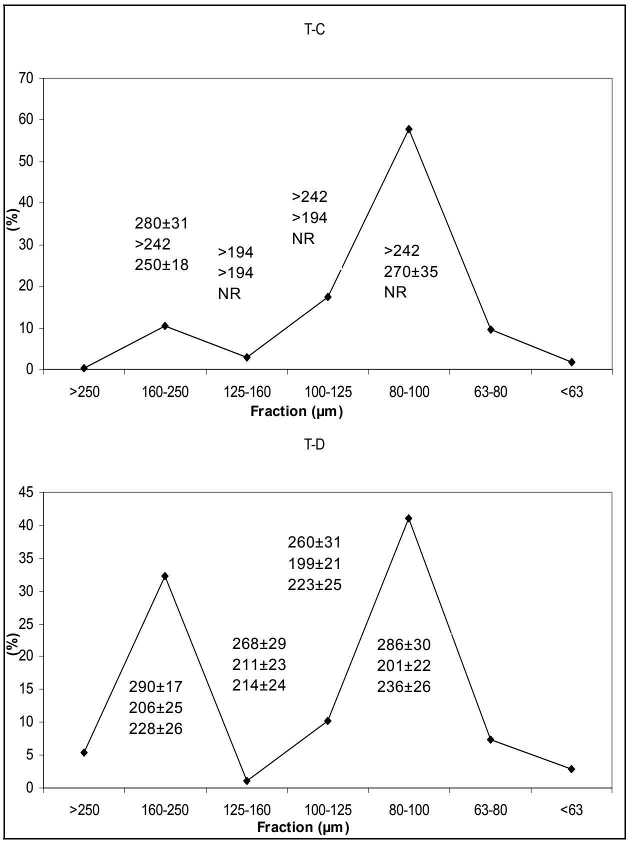


Fig. 8. *Positive or coarse (T-C and T-D) skew of grain-size distribution with TL dates of different fractions using additive (A), regeneration (R) and partial bleach (RΓ) methods. T-C and T-D – samples (**Table 4**).*

The dating results of selected fractions in **Table 4** are obtained exploring different modes: A (additive method), R (regeneration method) and R-Γ (partly bleaching method). As we see, the results are different in most cases (**Figs. 7-8**). Such heterogeneous ages of various quartz grain size fractions require sedimentological explanation.

As we mentioned earlier, varying dosimetric ages of different granular fractions of the same sample yield dissimilar parameters. They depend on quartz grain size distribution during aquatic transportation and sedimentation as well as on the sources of material and its way of getting to the sedimentary environment. Quartz sand grain size fraction distribution, in turn, reflects hydrodynamic status of the sedimentary space. The relic age signal in different quartz sand grain size fractions in the same sample is defined by change in sedimentary environment (facies, genesis, sources of sediments, hydrodynamics, modes of transportation, post-sedimentary factors, etc.).

4.SEDIMENTOLOGICAL INTERPRETATION.

Let us discuss application possibilities of sedimentological methods for interpretation of the thermoluminescence age data.

Sedimentary process starts with the preparation of sedimentary material which comes from original sources. In our case, the sandy material for the sedimentary process was brought from glacial (glacigenic) alluvium.

In the quartz grains of sandy fractions, in deposits from previous glaciation and interglaciation, the relic signal remained from the older times as well as was newly obtained during repeated sedimentation, i.e. resedimentational relic effect. The removal or survival of this age signal depends first of all on transportation conditions of the material. During the transportation, the material could be in several forms: in solutions, colloids, suspension and in solid state. In the given case of sandy particle transportation, two following groups of transported material are the most important for us: 1) in solid (clast) and 2) suspended mineral states. Clasts are rolled and dragged by streams on the river bed. They move forward by hopping (saltation) and jumping while bumping to the bottom. The possibility of their illumination and relic effect removal is higher in shallow waters, beach and littoral zones. The investigated sands accumulated in a lake; however, the material is brought to it by water flows flushing from the area around the lake. Further differentiation of material occurred in the basin conditions.

