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TRACES OF HIGH SEISMIC ACTIVITY IN THE UPPERMOST SEDIMENTS OF LAKE BAIKAL, SIBERIA

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ABSTRACT. Sedimentation in Lake Baikal is significantly affected by continuous seismic activity in the Baikal Rift Zone. Our study shows that historical earthquakes, as well as recent seismic events, considerably influenced sedimentation in this deep tectonic basin. Here we present some of the results of extensive international research activities during the period of 1996–2019. To identify traces of seismic events in the uppermost sediments (<1.5 m), short cores were recovered from many coring stations throughout the entire lake. Based on lithological descriptions, measurements of magnetic susceptibility, and concentration of inorganic and organic components, we identified earthquake indicators in the sediment cores. Impacts of historical earthquakes were traced within South Baikal (near the Sharyzhalgai Station and the Station 106-km of the Circum-Baikal railway, hereafter CBR) and Proval Bay (near the Selenga River delta).

KEYWORDS: Lake Baikal; sedimentation; earthquake; bottom sediments; sedimentation rate; pelagic mud; turbidites; oxidized layers

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СЛЕДЫ ВЫСОКОЙ СЕЙСМИЧЕСКОЙ АКТИВНОСТИ В ПОВЕРХНОСТНЫХ ОТЛОЖЕНИЯХ ОЗЕРА БАЙКАЛ, СИБИРЬ

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АННОТАЦИЯ. Осадконакопление в озере Байкал происходит на фоне постоянной сейсмической активности Байкальской рифтовой зоны. Современные и исторические землетрясения оказывают значительное влияние на формирование донных отложений в этом глубоком тектоническом бассейне. В статье представлены результаты международных исследований за период 1996–2019 гг. Для обнаружения следов сейсмических событий в самых верхних слоях отложений (<1.5 м) были отобраны короткие керны по всему озеру. Приведены карты с точками отбора кернов и сейсмичностью озера. Литологический состав, данные измерения магнитной восприимчивости, оценка органических и неорганических компонентов осадков позволяют определить индикаторы землетрясений в донных отложениях озера. Следы исторических землетрясений были обнаружены в пределах Южной котловины Байкала (районы станций Шарыжалгай и 106-й км Кругобайкальской железной дороги) и в заливе Провал рядом с дельтой р. Селенги.

КЛЮЧЕВЫЕ СЛОВА: озеро Байкал; осадконакопление; землетрясение; донные отложения; скорость осадконакопления; пелагический ил; турбидиты; окисленные слои

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1. INTRODUCTION

Lake Baikal is considered a unique lacustrine ocean. This 650 km long, 80 km wide and 1637 m deep water body is located within the Baikal rift zone, one of the most hazardous seismic regions of Russia. The Baikal depression diverges at a rate of 1.25 to 2.3 mm·year^{-1} [Ashurkov et al., 2011]. On average, almost 8–10 thousand earthquakes are recorded annually in the Baikal region and Transbaikalia [Mel'nikova et al., 2010]. Actually, sedimentation in Lake Baikal takes place under conditions of high seismic activity.

Several interdisciplinary international and Russian research projects have been carried out in the lake, including INTAS, BICER, GEOPASS, EU-Project CONTINENT, RFBR, Baikal Neutrino Project, etc. Our study aimed to search for traces of recent and historical earthquakes within the lake sediments. Here we present a summary of the research results and new data on the uppermost sediments of Lake Baikal and discuss the role of seismic activity during sedimentation.

2. MATERIAL AND METHODS

Sediment cores were recovered by two different gravity corers (EAWAG-63/S and UWITEC-corer), which ensured the undisturbed recovery of the uppermost, water-rich sediments. Both corers used plastic tubes of 6.3 cm Ø. Coring activities were carried out from three research vessels (R/Vs *Vereshchagin*, *Titov*, and *Geolog*). In winter, sampling was performed from the ice cover of Lake Baikal. Altogether 246 short cores (maximum length of 1.5 m) were taken from various areas of the lake (Fig. 1; Appendix 1). After recovery, the cores were cut, photographed, lithologically described by using smear-slides and sampled at 0.5 cm and 1 cm intervals for subsequent analyses. Magnetic susceptibility was measured with a BARTINGTON® MS2E Surface Scanning Sensor (resolution of 1 cm). Detailed descriptions, the determination of biogenic silica (SiO_{2bio}), organic carbon (C_{org}), total nitrogen (N_{tot}), diatom analyses, granulometry and mineralogy are given in other publications [Lees et al., 1998; Vologina et al., 2003, 2007, 2010, 2012; Ohlendorf, Sturm, 2008; Vologina, Sturm, 2009; Sturm et al., 2016]. Dating of cores was carried out by ^{210}Pb and ^{32}Si measurements [Morgenstern et al., 2013; Sturm et al., 2016].

3. SEISMICITY OF THE BAIKAL BASIN

The Lake Baikal basin is the central link of the Baikal rift zone, which is characterized by a very high level of seismic activity. Out of the total number of seismic events recorded in this region, almost 17 % occur in the lake area (according to the Baikal Branch of FRC "Geophysical Survey of RAS"). The earthquake hypocenters are mostly located in a depth range of 10 to 20 km [Radziminovich, 2010]. The overwhelming majority of earthquake focal mechanisms in the lake basin represent normal faulting [Mel'nikova et al., 2010].

The epicentral field of the Baikal basin is highly nonuniform. Most of the earthquake epicenters are concentrated within the South and Middle Baikal areas, while the seismic activity of North Baikal is significantly lower (Fig. 2). Apparently, such a distribution of epicenters reflects the geological structure and history of the depression. According to N.A. Logachev, the Lake Baikal basin consists of two comparable sedimentation basins, the southern and northern ones (South Baikal and North Baikal, respectively), which are separated by a structural ridge (Olkhon Island – Academician Ridge) [Logachev, 2000]. South Baikal is characterized by greater tectonic fragmentation and longer evolution [Logachev, 2003].

The seismic potential of the Baikal basin reaches a magnitude (M) of up to 7.5 [Ulomov, 2014], as estimated from the data on the Tsagan earthquake of January 12, 1862, which was the strongest seismic event within the Baikal basin during the historical observation period before 1901. Its magnitude was 7.5(±0.3); the shaking intensity in the epicentral area was estimated as degree X (MSK-64 scale) [Kondorskaya, Shebalin, 1982; Golenetskii, 1996]. During the 20th century, no events similar to the Tsagan earthquake occurred in the Lake Baikal basin. In the instrumental

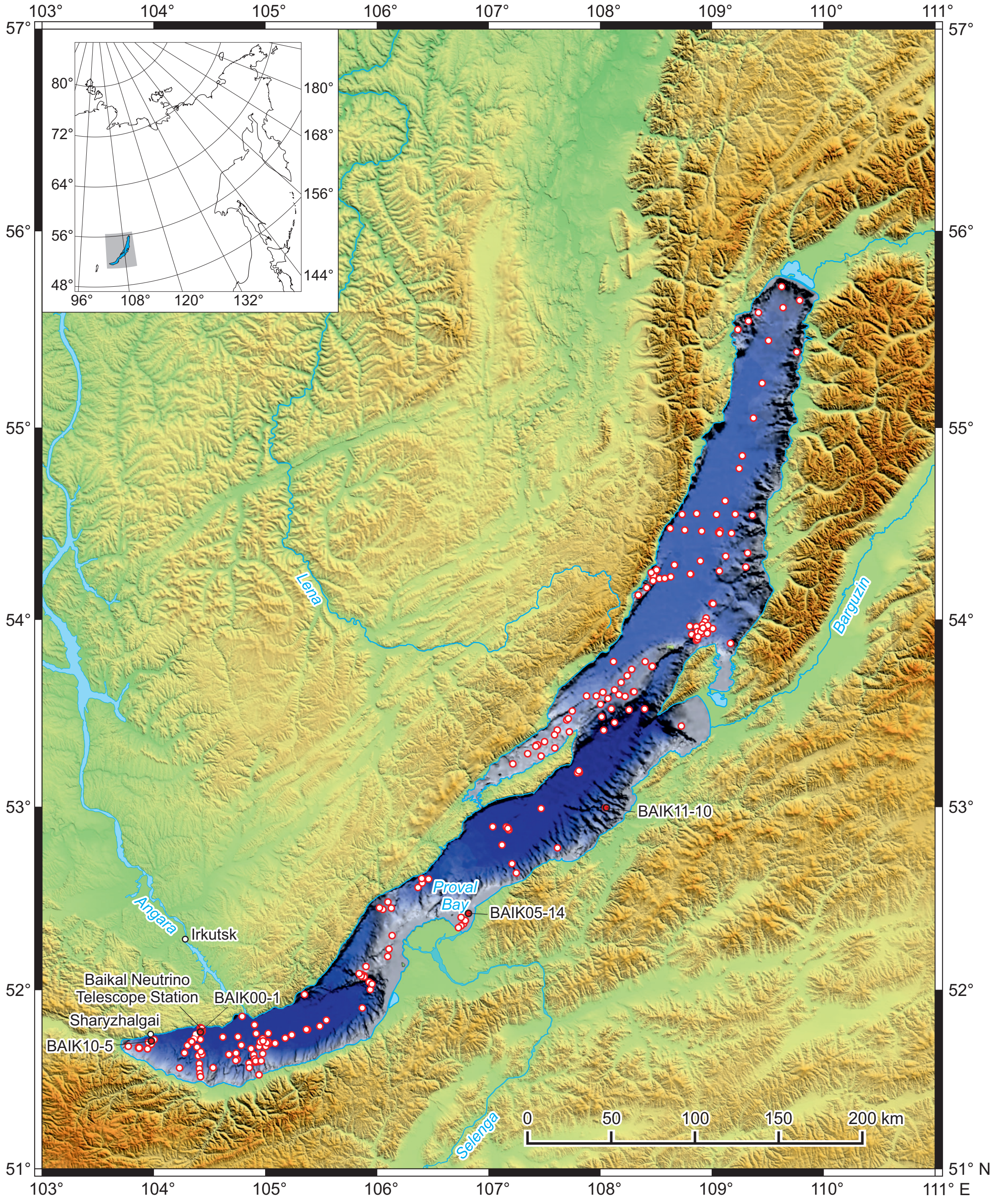

Fig. 1. Map of Lake Baikal. Core sampling sites are shown for the period of 1996–2019; the digital elevation model uses the Shuttle Radar Topography Mission (SRTM) data [Jarvis et al., 2008]; the shadow relief map of Lake Baikal after [De Batist et al., 2002].

