Origin of methane in gas hydrate field, Hikurangi Subduction Margin: application of geochronological method using a long-lived radioisotope of iodine

*Satoko Owari[1], Hitoshi Tomaru[2]

1. Tokyo University of Marine Science and Technology, 2. Chiba University

Organic materials such as marine algae are enriched in iodine because iodine is incorporated with the algae due to its strongly biophilic character. Iodine and methane are released into an interstitial water during the degradation of the organic materials and migrate together due to the similar diffusion coefficient in marine sediment. Iodine is concentrated in interstitial water relative to seawater (0.4 μM), the concentration therefore increases up to a few hundred μM. Iodine has one long-lived radio isotope (^{129}I, $t_{½}$= 15.7 Myr) and it has been used as a geochronological indicator. The ^{129}I geochronology has been applied to identify the depositional age of source organic materials, fluid migration pathway, and relative age of iodine/methane-rich fluid in gas hydrate field. This research aims at characterizing the source and potential age of organic materials for methane in the gas hydrate field related to the fracture-developed sediment in the Hikurangi Subduction Margin.
We collected interstitial water (down to ~1000 mbsf) at four sites across the trench axis in the Hikurangi margin during the IODP Exps. 372 and 375. The iodine and methane concentration at Site U1520, seaward of the trench axis, increased from seawater level to 200 μM and 10^5 ppmv, respectively, at 100 mbsf and decreased with depth. The $^{129}I/I$ ratios were almost constant at ~100×10^{-15}, corresponding to the potential iodine age ~50 Ma. The old iodine are derived from Cretaceous sediment underlying Site U1520. The seaward iodine and methane were, therefore, liberated through the degradation of iodine-rich organic matter and mixed with young/shallow iodine. Pore-filling gas hydrate layers were found by IR scanning at Sites U1517, U1518, and U1519, landward of the trench axis. The saturation and depths of gas hydrates were identified by low concentration anomaly of the chloride. The chloride data suggest the presence of gas hydrate occurrences between ~100 to 170 mbsf, with S_h values ranging between 1 to 70 % at the Site U1517 and between ~33 to 390 mbsf, with 2 to 46% of saturation at the site U1518. At the Site U1519, the low concentration of chloride were found between ~600 to 620 mbsf, however there is not a clearly defined background Cl concentration profile due to the coring gap, there is no saturation data at this site. Most gas hydrate layers were found in the relatively high permeability sediments such as sand or silt. The iodine concentrations at landward sites increased up to 700 μM with depth and the methane concentration increased rapidly to 10^3 to 10^4 ppmv at 50 mbsf. The $^{129}I/I$ ratios at landward site were constant around 100×10^{-15}, corresponding to the potential iodine age ~50 Ma. The iodine and methane landward sites are potentially derived from deep/old landward sediment such as deformed backstop at these sites. The distribution of methane is controlled by advection/migration of iodine-methane-rich fluid through fractured layers developed in accreted landward sediments. The landward sediments of the Hikurangi subduction margin are characterized by relatively old fluid with high methane concentration. The gas hydrate system is, therefore, developed typically within the landward sediment especially porous layers.

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