Employing median diameter and amount of particles of that diameter, R. Passega (1957, 1964) distinguished separate field in the genetic diagram of aquatic deposits: I – pelagic suspension, II – uniform (constant) suspension, III – sorted suspension, IV – bed loads, and V – turbid flows. From the above mentioned suspended materials, the remaining sun energy is best removed in those that can be in suspension for the longest period of time in the near-surface waters. This phenomenon is limited when the accumulation of the suspended material occurs during winter in a basin covered with ice. The following fields in the genetic diagram are important for us: 1) river bed streams, 2) lake littoral, 3) turbid streams, 4) still water condition, and 5) beach deposits.

Transportation of mineral material to the final sedimentary basin occurs by rolling on the bottom, hopping (saltation) and in suspension. In the same way, material is transported by wind on land. Eolian material gets to the basin sedimentation. During eolian transportation relic zero signal in quartz grains is reached.

5. FINAL REMARKS

As it was mentioned earlier, the ages of fine-grained sand (125- 160 µm and 100-125 µm) and very fine-grained or aleurite (80-100 µm) fractions in one sample (T-2) are the same. They are genetically related because they settle in inundation zone where initial differentiation of material took place. Deposits at the bottom of the outcrop (samples T-1 to T-5) reflect natural process of clastic material sorting that is clear from gradual reduction of sand fraction (160-250 µm) towards top (from sample T-1 to sample T-5). Sample sorting in granulometric diagrams is underlined by unimodal asymmetric distribution of grains (**Figs. 9** and **10**; Samples T1 to T5).

The minimal TL age of fine-grained fractions in the spectrum of sample's granulometric fractions (samples T-6 and T 10) is explained by the input of eolian dust to the basin and sedimentation along with clasts that came to lake with the flows. In such cases, granulometric diagrams show minimal ages in fine grain quartz fractions (63-80 µm). They exist in appreciable amounts in those samples. In the granulometric curves of those samples the signs of bimodality are noticeable. Eolian drift precisely performed multigenetic sedimentation that took place at that time. The bimodality of granulometric composition is defined by material's arrival from various sources, which differ in lithological composition.

The minimum age of coarser-grained fractions (160-250 µm; samples T-1, T-4, T-5 and T-11) is sedimentologically explained by formation of these deposits in the near-cost zone and on the beach. The dated fractions are dominant in the positive asymmetric granulometric spectrum.