Рис. 1. Карта озера Байкал с точками отбора кернов донных осадков за период 1996–2019 гг. Цифровая модель рельефа построена по данным SRTM [Jarvis et al., 2008], карта теневого рельефа впадины оз. Байкал – по данным [De Batist et al., 2002].

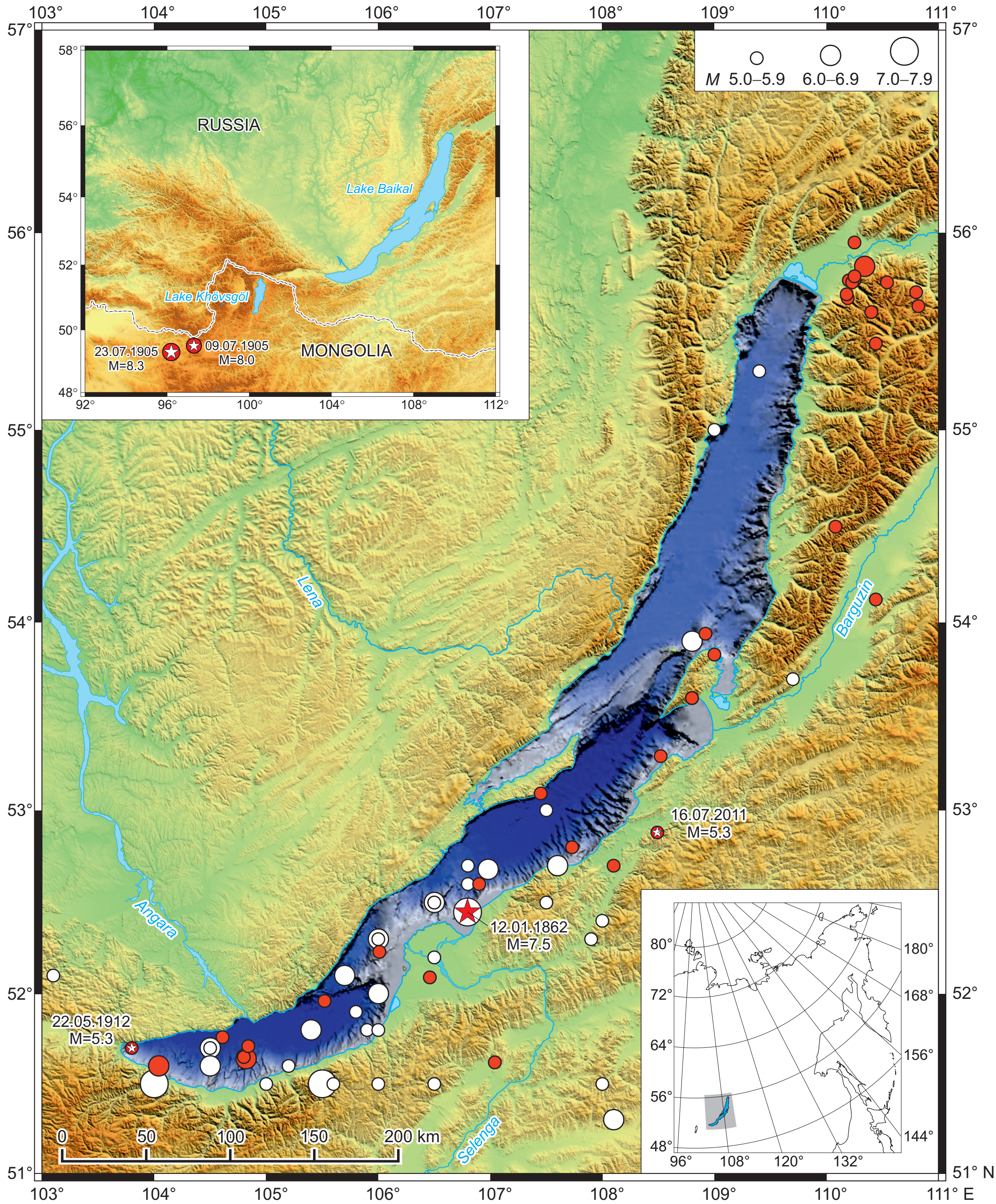

Fig. 2. Seismicity of the Lake Baikal basin (M≥5.0 earthquakes) according to historical and instrumental data.
Epicenters of historical earthquakes (white circles) after [Kondorskaya, Shebalin, 1982]; epicenters of instrumentally recorded earthquakes (red circles) – Baikal Branch of FRC "Geophysical Survey of RAS". Stars (in circles) – epicenters of earthquakes that might have influenced sedimentation processes in the lake basin. Inset – epicenters of the Tsetserleg (July 9, 1905) and Bolnai (July 23, 1905) earthquakes. The digital elevation model uses the Shuttle Radar Topography Mission (SRTM) data [Jarvis et al., 2008]; the shadow relief map of Lake Baikal after [De Batist et al., 2002].

Рис. 2. Сейсмичность впадины озера Байкал (землетрясения с магнитудой M≥5.0) по историческим и инструментальным данным.
Эпицентры исторических землетрясений (белые кружки) показаны согласно [Kondorskaya, Shebalin, 1982]; эпицентры инструментально зарегистрированных землетрясений (красные кружки) приведены по данным Байкальского филиала ФИЦ ЕГС РАН. Звездочками в кружках обозначены эпицентры землетрясений, которые могли оказать влияние на процессы осадконакопления во впадине озера. На врезке показано местоположение эпицентров Цэцэрлэгского (9 июля 1905 г.) и Болнайского (23 июля 1905 г.) землетрясений. Цифровая модель рельефа построена по данным SRTM [Jarvis et al., 2008], карта теневого рельефа впадины оз. Байкал – по данным [De Batist et al., 2002].

registration period (after 1901), the strongest seismic events in the study area were the Middle Baikal earthquake of August 29, 1959 (M_{LH}=6.8) [Solonenko, Treskov, 1960; Kondorskaya, Shebalin, 1982] and the Kultuk earthquake of August 27, 2008 (M_w=6.3) [Mel'nikova et al., 2012].

It is remarkable that two of the strongest earthquakes in the Baikal basin (Tsagan and Middle Baikal events) were recorded within or close to the delta of the Selenga River. The epicenters of several less strong seismic events were also located in the same area on March 3, 1871 (M=6.3), January 12, 1885 (M=6.7) and November 26, 1903 (M=6.7) [Kondorskaya, Shebalin, 1982]. In this regard, it is important that the area of the Selenga River delta is considered a center of the formation and development of the Baikal rift zone [Logachev, 2003]. We also note that strong seismic events similar to the Tsagan earthquake (M=7.5) should be considered as separate key episodes of the development of the Baikal basin [Shchetnikov et al., 2012].

Seismic activity has significant effects on the formation of lake sediments. Strong M≥5 earthquakes can cause shaking intensity of degree VI–VII and higher within the near-epicentral area. According to macroseismic intensity scales, such as MM, MSK-64, EMS or ESI-2007, high-intensity seismic shakes may provoke noticeable effects on natural environment. In particular, intensive shaking can induce displacements of sediments along sub-aerial mountain slopes, as well as trigger massive underwater landslides and turbidity currents with high densities in comparison to the ambient lake water [El-Robrini et al., 1985; Beck et al., 1996; Schnellmann et al., 2002; Nomade et al., 2005; Michetti et al., 2007; Vandekerkhove et al., 2020]. Such quake-triggered suspension flows cause the formation of large turbidite layers. Thus, turbidites can serve as possible markers of severe historical and prehistoric earthquakes [Inouchi et al., 1996; Goldfinger et al., 2003; Monecke et al., 2004; Fanetti et al., 2008; Goldfinger, 2011; Gutiérrez-Pastor et al., 2013; Stockhecke et al., 2014]. However, turbidites can also be formed as a result of other catastrophic events, such as torrential flows of large rivers during exceptionally large flood events, or due to collapsing of oversteeped delta fronts [Sturm, Matter, 1978; Sturm et al., 1995; Vandekerkhove et al., 2020]. This should be taken into account when interpreting individual turbidites and reconstructing events that are responsible for their formation.

