

## Microbial ethane in natural gas hydrates retrieved from Lake Baikal

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Natural gas hydrate exists in sublacustrine sediments of Lake Baikal. Multi-phase Gas Hydrate Project (MHP, 2009-2019) has revealed characteristics of near-surface gas hydrates retrieved from the southern and central Baikal basins. Recently, we found six new places (Zelen MV, Zelen Seep, Katko MV, BelKamen MV, Melky Seep, and Kukuy K-17 MV) during the VER19-03 cruise in 2019. The total number of places where near-surface gas hydrates were retrieved at Lake Baikal is 60. In this study, we summarize characteristics of hydrate-bound gases retrieved from all the sites since 2005, and focus on hydrate-bound ethane and its gas origin. Hydrate-bearing sediment cores were recovered using a gravity corer and samples of hydrate-bound gas were stored in glass vials with butyl-rubber septum. Total number of hydrate-bound gas samples was 667. Molecular and isotopic compositions of hydrate-bound gas were measured using a gas chromatograph and a stable isotope ratio mass spectrometer. The data plotted in the Bernard plot showed that the gas origin of Lake Baikal gas hydrates distributes microbial, thermogenic, and their mixed-gas.  $\delta^{13}\text{C}$  of ethane distributes from -69‰ (Solzan, gas hydrate mound) to -23‰ (Kukuy K-P, pockmark). The relation between  $\delta^{13}\text{C}$  of methane and ethane showed “L shape”, suggesting that hydrate-bound ethane in Lake Baikal is composed of ethane-rich thermogenic gas and ethane-depleted microbial gas. We propose a new diagram, relation between  $\delta^{13}\text{C}$  and  $\delta\text{D}$  of ethane, similar to the Whiticar diagram (relation between  $\delta^{13}\text{C}$  and  $\delta\text{D}$  of methane). The diagram showed that light ethane in  $\delta^{13}\text{C}$  also depleted in  $\delta\text{D}$ ; hydrate-bound thermogenic ethane is plotted around -25‰ in  $\delta^{13}\text{C}$  and -210‰ in  $\delta\text{D}$ , whereas those of microbial ethane is plotted around -60‰ in  $\delta^{13}\text{C}$  and -280‰ in  $\delta\text{D}$ . These results indicate that the light ethane depleted in  $^{13}\text{C}$  and D is generated by a microbial process, and the origin of hydrogen in ethane molecules is thought to be lake water, same as methane.

Keywords: gas hydrate, Lake Baikal, ethane, gas origin