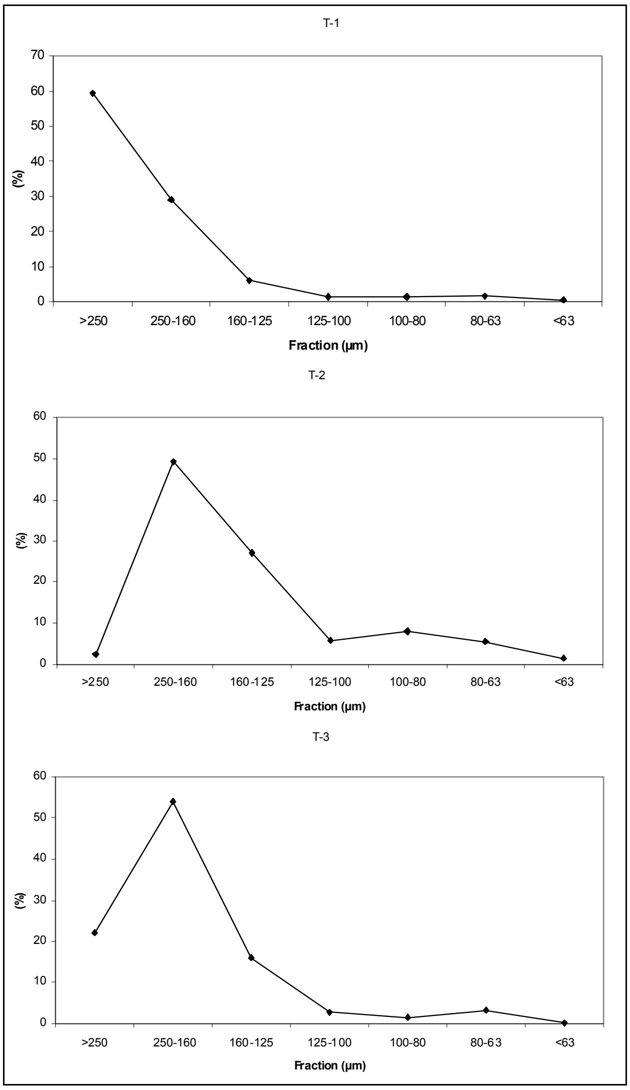


Fig. 9. *Granular composition's of sample's T-1 - T-3 from outcrop Tartokai.*

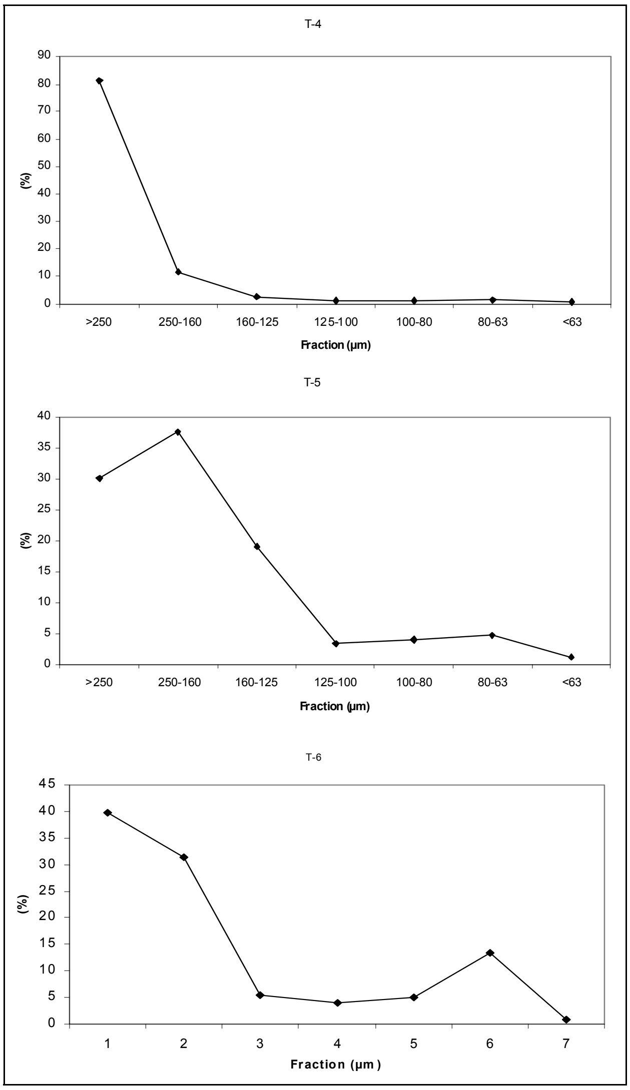


Fig. 10. *Granular composition's of sample's T-4 - T-6 from outcrop Tartokai.*

In the upper part of the cross-section (samples T-20, T-2 and T-22), the older ages of fine-grained fractions (100-125 µm, 100-80 µm and 63-80 µm) are explained by the input of material which did not reach the sign of zero signal and was brought by melting waters from a progressing glacier.

Heterogeneity of granulometric composition and entropy of the thermoluminescence age in various fractions arises from the manner of sampling for analysis. If one collects a sample from a very fine laminated bed, the material will inevitably come from laminas with different lithological compositions. It mechanically mixes during the analysis. It is necessary to keep in mind that different laminas formed in different sedimentary environment. Therefore their thermoluminescence age is dated ambiguously. More precise age may be obtained when sand deposits are homogeneously sorted and quartz grains are not covered by iron oxide or other mineral films.

While evaluating results of thermoluminescence dating, it is necessary to take into account the importance of sampling procedure from the layers of interest, their lithological composition (especially granulometric one), sedimentary environment, including material sources, their way to transportation streams, modes of transportation, and basin differentiation.

Upon completion of the sedimentological interpretation of the thermoluminescence (TL) age data, we can state that formation of the aquatic fine-grained sands took place 83±10 – 116±13 thousand years ago and 130±15 – 276±32 thousand years ago. Those geochronological intervals coincide with interglacial periods of Merkine (75.5-114 thousand years ago) and Snaigupele (180-280 thousand years ago) in Lithuania (Gaigalas and Fedorowicz, 2002; Gaigalas *et al.*, 2005).

ACKNOWLEDGEMENT

This paper presents the results of interdisciplinary studies. The study was to be continued in the future.Unfortunately, it will not, as the co-author, a geologist and sedimentologist, has died. Professor Algirdas Gaigalas died in June 2009 in Vilnius. This publication is the last co-authorship work.

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