4. RESULTS AND DISCUSSION

Sediment distribution within the Lake Baikal area is largely determined by the basin relief (i.e. bottom morphology) and by the large tributaries. In turn, the basin relief results from the regional tectonic activity. Sedimentation rates (SR) differ in different areas of the lake (Fig. 3), with the highest values within river deltas and delta-fan sites near the mouths of the large tributaries, lower values at the basin plains, and minimal values at underwater ridges and steep coastal slopes [Vologina, Sturm, 2009; Sturm et al., 2016].

Using sedimentological results reported by our team [Sturm et al., 1998, 1999, 2016; Vologina et al., 2003, 2007, 2010, 2012; Vologina, Sturm, 2009] and other researchers [Goldyrev, 1975; Karabanov, 1999], made it possible to regionalize the composition and distribution of Baikal sediments and to identify six different depositional areas within the lake (Fig. 3):

(1) Deep-water zones of the profundal basins with periodical occurrences of turbidites intercalated to pelagic mud;

(2) Littoral zones along the E-shore of North Baikal and along the SE-shore of South Baikal with biogenic-terrigenous mud formed under mainly calm depositional conditions without turbidites;

(3) Underwater ridges (rises) with fine-grained mud accumulated under calm deposition conditions at a very low sedimentation rate (SR), which overlays Late Pleistocene clay;

(4) Delta areas and delta-fan sites near the mouths of the large rivers, where the sediments consist mainly of coarser and more terrigenous material and show a higher SR;

(5) Strait Maloe More (water depth from few meters to 210 m in its northern part) with poorly sorted terrigenous material and abundant sand;

(6) A fault zone bordering Cape Zavorotny with small tectonic sub-basins along the western side of North Baikal (water depth <500 m) with disturbed sediment accumulation [Hus et al., 2006; Matton, Klerkx, 1995].

The sediments of Lake Baikal are oxidized at the water-sediment interface in all areas (Fig. 3). The oxidized deposits are brown, reddish and black. The oxidized layers significantly vary in thickness (TOL) in different parts of the lake due to a number of factors, including sedimentation rates, types and contents of the buried organic matter, bottom topography, oxygen contents in bottom waters, etc. [Mizandrontsev, 1982; Martin et al., 1998; Granina et al., 2000; Vologina et al., 2003; Och et al., 2012]. TOL is maximal at the underwater ridges, has lower values in the deep-water basins, and is minimal in the sediments of Maloe More, estuarine and near the river delta areas [Vologina et al., 2003]. Fig. 4, a shows photographs of the upper part of cores as TOL examples from different areas of the lake (see Fig. 1; Appendix 1). The differences in TOL values are striking. At the underwater ridge in the southern part of North Baikal (Continent Ridge) TOL=21.5 cm in core BAIK02-4A at a water depth of 390 m, whereas in South Baikal in core BAIK01-34C at a water depth of 1340 m TOL=3.7 cm (Fig. 4, a).

4.1. Probable trace of a recent earthquake

An oxidized layer is absent in core BAIK11-10 recovered on July 26, 2011 at a water depth of 660 m in Middle Baikal (Fig. 4, b). We assume that this layer might have been removed by shaking due to the relatively strong earthquake (M_w=5.3) of July 16, 2011, which epicenter was located in the Turka basin outside the lake (Table 1) [Mel'nikova et al., 2013]. The shaking intensity in the epicentral area reached degree VII (MSK-64 scale), while the shaking intensity within the coastal zone of the lake reached degree VI [Gileva et al., 2017]. Such a seismic effect might have been sufficient

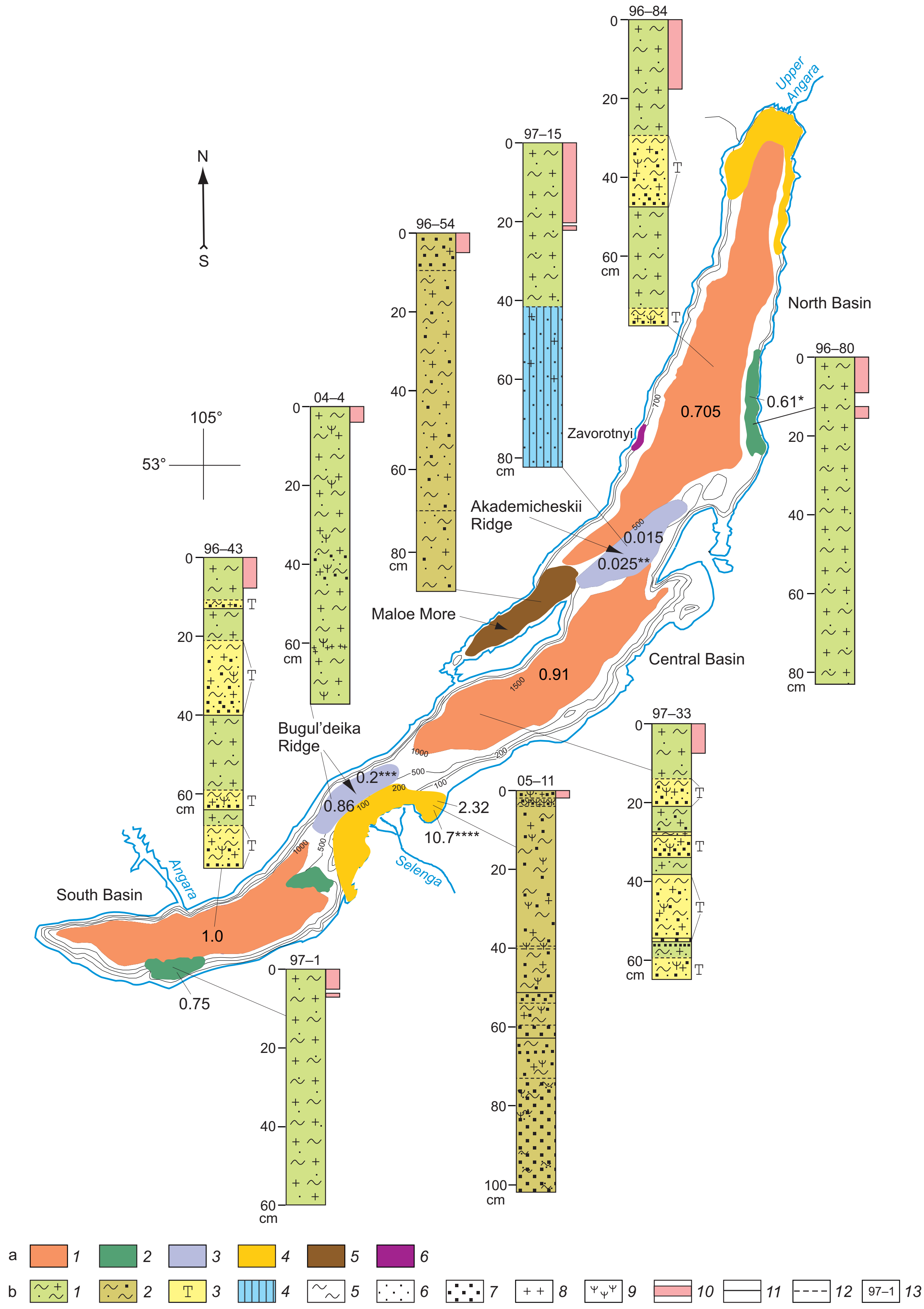

Fig. 3. Map showing the distribution of Holocene sediments and sediment sections for different areas of Lake Baikal (modified after [Vologina, Sturm, 2009]).
Map (a): *1* – deep-water plains; *2* – littoral zones; *3* – underwater ridges; *4* – delta (fan) areas near the mouths of large rivers; *5* – Strait Maloe More; *6* – tectonic basin of Cape Zavorotny. Numbers (bold) – recent sedimentation rates, mm/year (*[Bangs et al., 2000];

[Colman et al., 1993]; *[Kuz'min et al., 2001]; ****[Tulokhonov et al., 2006]). Lithology (b): *1–3* – Holocene deposits: *1* – biogenic terrigenous mud, *2* – mainly terrigenous mud, *3* – turbidite; *4* – Late Pleistocene clay; *5–7* – types of sediments (fractions): *5* – clay, *6* – silt, *7* – sand; *8* – diatoms; *9* – terrestrial plant remains; *10* – oxidized layers (shown to the right of the lithological columns); *11 – 12* – boundaries between layers: *11* – distinct, *12* – indistinct; *13* – numbers of cores.

Рис. 3. Карта распределения голоценовых осадков и типовые разрезы отложений из различных районов озера Байкал согласно [Vologina, Sturm, 2009], с дополнениями.
Условные обозначения к карте (a): *1* – глубоководные равнины; *2* – литоральные зоны; *3* – подводные хребты; *4* – авандельты и участки дна вблизи устьев больших рек; *5* – пролив Малое Море; *6* – тектонический бассейн Заворотный. Цифры, выделенные жирным шрифтом, обозначают скорость современного осадконакопления в мм/год (*[Bangs et al., 2000]; **[Colman et al., 1993]; ***[Kuz'min et al., 2001]; ****[Tulokhonov et al., 2006]). Условные обозначения к литологическим колонкам (b): *1–3* – голоценовые отложения: *1* – биогенно-терригенный ил, *2* – существенно терригенный ил, *3* – турбидит; *4* – позднеплейстоценовая глина; *5–7* – типы осадков (фракции): *5* – пелит, *6* – алеврит, *7* – песок; *8* – диатомеи, *9* – наземные растительные остатки; *10* – окисленные слои (показаны справа от литологических колонок); *11–12* – границы между слоями: *11* – четкие, *12* – нечеткие; *13* – номера кернов.

