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Saint Petersburg

VNIIOkeangeologia

Joint International Conference

MINERALS OF THE OCEAN-8 & DEEP-SEA MINERALS AND MINING-5

ABSTRACTS

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GAS MIGRATION PATHWAYS AND DISTRIBUTION IN THE BOTTOM SEDIMENTS OF LAKE BAIKAL AS OBSERVED ON X-RAY TOMOGRAPHY IMAGERY

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Two International expeditions of the Class@Baikal project were organized by the Moscow State University and the Limnological Institution (Irkutsk) of Russian Academy of Sciences (LIN RAS) in 2014 and 2015 (http://www.baikal.festivalnauki.ru/). The R/V «G.Yu. Vereshchagin» owned by LIN RAS represented the fleet of the Floating University, a long-lasting international research and training program, which has been initiated by the Moscow State University and executed with the UNESCO support since 1991. The main educational activity of the Floating University is "Training-through-Research" (TTR). Its experience served as a solid foundation of the Class@Baikal project. In addition to its particular significance, the Class@Baikal project also has a goal to prepare a team for organization and execution of a potential, already the 19th, oceanic expedition of the parent "Training-through-Research (Floating University)" Program (http://floatinguniversity.ru/)

Lake Baikal is one of the best places for studying gas hydrates and features of their distribution in sediments. This is the largest and the most ancient fresh-water basin on the Earth and also the only lake where gas hydrate accumulations have been found. Natural gas hydrates and submarine fluid escape features were among the principal research topics of the Floating University since the very beginning. Thus, the investigations related to gas seepage sites on the bottom of Lake Baikal, on the one hand, are supported by some experience from the previous studies and, on the other hand, open a new, Baikalian, page in the Floating University history.

Most standard methods were applied to study samples of sediments and gases collected during the Class@Baikal cruises: detailed core description and logging; grain size analyses, microscopy and X-ray diffraction for particular intervals; gas chromatography and carbon isotope analysis for sampled gases. Besides, for the first time ever, the sediments sampled on Lake Baikal were scanned, on a massive scale, with full-core-size X-ray computer tomography machine to study their internal structure. This has led to opening some features which can be hardly seen and recognized and, thus, were missed when the cores were described visually on the deck and in laboratories. For instance, in such a way, within visually very homogeneous sediment cores one was able to identify gradual lamination, slump structures, mud volcanic breccia structures and many unusual vertical structural

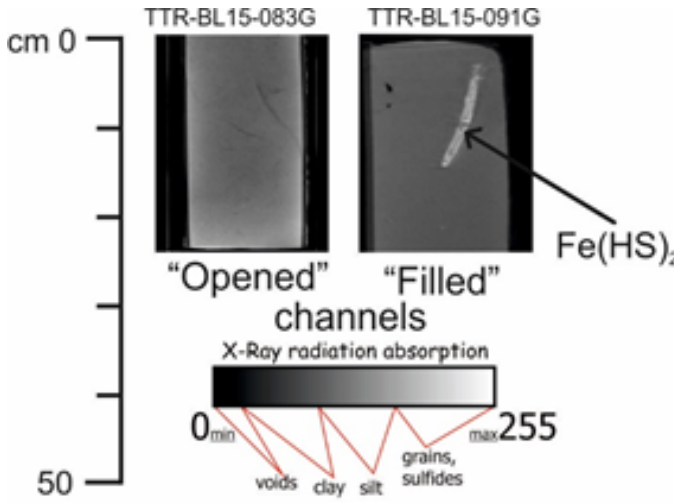

Fig. 1. Digital images of vertical structure elements determined in stations TTR-BL-083G and TTR-BL15-091G

elements. Most features observed on tomographic images are depositional in their origin and they were interpreted complementing to sedimentological analysis of the cores. The observed vertical elements (Fig. 1) cut the sedimentary structures and are clearly post-depositional in the sediment column. Their nature is very debatable and it is believed that a careful study of tomography imagery and a precise analysis of their spatial distribution over the lake deposits will bring us to better understanding of these elements.

First of all, it was found that the vertical structural elements are present only in the cores recovered from or very close to the sites of presumed gas seepages or gas hydrate accumulations, implying some genetic relationship/association between these natural phenomena. Then, two major types of the vertical elements were described: (1) "opened channels" and (2) "filled channels". Although the channels appeared to be morphologically identical or very similar, a study of granulometric and mineral composition of the infills was carried out and revealed some differences between the vertical elements. The most interesting finding is that, unlike the open channels, the filled channels contain a significant portion of ferrous sulfide (table 1). This can be an indicator of specific authigenic mineralization which the filled channels have undergone. It is possible that the channel infills were transformed due to bacteria vital activity in the bottom sediments, for example, by association of methane-oxidizing and sulphate-reducing bacteria. Such transformations imply distinctive gas concentrations in the studied sediments nowadays or in the past.

The "open channels" were identified only in the cores from the areas of active gas discharge (e.g. the Novosibirsk mud volcano, the Bolshoy mud volcano, the Elovskiy Area and the Krasniy Yar area). The active seepage is confirmed by the data of geophysical surveys and by the results of analysis of gas concentration in the sampled sediments. The channels of this type can be existing pathways of discharging gases, which migrate in the very sub-bottom sedimentary column. The "filled channels" are more abundant in the studied cores and they were observed not only in the sediments from the areas of well-defined gas seepages. However, it is

believed that the "filled channels" may be considered as a kind of fossil analogues of the channels of the type (1). Thus, they can mark the areas where gas seepage was active some time ago.

Table 1

The comparison of two types of channels: "opened" and "filled"

	Type I	Type II
Length	3—40 cm	3—40 cm
X-Ray absorption	Lower than host oozes	Higher than host sediments
Infill	Host sediments	Ferrous sulphides
Compaction	Undercompacted	Compacted (clumpy)
Number of stations with element	6	40

To conclude, X-ray tomography has been for the first time applied to the routine study of the sediment cores from Lake Baikal. Tomography imagery helps in recognition of inner structural elements which are not visible at ordinary visual description of cores. Some feature possibly related to intensive gas discharge on the bottom have been identified and primarily interpreted. A model of their formation has been proposed. Further investigation of the Baikal lake sediments with an use of X-ray tomography seems to be very perspective.