Stable isotope analysis of methane in Iheya North and Minami-Ensei hydrothermal fields, Okinawa Trough

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The Okinawa Trough is a sediments-hosted back-arc basin located between the Ryukyu Arc-Trench system and the Asian continent. The hydrothermal activities in the Okinawa Trough are the most strikingly characterized by extreme abundance of gaseous carbon compounds. Here, we focus on two hydrothermal fields in the Okinawa Trough: the Minami-Ensei Knoll and the Iheya North hydrothermal fields and report stable isotopic compositions of methane in order to understand mechanism of formation and consumption of CH_4 in these hydrothermal systems.

Samples were collected in YK06-09, NT07-11 and NT07-13 cruises using *ROV* Hyper-Dolphin in 2006 and 2007. We analyzed methane in hydrothermal vent fluids, surrounding waters in faunal colonies around chimney (polychaete, galetheid and mussel), and seawaters inside and outside the caldera hosting the hydrothermal activities. Concentrations and carbon isotopic compositions of CH_4 and CO_2 were measured using GC/C/IRMS system and GasBench-II, respectively.

The $d^{13}C$-VPDB value of hydrothermal end-member methane in the Minami-Ensei Knoll is estimated to be -25 permil, which is similar to that of the Yonaguni Knoll IV (Konno *et al.*, 2006). Such methane may be a mixture of roughly 40% of magmatic CH_4 and 60% of thermogenic CH_4. On the other hand, hydrothermal end-member of methane in the Iheya North hydrothermal field shows concentration of 5.3 mmol/kg and $d^{13}C$ value of -54 permil. This extremely low $d^{13}C$ value cannot be achieved only by magmatic and thermogenic sources of CH_4, and thus implies a source of microbially produced CH_4 beneath the seafloor. Such methane emitted from the vent is subsequently consumed in so-called ‘mixing zones‘. Our incubation experiment of water samples collected from polychaete colony under the in situ temperature and pressure conditions indicates microbial oxidation of CH_4 for 16 hours. Using this systematic decrease of concentration and gradual ^{13}C-enrichment of residual methane, we estimate the isotopic fractionation factor of 1.0038 for in-situ oxidation of methane. This fractionation factor is similar to that estimated in the Myojin Knoll Caldera, Izu-Bonin arc (1.005; Tsunogai *et al.*, 2000). Methane in ambient water within the caldera shows about 5 permil enrichment of ^{13}C relative to that resulted from simple dilution of hydrothermal methane, suggesting microbial consumption of CH_4 within the mixing zone.