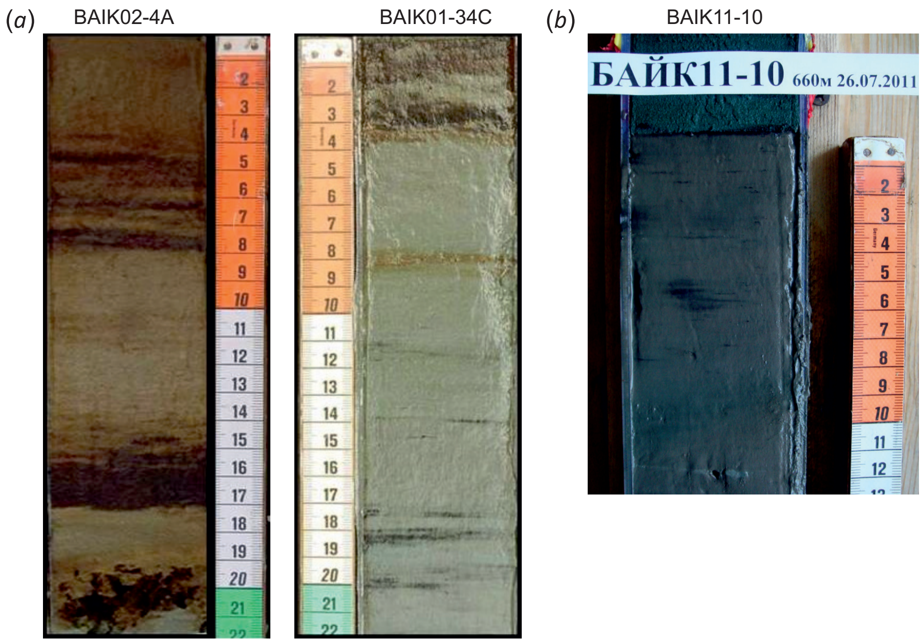

Fig. 4. Photos of the upper parts of cores: (*a*) – cores BAIK02-4A and BAIK01-34C (different TOL values); (*b*) – core BAIK11-10 (no oxidized layer). Cores sampling areas indicated in Appendix 1.

Рис. 4. Фотографии верхних частей колонок: (*a*) – керны BAIK02-4A, BAIK01-34C с различной мощностью окисленных слоев; (*b*) – керн BAIK11-10 без окисленного слоя. Места отбора кернов указаны в Приложении 1.

to trigger a turbid flow causing the displacement of the slope material, which, in turn, led to the removal of an oxidized layer on the BAIK11-10 coring site.

4.2. Traces of historical earthquakes

Deep-water plain of South Baikal. In 1912, seismic activity increased in South Baikal, which is evidenced by several relatively strong earthquakes [Kondorskaya, Shebalin, 1982] and almost 40 small local quakes recorded by the Irkutsk Seismic Station during that year [Minchikovskii, 1914]. Some of these seismic events probably provoked the release of a large volume of methane gas into the lake water and the atmosphere near the Sharyzhalgai Station. Local residents described that in August 1912, "water columns several meters high" were observed at Lake Baikal, and this phenomenon was reported in the regional press [Radziminovich et al., 2010; Vologina et al., 2012].

The strongest earthquake of 1912 was registered on May 22 (M_{LH}=5.3). Its epicenter was located at the SW-end of the lake (Table 1). We discovered traces of that earthquake in core BAIK10-5 taken at a water depth of 1300 m in the vicinity of the Sharyzhalgai Station. This core contains pelagic biogenic terrigenous mud intercalated by several turbidites. In the upper part of the core, two oxidized layers of brown and brown-black colours are observed at 0–1 cm and 8.7–11.4 cm (Fig. 5). These two layers are separated by a dark grey, silty-clayey material with low magnetic susceptibility (about $50 \cdot 10^{-6}$ SI units [Vologina et al., 2012]), which contains a significant amount of terrestrial plant debris, a reduced number of planktonic diatoms, and an increased amount of benthic, ancient diatoms [Vologina et al., 2012]. Considering the low content of SiO_{2biog} and the higher concentrations of C_{org}, it as a turbidite that buried the oxidized layer at the core depth of 8.7–11.4 cm (Fig. 5). Obviously, this turbidite is a result of the above-mentioned earthquake of May 22, 1912. It could be dated by ^{210}Pb measurements, which yield a recent sedimentation rate of 0.01 cm·year^{-1} near the Sharyzhalgai Station [Vologina et al., 2012].

Core BAIK00-1 (Fig. 6) was taken at a water depth of 1366 m near the Baikal Neutrino Telescope Station (Cape Ivanovsky, Station 106-km of CBR) approximately 32 km to the east from the Sharyzhalgai Station (Station 138-km of CBR). Bottom sediments are represented by interbedded biogenic terrigenous mud and turbidites (Fig. 6). Four turbidites are observed at 14.5–19.0 cm, 32.5–35.5 cm, 48.8–57.5 cm, and 79.0–108.5 cm of the core [Sturm et al., 2016]. The turbidites are clearly visible and marked by their darker colour, upward grading from sand to silt and clay, and a higher

Table 1. Parameters of earthquakes that may have influenced sedimentation processes in Lake Baikal
Таблица 1. Параметры землетрясений, которые могли повлиять на процессы осадконакопления в озере Байкал

Earthquake	Date	Coordinates		Magnitude	Area	Reference
		Latitude	Longitude			
Tsagan	January 12, 1862	52.50	106.80	M_{LH} 7.5	Middle Baikal	[Golenetskii, 1996]
Tsetserleg	July 9, 1905	49.50	97.30	M_w 8.0	Mongolia	[Kondorskaya, Shebalin, 1982; Schlupp, Cisternas, 2007]
Bolnay	July 23, 1905	49.30	96.20	M_w 8.3–8.5	Mongolia	[Kondorskaya, Shebalin, 1982; Schlupp, Cisternas, 2007]
	May 22, 1912	51.70	103.80	M_{LH} 5.3	South Baikal	[Kondorskaya, Shebalin, 1982]
Turka	July 16, 2011	52.88	108.49	M_w 5.3	Middle Baikal	[Gileva et al., 2017]

Note. M_{LH} – earthquake magnitude estimated from surface waves; M_w – moment magnitude estimated from earthquake seismic moment. The magnitudes of historical earthquakes in the Baikal region are determined from macroseismic data and considered equivalent to magnitude M_{LH} [Kondorskaya, Shebalin, 1982].

Примечание. M_{LH} – магнитуда по поверхностным волнам; M_w – моментная магнитуда, рассчитанная по сейсмическому моменту землетрясения. Магнитуды исторических землетрясений Прибайкалья рассчитаны по макросейсмическим данным и могут рассматриваться как эквивалент магнитуды M_{LH} [Kondorskaya, Shebalin, 1982].

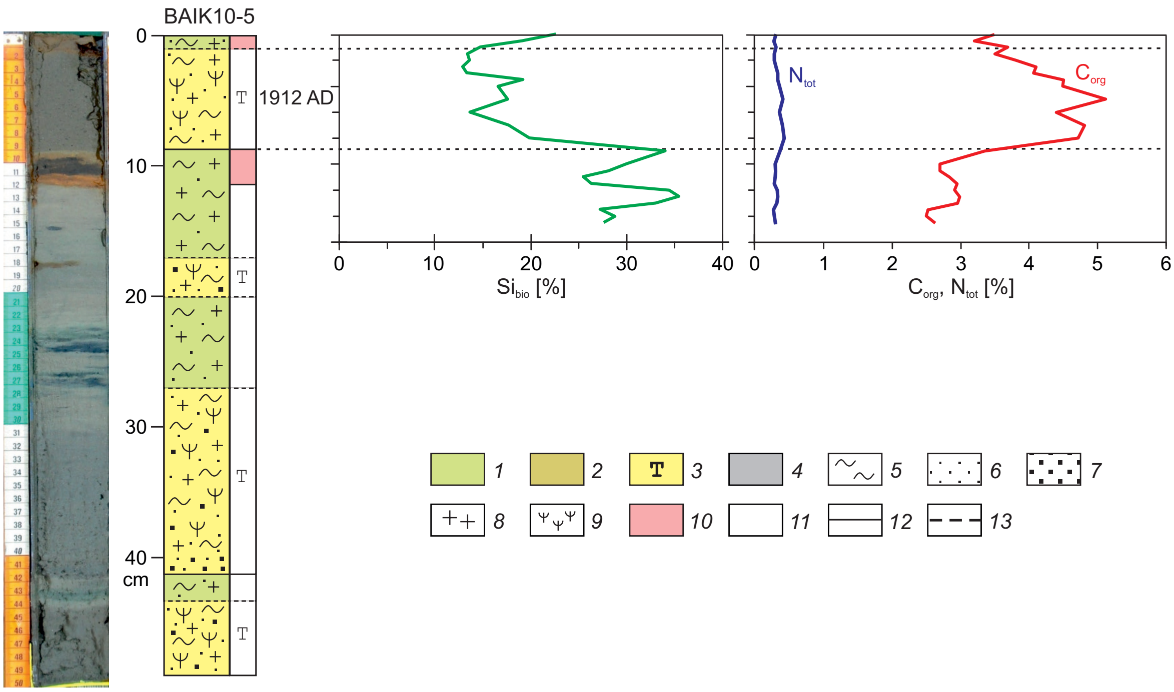

Fig. 5. Deep-water core BAIK10-5: photo, lithology data, and contents of Si_{bio}, N_{tot}, C_{org} (after [Vologina et al., 2012]).
Lithology: *1* – biogenic-terrigenous mud; *2* – mainly terrigenous mud; *3* – turbidite; *4* – black peat-like layer; *5–7* – types of sediments (fractions): *5* – clay, *6* – silt, *7* – sand; *8* – diatoms; *9* – terrestrial plant remains; *10* – oxidized sediment, *11* – O_2-reduced sediment; *12–13* – boundaries between layers: *12* – distinct, *13* – indistinct.

