Geochemical analyses of subsurface sediments retrieved off Mombetsu and Abashiri using Garinko II and III

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We have been conducting training of oceanographic research for students using the icebreaker Garinko since 2014. The Garinko III (366 t), which is larger than the Garinko II (150 t), started the service in 2021. Because these ships are equipped with an alchymedian screw to break the sea ice, they have advantage for controlling the ship position during operation for sediment coring. The Garinko III is a research vessel equipped with an A-frame. In this paper, we summarize the results of gas and sediment analysis using these ships.

Sea-bottom sediment cores were obtained by the Garinko II at Monbetsu Port (GA17, GA18, GA19, and GA21) and by the Garinko III off Abashiri (GRN21) using gravity and hydrostatic corers. The sediments were split in half and sediment gas was obtained by a headspace method. A glass vial (25 mL) was sealed with sediment (10 mL), water saturated with NaCl (10 mL), and preservative, and the headspace was replaced with helium and shaken well. These gas samples were introduced to a gas chromatograph to determine their gas composition, and then the carbon isotope ratios of methane and carbon dioxide were measured using an isotope ratio mass spectrometer. On the other hand, a small amount of sediment was collected at each depth of the sediment core, and the total organic carbon (TOC) in the sediment and its carbon isotope ratio were measured. The sediment samples were dried, homogenized, and about 5 mg of samples were put into silver foil capsules. They were decarbonized with 12N hydrochloric acid for 24 h, and then dried and wrapped in tin capsules. These samples were analyzed their TOC with a flash elemental analyzer connected to the isotope ratio mass spectrometer.

In the Mombetsu port, 18 sediment cores were obtained at the same place in four years. These cores were about 1 m in length, and some cores had a strong hydrogen sulfide odor. Majority of the sediment cores showed methane concentration reaching 1 mM at 40 cm depth, while others remained on the order of 0.01 mM. Some cores also showed a peak of methane concentration near 50 cm depth. Hydrogen sulfide concentrations peaked around 40-50 cm depth in all cores. Methane $\delta^{13}C$ and δD are widely distributed in the range of -100 to -60‰ and -300 to -200‰, respectively, suggesting microbial methane produced by a methanogen at the depth of the sediment cores. 1.6% and -26.4‰ were the median values of TOC and its $\delta^{13}C$, respectively, and the TOC reached a maximum of 4%, indicating abundance of organic matter.

In the offshore Abashiri, 11 sediment cores were obtained on September 2021 (GRN21 cruise) from the gas seepage area at a depth of 420-520 m, where HKS20 cruise (Moriya *et al.*, 2021) was conducted in 2020. Although the aim of the cruise was to retrieve natural gas hydrates, we could not get them at the place. The median values of TOC and their $\delta^{13}C$ were 1.3% and -24.4‰, respectively, which were similar to the results of the HKS20 cruise. Some sediment cores contained carbonates, suggesting that an active methane seepage is oxidized in the subsurface sediment and combined with calcium ions in the sediment interstitial water.

References

Moriya Y, Kimura H, Hachikubo A, *et al.* (2021) Gas hydrate survey at the gas seepage area off Abashiri, the Sea of Okhotsk. *Japan Geoscience Union Meeting 2021*, MIS26-P02.

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