バイカル湖ガスハイドレート包接ガスの起源
Gas origin of hydrate-bound gas in Lake Baikal

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In the framework of international collaboration between Kitami Institute of Technology (Japan), Limnological Institute (Russia), and Ghent University (Belgium), natural gas hydrates have been recovered from lake-bottom sediments at Lake Baikal. Near-surface gas hydrate was first discovered at the Malenky mud volcano at the southern Baikal basin in 2000. Multi-phase Gas Hydrate Project (MHP, 2009-2018) has revealed distribution of near-surface gas hydrates at the southern and central Baikal basins. We found six new places (Enkhelook, Soukhaya, KIT, LIN, PosolCanyon1, and PosolCanyon2) during the VER18-03 cruise in 2018. The total number of places where near-surface gas hydrates were retrieved is 53. In this report, we summarize characteristics of hydrate-bound gases retrieved from all the sites since 2005.

Gas hydrate crystals were recovered from lake-bottom sediment cores, and hydrate-bound gas samples were stored in 5-mL vials. Total number of hydrate-bound gas samples was 626. Molecular and isotopic compositions of hydrate-bound gas were measured using a gas chromatograph and a stable isotope ratio mass spectrometer.

In the Bernard plot, C_1 $\delta^{13}C$ and C_1 / (C_2 + C_3) distributes from -70‰ to -44‰ and from 6 to 100,000, respectively, suggesting that the origin of hydrate-bound gas is microbial, thermogenic, and their mixed-gas. Almost all data are plotted on the mixing line between microbial and thermogenic, however, Gorevoy Utes (oil seep site) showed thermogenic C_1 with small composition of C_2 and C_3. The data concentrates in the microbial field (C_1 $\delta^{13}C$: -66‰ and C_1 / (C_2 + C_3): 1,000-10,000). C_1 δD of thermogenic C_1 increases with C_1 $\delta^{13}C$. C_2 $\delta^{13}C$ distributes from -69‰ to -23‰. 17 sites (ex. Solzan, Talanka, Turka, KIT, etc.) showed microbial C_1 and C_2. 27 sites (Malenky, Oblom, Seep13, Kukuy K6, etc.) showed microbial C_1 and thermogenic C_2, indicating that small amount of thermogenic gas is mixed with microbial gas. Other sites (Mamay, PosolBank, Gorevoy Utes, Kedr, etc.) showed thermogenic C_1 and C_2. The Milkov plot (relation between C_1 $\delta^{13}C$ and C_2 $\delta^{13}C$) can express mixing condition between microbial and thermogenic rather than the Bernard plot. C_2 δD decreased with decrease in C_2 $\delta^{13}C$, therefore microbial C_2 is both depleted in ^{13}C and D. We conclude that hydrate-bound gas at Lake Baikal is mainly microbial gas, and thermogenic gas ascends from deep layer at some areas (Kedr, PosolBank, Kukuy, and Gorevoy Utes) and forms the structure II gas hydrate.

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