Рис. 5. Фотография колонки, литологическое строение разреза и содержания $SiO_{2биог}$, $N_{общ}$ и $C_{орг}$ в донных осадках керна BAIK10-5 согласно [Vologina et al., 2012].
Условные обозначения к литологической колонке: *1* – биогенно-терригенный ил; *2* – существенно терригенный ил; *3* – турбидит; *4* – черный торфоподобный слой; *5–7* – типы осадков (фракции): *5* – пелит, *6* – алеврит, *7* – песок; *8* – диатомеи; *9* – наземные растительные остатки; *10* – окисленные осадки; *11* – O_2-восстановленные осадки; *12–13* – границы между слоями: *12* – четкие, *13* – нечеткие.

amount of terrestrial plant remains. The turbidites are also characterized by minimal values of biogenic components ($SiO_{2\ biog}$, C_{org} and N_{tot}) (Fig. 6). We obtained for the first time results of ^{32}Si isotope dating of the bottom sediments of Lake Baikal and determined the ages of the last three turbidites as follows: 1030 AD, 1310 AD, and 1670 AD. Events that triggered the formation of these turbidites occurred at intervals of 280 and 360 years, respectively [Morgenstern et al., 2013; Sturm et al., 2016]. Presently, we do not have sufficient data to attribute the formation of these turbidites to any individual earthquake. Nonetheless, the ^{32}Si dating provides a possibility to search for traces of specific earthquakes in Lake Baikal sediments. The available data show that the sedimentation rate during the formation of the upper 5 cm of core BAIK00-1 was 0.063 cm·year^{-1} per year; for the interval 5–40 cm, it was 0.036 cm·year^{-1} [Morgenstern et al., 2013]. Two oxidized layers are observed in this core at 0–2 cm and 6–8 cm, respectively (Fig. 6). A buried oxidized layer at the depth of 6–8 cm can indicate an increase in the sedimentation rate after its formation. This core was taken in 2000; the age of the upper 6 cm of this core is approximately 95 years, which means that the oxidized layer was buried around 1905.

The above-mentioned increase in the sedimentation rate could be due to the catastrophic Tannu-Ola seismic events with epicenters in the northwestern Mongolia: the Tsetserleg earthquake of July 9, 1905 (M_w=8.0), and the Bolnay earthquake of July 23, 1905 (M_w=8.3) [Kondorskaya, Shebalin, 1982; Schlupp, Cisternas, 2007]. Despite a large epicentral distance (more than 600 km), the shaking intensity in the settlements of the South Baikal region reached a degree of VI–VII. According to the published data, the earthquakes were distinctly manifested in the surrounding environment. In particular, the earthquakes had a significant impact on the water body of Lake Baikal, causing visible short-term fluctuations of the lake water level. According to A.V. Voznesensky (head of the Irkutsk Seismic Station in 1901–1917), waves were observed on the water surfaces of Lake Baikal and other lakes, as well as in rivers of the Baikal region during the Tsetserleg earthquake: "... A rare wave phenomenon on Lake Baikal and in a number of rivers is of particular interest... At the Baklanii railway siding, the wave formed during the earthquake reached 1/5 of sazhen (~42 cm), according to instrumental observations, and the same wave passed all over Lake Baikal and was noticeable even in Dagary, where its height was about 50 mm" [Voznesensky, 1905] (note: Dagary – a village at the NE-termination of Lake Baikal).

The impacts of the Bolnay earthquake of July 23, 1905 at the Baikal Station of CBR were described in the local newspaper "Eastern Review": "... at the time of the earthquake, the water rapidly dropped by one foot, which is why almost all the cables from steamboats and other ships at the pier were broke off" [Earthquake..., 1905]. The Permanent Central Seismic Commission reported that near the Kultuk village located at the southern termination of the lake, "... a phenomenon similar to low tide was observed on Lake Baikal" [Bulletin..., 1907].

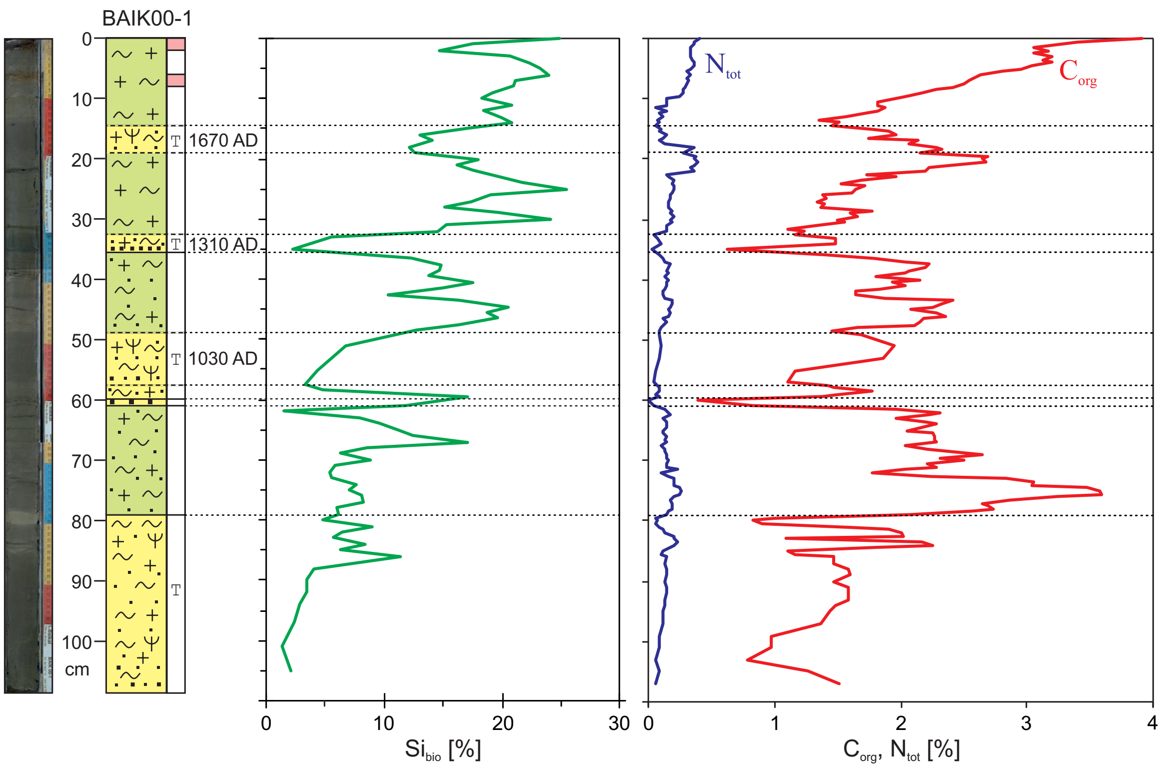

Fig. 6. Deep-water core BAIK00-1: photo, lithology data, and contents of Si_{bio}, N_{tot}, C_{org} ([Sturm et al., 2016]). Legend – see Fig. 5.

Рис. 6. Фотография колонки, литологическое строение разреза и содержания $SiO_{2биог}$, $N_{общ}$ и $C_{орг}$ в донных осадках керна BAIK00-1 согласно [Sturm et al., 2016]. Условные обозначения – см. рис. 5.

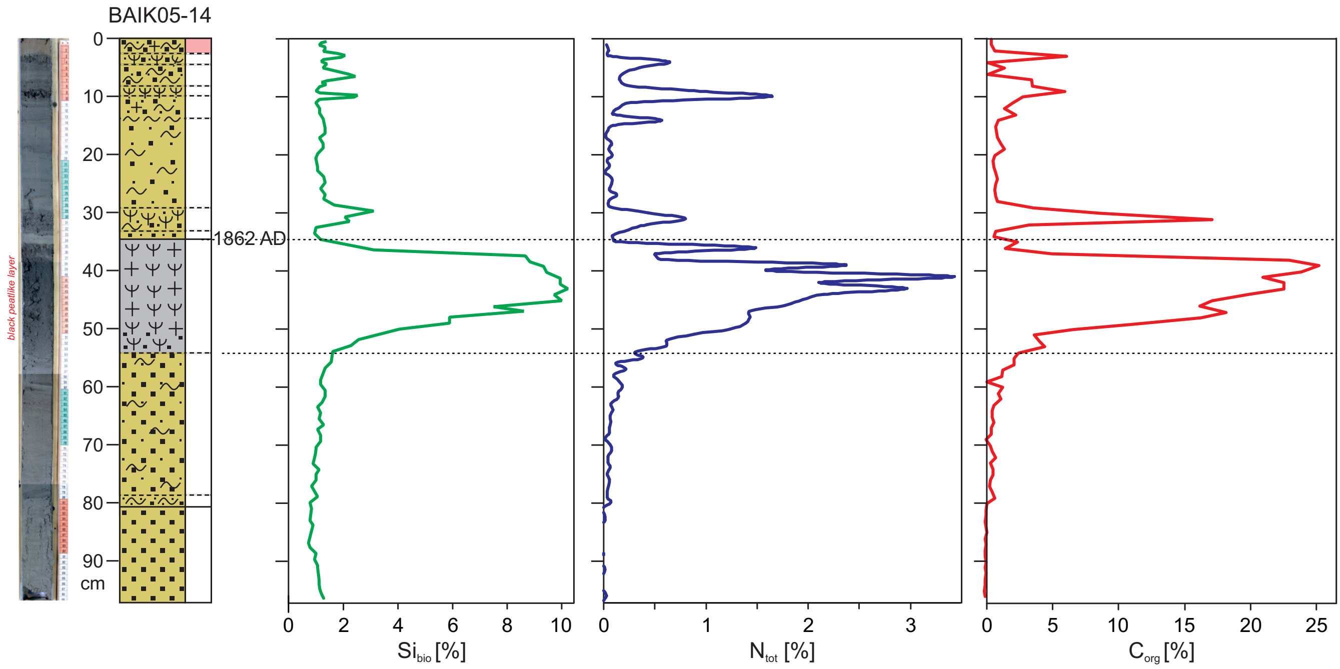

Fig. 7. Core BAIK05-14: photo, lithology data, and contents of Si_{bio}, N_{tot}, C_{org} (modified after [Vologina et al., 2010]). Legend – see Fig. 5.

Рис. 7. Фотография колонки, литологическое строение разреза и содержания $SiO_{2биог}$, $N_{общ}$ и $C_{орг}$ в донных осадках керна BAIK05-14 согласно [Vologina et al., 2010] с изменениями. Условные обозначения – см. рис. 5.

Thus, it can be concluded that even a distant earthquake is capable to cause significant fluctuations on the water body of Lake Baikal and to trigger turbidity currents on underwater slopes of the lake basin. Seismic events can also lead to a sudden increase of sedimentation rates and to the burial of an oxidized layer, as shown by core BAIK00-1 (Fig. 6). However, the large distance to the epicenter of the May 22, 1912 earthquake did prevent the formation of a pronounced turbidite layer, but the event could still trigger an increase in the sedimentation rate, which is determined by direct ^{32}Si dating [Morgenstern et al., 2013].

Proval Bay. Proval Bay represents an exellent natural example of the relief-forming role of strong earthquakes. It resulted from the catastrophic Tsagan earthquake that occurred in the northern part of the Selenga River delta on January 12, 1862 (December 31, 1861 in the old-style calendar). Its estimated magnitude M was 7.5, and the shaking intensity at the epicenter area reached degree X (MSK-64 scale) [Kondorskaya, Shebalin, 1982; Golenetskii, 1996]. This earthquake caused the subsidence of a tectonic block and the sinking of almost 5 m of a land area of more than 200 km^2 into Lake Baikal [Sgibnev, 1864; Shchetnikov et al., 2012]. Consequently, sedimentation conditions in a significant part of the Selenga delta were drastically changed. As the change in the relief is precisely dated, Proval Bay is a perfect reference site for further studies of sedimentation processes in the delta of the largest tributary of Lake Baikal.

The sediments in the Proval Bay area are represented by sand, silty clay, and clayish silt. Terrigenous material prevails and consists of clastogenic mineral grains and terrestrial plant debris (wood fragments, plant branches, etc.). Oxidized sediments are dark brown, and TOL varies from 1.5 to 4 cm. The O_2-reduced sediments are olive black and brownish black. Sedimentation rates in different parts of Proval Bay vary in a range of 0.232–1.070 cm·year^{-1} and depend directly on the supply of material from the Selenga River [Tulokhonov et al., 2006; Vologina et al., 2010]. In the NE part of the bay, a peat-like layer is observed in core BAIK05-14 (interval 34–55 cm, Fig. 7). In this layer, the number of diatoms increases sharply. Epiphytic periphyton dominates (up to 89 %), among which dominating species are *Staurosirella pinnata* (47–52 %), *Pseudostaurosira brevistriata* (13 %), and *Ps. binodis* (11 %). This suggests accumulation of the sediments in a shallow (few meters) pond, overgrown with higher aquatic vegetation. According to the diatom analysis data and ^{210}Pb dating results, the peat-like layer represents the former deposits of the eutrophic Lake Beloe that existed in the Tsagan steppe before the earthquake of 1862 [Vologina et al., 2010]. Concentrations of SiO_{2bio}, C_{org} and N_{tot} are at a maximum in this layer (Fig. 7). Within the SW part of the bay, the deposition of turbidites is established, probably as a result of flood events of the Selenga River [Vologina et al., 2010].

5. CONCLUSION

The study of 246 short gravity cores from different parts of Lake Baikal resulted in the discovery of traces of recent and historical earthquakes in the sediments. A turbidite caused by the earthquake of 1912 has been discovered in a core from South Baikal, which was taken at the water depth >1300 m near the Sharyzhalgai CBR Station. For the first time, three individual turbidites were dated in the sediment core taken at the water depth of 1366 m near the Baikal Neutrino Telescope Station (Ivanovskii Cape, Station 106-km of CBR). Based on the analysis, we conclude that these three turbidites formed in 1030 AD, 1310 AD, and 1670 AD (i.e. with intervals of 280 and 360 years). The buried oxidized layer in this core may be due to an increase in the sedimentation rate as a result of the Tannu-Ola earthquakes of 1905 or, possibly, the earthquake of 1912. Another trace of recent seismic activity has been determinded by the loss of the uppermost layers of sediments, as observed in the sediments of Middle Baikal, which were affected by the July 16, 2011 earthquake (epicenter in the Turka basin).

The most spectacular example of a huge deterioration of the natural relief results from a strong earthquake is Proval Bay, which appeared after the catastrophic earthquake of 1862, when an area of 200 km^2 of the Tsagan steppe disappeared in Lake Baikal. In the NE part of this newly formed bay, the peat-like layer at the 34–55 cm core interval represents the former deposits of the eutrophic Lake Beloe that existed in the Tsagan steppe before the earthquake of 1862.

Thus, the sediments of Lake Baikal contain detailed traces of seismic activities within the lake itself and give evidence of seismic events that occurred even at far distances from Lake Baikal.

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7. CONFLICT OF INTEREST

The authors confirm that there are no conflicts of interest.

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APPENDIX 1

Table 1. List of core samples from the Lake Baikal area (1996–2019)
Таблица 1. Список кернов, отобранных в оз. Байкал за период 1996–2019 гг.

Core number	Coordinates		Water depth, m	Core length, cm	Sampling area
	Latitude, N	Longitude, E			
BAIK96-42	51.85389	104.79083	100	35.4	South Baikal
BAIK96-43	51.70500	105.00667	1450	76	South Baikal
BAIK96-45	51.70194	105.03194	1420	63	South Baikal
BAIK96-46	53.23139	107.21472	150	32	Maloe More
BAIK96-47	53.33139	107.42194	130	86	Maloe More
BAIK96-48	53.28483	107.34767	125	32	Maloe More
BAIK96-53	53.32472	107.42083	125	29	Maloe More
BAIK96-54	53.33222	107.43722	140	91	Maloe More
BAIK96-55	53.41333	107.61167	230	36.5	Maloe More
BAIK96-56	53.51472	107.74583	515	51.5	Akademichesky Ridge
BAIK96-57	53.59556	107.87472	565	76.5	Akademichesky Ridge
BAIK96-58	53.61694	108.29389	280	66	Akademichesky Ridge
BAIK96-61	53.61750	108.30028	280	28.5	Akademichesky Ridge
BAIK96-64	53.75167	108.45944	250	94	Akademichesky Ridge
BAIK96-65	53.75361	108.46306	250	84.4	Akademichesky Ridge
BAIK96-67	53.75194	108.46222	250	24	Akademichesky Ridge
BAIK96-69	53.77722	108.11472	891	32	North Baikal
BAIK96-70	53.77722	108.40028	910	40	North Baikal
BAIK96-71	54.21556	108.52778	915	60	Cape Zavorotny, North Baikal
BAIK96-72	54.23111	108.46667	485	59.8	Cape Zavorotny, North Baikal
BAIK96-73	54.26056	108.50222	535	96.3	Cape Zavorotny, North Baikal
BAIK96-74	54.26000	108.50167	535	102	Cape Zavorotny, North Baikal
BAIK96-75	54.26083	108.50194	540	106	Cape Zavorotny, North Baikal
BAIK96-77	54.22472	108.62972	920	98.8	Cape Zavorotny, North Baikal
BAIK96-78	54.23944	108.80917	910	61.5	Cape Zavorotny, North Baikal
BAIK96-79	54.25583	109.06361	850	78	Cape Zavorotny, North Baikal
BAIK96-80	54.27667	109.29972	345	82.8	Cape Zavorotny, North Baikal
BAIK96-82	54.54722	109.35917	565	48.8	North Baikal
BAIK96-83	54.55167	109.20556	805	86.3	North Baikal
BAIK96-84	54.55056	109.03750	915	78	North Baikal
BAIK96-85	54.55408	108.86033	915	83	North Baikal
BAIK96-86	54.54970	108.72980	885	61.6	North Baikal
BAIK96-88	55.61333	109.63333	590	82	North Baikal
BAIK96-89	55.38750	109.75667	590	50.6	North Baikal
BAIK96-92	55.44500	109.50361	770	81	North Baikal
BAIK96-94	55.50222	109.22889	300	84.3	North Baikal
BAIK96-96	55.54417	109.32472	300	89.8	North Baikal
BAIK96-98	55.58722	109.41361	310	117	North Baikal
BAIK96-100	55.22778	109.44722	820	56.6	North Baikal
BAIK96-101	55.04870	109.36833	830	70	North Baikal
BAIK96-102	54.85437	109.26872	895	85.8	North Baikal
BAIK96-105	54.21667	108.57361	940	90.4	Cape Zavorotny, North Baikal
BAIK96-106	54.23056	108.47444	480	119.6	Cape Zavorotny, North Baikal
BAIK96-107	54.20444	108.47083	480	131.9	Cape Zavorotny, North Baikal

Table 1. (continued)
Таблица 1. (продолжение)

Core number	Coordinates		Water depth, m	Core length, cm	Sampling area
	Latitude, N	Longitude, E			
BAIK96-109	53.87389	109.16361	595	65.3	North Baikal
BAIK97-01	51.60390	104.95947	576	59	South Baikal
BAIK97-02	51.64667	104.97500	1120	82	South Baikal
BAIK97-03	51.68667	105.00000	1434	49.7	South Baikal
BAIK97-04	51.68667	104.94167	1410	55.5	South Baikal
BAIK97-05	51.67444	104.87000	1200	52.1	South Baikal
BAIK97-06	51.65000	104.73528	1070	15.4	South Baikal
BAIK97-07	51.71111	104.95028	1430	29.2	South Baikal
BAIK97-08	51.75806	104.91556	1410	33.7	South Baikal
BAIK97-09	51.70333	105.08500	1430	41.7	South Baikal
BAIK97-10	51.73333	105.17500	1435	46.9	South Baikal
BAIK97-11	51.75028	105.23500	1436	34.8	South Baikal
BAIK97-12	52.99111	107.46750	1580	65.5	Middle Baikal
BAIK97-13	53.18667	107.81028	1630	97.2	Middle Baikal
BAIK97-14	53.52000	108.25417	530	86.3	Akademichesky Ridge
BAIK97-15	53.59167	108.22000	340	107.5	Akademichesky Ridge
BAIK97-16	53.59168	108.22002	325	95	Akademichesky Ridge
BAIK97-17	53.66667	108.18333	480	47.3	Akademichesky Ridge
BAIK97-18	53.58000	108.06667	540	95.2	Akademichesky Ridge
BAIK97-19	53.52550	108.09583	335	56	Akademichesky Ridge
BAIK97-20	53.45250	108.12500	515	96.8	Akademichesky Ridge
BAIK97-21	53.41083	108.02667	490	80.5	Akademichesky Ridge
BAIK97-22	53.48333	108.00833	360	73.3	Akademichesky Ridge
BAIK97-23	53.55000	108.00000	515	95.7	Akademichesky Ridge
BAIK97-24	54.28167	108.66833	905	88.5	Cape Zavorotny, North Baikal
BAIK97-25	54.34944	109.31667	580	86.5	Cape Zavorotny, North Baikal
BAIK97-26	54.33306	109.12000	730	43.5	Cape Zavorotny, North Baikal
BAIK97-27	54.30750	108.89472	830	62.5	Cape Zavorotny, North Baikal
BAIK97-28	53.40300	107.72083	20	5.5	Maloe More
BAIK97-29	53.31667	107.59000	50	5.7	Maloe More
BAIK97-32	52.89333	107.03417	1420	84.5	Middle Baikal
BAIK97-33	52.79417	107.11833	1455	65	Middle Baikal
BAIK97-34	52.69250	107.20722	1340	98.5	Middle Baikal
BAIK97-35	52.64139	107.24417	963	23.4	Middle Baikal
BAIK97-36	51.80667	104.90056	1500	83.8	South Baikal
BAIK00-1	51.76775	104.41638	1366	108.5	South Baikal
BAIK00-2	51.72550	104.41647	1408	48.5	South Baikal
BAIK00-3	51.68382	104.38573	1380	78.3	South Baikal
BAIK00-4	51.63478	104.39817	1295	96.5	South Baikal
BAIK00-5	51.58983	104.40695	1140	29.2 (29.4)	South Baikal
BAIK00-6	51.56260	104.40663	990	10.4	South Baikal
BAIK00-7	51.53527	104.41187	719	42	South Baikal
BAIK00-8	51.51667	104.41667	803	104	South Baikal
BAIK00-10	52.08333	105.84667	180	94.1 (94.5)	Posolskaya Bank, South Baikal
BAIK00-11	52.07833	105.88333	66	88	Posolskaya Bank, South Baikal

Table 1. (continued)
Таблица 1. (продолжение)

Core number	Coordinates		Water depth, m	Core length, cm	Sampling area
	Latitude, N	Longitude, E			
BAIK00-12	52.07222	105.88333	405	81.2	Posolskaya Bank, South Baikal
BAIK00-13	52.04333	105.92667	700	98.2	Posolskaya Bank, South Baikal
BAIK00-14	52.12944	105.90000	364	89.5	Posolskaya Bank, South Baikal
BAIK00-15	52.00000	105.93630	1200	107.8	South Baikal
BAIK00-16	51.90000	105.86667	1328	85.5	South Baikal
BAIK00-17	51.83333	105.54417	1450	56.4	South Baikal
BAIK00-18	51.77944	105.37639	1500	74.2	South Baikal
BAIK00-19	51.52861	104.94056	31	64.2 (64.7)	South Baikal
BAIK00-20	51.52861	104.94050	11	22.3 (23.3)	South Baikal
BAIK00-21	51.60164	104.93183	660	94.5	South Baikal
BAIK00-22	51.64078	104.89431	1200	97.7	South Baikal
BAIK00-23	51.59386	104.85097	700	112.3	South Baikal
BAIK00-26	51.73856	104.61706	1430	45.3	South Baikal
BAIK00-27	51.68786	103.76931	340	112.5	South Baikal
BAIK00-29	51.67328	103.94214	868	87.7	South Baikal
BAIK00-31	51.74119	104.75117	1430	36.9	South Baikal
BAIK00-32	51.70731	105.02178	1436	76.9	South Baikal
BAIK01-1.5	51.59998	104.90837	600	98.4	South Baikal
BAIK01-2.2	51.61668	104.90017	700	73.6	South Baikal
BAIK01-4.2	51.69337	104.78343	1400	29	South Baikal
BAIK01-5A	54.47777	108.62323	898	84	North Baikal
BAIK01-6	54.47003	108.75482	925	108.5	North Baikal
BAIK01-7	54.46395	108.90553	933	101.2	North Baikal
BAIK01-8C	54.45925	109.06433	904	112	North Baikal
BAIK01-9B	54.45292	109.17333	875	125.5	North Baikal
BAIK01-16	53.89098	108.85817	590	127	Continent Ridge, North Baikal*
BAIK01-17	53.92627	108.90813	402	129	Continent Ridge, North Baikal
BAIK01-19C	53.95393	108.91340	389	135.5	Continent Ridge, North Baikal
BAIK01-21	53.96390	108.93590	414	141.5	Continent Ridge, North Baikal
BAIK01-22	53.96628	108.92217	399	136	Continent Ridge, North Baikal
BAIK01-24	53.94367	108.90480	364	153.3	Continent Ridge, North Baikal
BAIK01-25	53.92015	108.87442	368	31.3	Continent Ridge, North Baikal
BAIK01-26	53.92588	108.88132	353	126	Continent Ridge, North Baikal
BAIK01-27A	53.73635	108.27950	400	88	Akademichesky Ridge
BAIK01-28A	52.08643	105.85788	157	114	Posolskaya Bank, South Baikal
BAIK01-29M	52.07768	105.85755	128	58.7	Posolskaya Bank, South Baikal
BAIK01-33	52.09027	105.83840	194	75.1	Posolskaya Bank, South Baikal
BAIK01-34C	51.56870	104.85452	628	67.5	South Baikal
BAIK01-35B	51.60138	104.91173	728	63.5	South Baikal
BAIK01-36A	51.70780	105.02207	1491	66.7	South Baikal
BAIK02-1	51.61388	104.74748	1190	47	South Baikal
BAIK02-3B	51.71087	105.02318	1490	52	South Baikal
BAIK02-4A	53.95467	108.91613	390	21.3	Continent Ridge, North Baikal
BAIK02-5B	54.08613	108.99882	800	39	North Baikal
BAIK02-6A	54.46493	109.07152	905	28.7	North Baikal

Table 1. (continued)
Таблица 1. (продолжение)

Core number	Coordinates		Water depth, m	Core length, cm	Sampling area
	Latitude, N	Longitude, E			
BAIK02-7A	54.00790	108.94515	502	84.8	North Baikal
BAIK02-8	53.98828	108.93382	442	75	North Baikal
BAIK02-10	53.95295	109.00433	618	71.5	Continent Ridge, North Baikal
BAIK02-11	53.95373	108.95178	463	89.5	Continent Ridge, North Baikal
BAIK02-12	53.92693	108.95608	529	89.2	Continent Ridge, North Baikal
BAIK02-13B	53.43467	108.72345	157	70	Barguzinskyi Bay
BAIK02-14	53.96552	108.79877	850	41.5	Continent Ridge, North Baikal
BAIK02-15	53.92143	108.81625	630	80.3	Continent Ridge, North Baikal
BAIK02-16	53.96277	108.85810	650	71.5	Continent Ridge, North Baikal
BAIK02-17	53.90910	108.85848	380	83.3	Continent Ridge, North Baikal
BAIK03-2	53.18383	107.79422	1700	63.3	Middle Baikal
BAIK03-4	53.93753	108.86722	447	91	Continent Ridge, North Baikal
BAIK03-6	53.93552	108.89900	367	80	Continent Ridge, North Baikal
BAIK03-8	53.95527	108.92855	406	81.5	Continent Ridge, North Baikal
BAIK03-12	53.97132	108.91272	411	60.3	Continent Ridge, North Baikal
BAIK03-14	53.96977	108.96032	442	81.3	Continent Ridge, North Baikal
BAIK03-15	54.08317	109.00643	785	45	Continent Ridge, North Baikal
BAIK03-18	53.89652	108.86775	570	75.5	Continent Ridge, North Baikal
BAIK03-19	53.90945	108.87125	450	88.3	Continent Ridge, North Baikal
BAIK03-22	53.33362	107.43737	158	73.8	Maloe More
BAIK03-26	51.79910	105.48635	1500	64	South Baikal
BAIK03-27	51.60560	104.91140	721	77	South Baikal
BAIK04-2	53.59572	107.96242	258	94	Akademichesky Ridge
BAIK04-4	52.48355	106.09525	386	75.4	Buguldeika Ridge
BAIK05-4	52.36505	106.77527	2.5	94.3	Proval Bay
BAIK05-5	52.35343	106.74990	2.5	73.8	Proval Bay
BAIK05-9	52.34238	106.72723	2	99.5	Proval Bay
BAIK05-10	52.38230	106.78772	3.84	98	Proval Bay
BAIK05-11	52.38230	106.78772	3.84	102	Proval Bay
BAIK05-13	52.39967	106.75100	4.1	98.5	Proval Bay
BAIK05-14	52.42138	106.81568	4.73	97	Proval Bay
BAIK08-1	51.78977	104.41488	550	76	South Baikal
BAIK08-2	51.76795	104.43118	1360	41.9	South Baikal
BAIK09-4	51.76782	104.43108	1367	45.8	South Baikal
BAIK10-1	51.78977	104.41488	550	82.5	South Baikal
BAIK10-3	51.78977	104.41488	550	72.2	South Baikal
BAIK10-4	51.78977	104.41488	550	82	South Baikal
BAIK10-5	51.71717	103.97620	1300	49	South Baikal
BAIK10-6	51.73058	103.97355	1250	51.3	South Baikal
BAIK10-7	51.76000	105.02500	1597	33 (34)	South Baikal
BAIK10-8	53.61500	108.02194	490	29.5	Akademichesky Ridge
BAIK10-8/I	53.61500	108.02194	492	20.6 (21.4)	Akademichesky Ridge
BAIK10-9	53.46688	107.69788	420	57.5	Maloe More
BAIK10-10	53.47383	107.71055	435	77.8	Maloe More
BAIK10-11	53.70361	108.23945	383	18.8	Akademichesky Ridge

Table 1. (continued)
Таблица 1. (продолжение)

Core number	Coordinates		Water depth, m	Core length, cm	Sampling area
	Latitude, N	Longitude, E			
BAIK10-11.1	53.70361	108.23945	383	25.3	Akademichesky Ridge
BAIK10-12	54.12880	108.33848	280	56.6	Cape Zavorotny, North Baikal
BAIK10-13	54.16750	108.41267	350	71.5	Cape Zavorotny, North Baikal
BAIK10-14	54.24658	108.45422	485	54	Cape Zavorotny, North Baikal
BAIK10-15	54.45528	109.06472	900	57.2	North Baikal
BAIK10-18	54.45658	109.05708	900	47	North Baikal
BAIK10-19.1	54.23805	108.80440	925	44.8	North Baikal
BAIK10-20	52.87622	107.17822	1492	68.2	Middle Baikal
BAIK10-21	52.89107	107.15567	1450	56	Middle Baikal
BAIK10-22	52.88610	107.17140	1475	55.3	Middle Baikal
BAIK10-25	51.67680	103.87158	1220	35.2 (36.5)	South Baikal
BAIK10-26	51.67638	103.86993	1372	39.6	South Baikal
BAIK10-27	51.68106	103.86263	1240	34	South Baikal
BAIK10-28	51.67725	103.86235	1200	36	South Baikal
BAIK10-29	51.67725	103.87218	1230	39.9	South Baikal
BAIK10-30	51.67776	103.86683	1214	40.4	South Baikal
BAIK10-31	51.67980	103.86978	1385	38.5	South Baikal
BAIK10-32	51.67867	103.86645	1399	34.3	South Baikal
BAIK11-3	52.56273	106.36597	945	46.7	Middle Baikal
BAIK11-4	52.58702	106.40280	1076	67.7	Middle Baikal
BAIK11-6	52.61187	106.39748	1045	58.7	Middle Baikal
BAIK11-7	52.60825	106.45970	1110	53.8	Middle Baikal
BAIK11-9	52.99607	108.04603	660	19.7	Middle Baikal
BAIK11-10	52.99577	108.04395	660	68.9	Middle Baikal
BAIK11-11	52.44245	106.05030	449	64.3	Buguldeika Ridge
BAIK11-12	52.45145	106.01930	490	65	Buguldeika Ridge
BAIK12-1	51.71711	103.97635	1300	38.5	South Baikal
BAIK12-2	51.69955	103.97663	1300	49.1	South Baikal
BAIK12-3	51.70987	103.95000	1300	39.3	South Baikal
BAIK13-1A	51.76789	104.41631	1360	49.3	South Baikal
BAIK13-2	51.74006	104.37164	1360	34.5	South Baikal
BAIK13-3	51.71458	104.32931	1360	33.9	South Baikal
BAIK13-4C	51.69272	104.30003	1360	38.3	South Baikal
BAIK13-5A	51.65053	104.27411	1350	43.4	South Baikal
BAIK13-6A	51.76764	104.41617	1360	78.1	South Baikal
BAIK13-7B	51.56833	104.52861	1080	47.2	South Baikal
BAIK13-10B	52.18528	106.09389	66	54	South Baikal
BAIK13-11A	52.45000	106.12556	345	63.3	Buguldeika Ridge
BAIK13-14B	53.35055	107.49808	200	29 (30)	Maloe More
BAIK13-15B	53.38783	107.58910	220	29.8 (30.5)	Maloe More
BAIK13-16A	53.87389	109.16361	650	58.4	Chivyrkyi Bay
BAIK13-18C	54.78953	109.24083	910	64.7	North Baikal
BAIK13-19A	55.64939	109.78269	460	71	North Baikal
BAIK13-20B	52.29939	106.13389	40	10.3 (11)	Area near the Selenga river delta, South Baikal
BAIK13-21C	52.22539	106.10431	76	43.5 (44.5)	Area near the Selenga river delta, South Baikal

Table 1. (continued)
Таблица 1. (продолжение)

Core number	Coordinates		Water depth, m	Core length, cm	Sampling area
	Latitude, N	Longitude, E			
BAIK14-2	51.70523	105.01030	1400	53 (54)	South Baikal
BAIK14-3	51.77765	105.37457	1420	50.5 (51)	South Baikal
BAIK14-4	52.77600	107.61502	930	43 (45)	Middle Baikal
BAIK14-5	53.62473	108.12560	370	37 (38)	Akademichesky Ridge
BAIK14-6	54.45098	109.06720	860	25 (26)	North Baikal
BAIK14-7	55.71857	109.62233	480	25 (25.5)	North Baikal
BAIK14-8	54.61957	109.11612	784	49.7	North Baikal
BAIK14-9	53.19308	107.80582	1680	44.3	Middle Baikal
BAIK14-10	52.88260	107.17037	1385	42 (43)	Middle Baikal
BAIK15-1	51.638172	104.671785	1235	1.8 (2)	South Baikal
BAIK15-2	51.639445	104.673812	1246	29.2	South Baikal
BAIK15-3	51.605492	104.734305	1078	18.5 (20)	South Baikal
BAIK16-1	51.563800	104.230100	859	13.8	South Baikal
BAIK16-2	51.654933	104.421750	1307	16.7 (17.5)	South Baikal
BAIK16-3	51.778550	105.367067	1433	38 (39)	South Baikal
BAIK16-4	51.972150	105.350100	477	34 (34.5)	South Baikal
BAIK16-5	52.030300	105.955233	712	42	Posolskaya Bank, South Baikal
BAIK16-6	53.524433	108.397483	1520	41 (42)	Middle Baikal
BAIK16-7	53.600683	108.168633	455	35 (36)	Akademichesky Ridge
BAIK17-1	51.767950	104.431183	1366	69	South Baikal
BAIK18-1	51.767933	104.415800	1366	59	South Baikal
BAIK19-1	51.767933	104.415800	1366	73.3	South Baikal

Note. *Continent Ridge is the term used in international literature to designate the northeastern extension of the subaquatic Akademichesky Ridge in the southern part of North Baikal. This term refers to the EU-Project CONTINENT that included bottom sediment sampling in this area and comprehensive analysis of the sediments.

Примечание. «Continent Ridge» – возвышенность в южной части Северного Байкала. Отбор и всестороннее исследование донных осадков из этого района были выполнены в рамках международного проекта «Континент». По этой причине в международной литературе данный район Байкала обозначается как «Continent Ridge».