Methane flux in accretionary complex: An example from the forearc basin and outer ridge of the Eastern Nankai trough

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Background and Objectives

Gas hydrate BSRs are widely distributed in shelf and slope sediments of the Nankai Trough off southwest Japan. Exploratory drilling in the eastern Nankai Trough in 1999-2000 has confirmed 20 to 30 m thick gas hydrate zones with 60 to 80 % gas hydrate saturation at about 250~270 meters below seafloor. Development of highly saturated zones in low TOC (<1%) sediments requires external supply of CH_4 into the zone of gas hydrate stability (<270mbsf). Assessing the amount and mode of transport of deep-seated CH_4 and CH_4-bearing fluids is critically important to understand the growth of gas hydrates, the resource potential, and environmental impact. Dai-ni-Hakurei 02DM cruise (Dec.02–Jan.03) recovered 30 piston and gravity cores from the eastern Nankai Trough. We analysed sulfate concentration of ~300 pore water samples to determined the depth of SMI (sulfate-methane interface) as a proxie of methane flux in marine sediments.

Results and Significance

SMI of the outer ridge sites, where major thrusts, earthquake faults, and methane seeps and seep-related phenomena have been observed, are unexpectedly deep, >10m, except for an active mud volcano site (~2m). Furthermore, the sulfate concentration is nearly constant for the top 1~2 meters, probably because of strong bioturbation. The observed “discrepancy” - low CH_4 flux at active seep sites, may indicate that venting and expulsion of methane are not steady state phenomena, but occur only intermittently and perhaps in very limited area. Active venting and release of methane may be related with such events as earthquakes.

Contrary to the outer ridge sites, the depths of SMI in the forearc basin sites are surprisingly shallow. Three sites in the Enshu basin range between 3.5 and 7.0 m, and two sites off Tokai are ~4.0 m. In addition to these five sites, two sites on the slope of the outer ridge, have also shallow SMI (1.5 to 3.5m). Enshu basin is characterized by three major E-W trending dextal faults and related high angle normal faults, which are tracable as deep as ~1 km on seismograms. A series of high angle faults are also observed in the top few hundred meters sediment in off Tokai area. Faults and fracture systems are thought to play an important role to transport CH_4 and CH_4-bearing fluids to gas hydrate stability zone and to the seafloor.

Observed depth variation in SMI would also provide critical constraints on the mode and amount of tectonically induced expulsion of fluids from the accretionary complex.

New noble gas data on basaltic glasses from eastern and western flanks of Loihi Seamount

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Characterization of noble gas isotopic signatures in deep and less-degassed mantle domain has a crucial importance in deciphering geochemical evolution of the Earth including its atmosphere. Loihi is undoubtedly one of the best places to study noble gas isotopes of such a primitive reservoir, but previous studies are largely focused on samples collected from currently most active rift zones. However, in order to fully understand evolutional history of Loihi and to obtain isotope signature of possibly earlier stage of its activity, we need to target relatively older samples from Loihi. Thus, during a 2002 research cruise to Hawaii by JAMSTEC (Japan Marine Science and Technology Center), we have collected samples from the interior of the volcano which is exposed now in steep eastern and western flanks of Loihi due to mass wasting.

So far five samples of fresh glassy rim of pillow basalts have been subjected for noble gas isotope analyses by crushing extraction. These samples have systematically high $^{3}He/^{4}He$ ratios compared with population of $^{3}He/^{4}He$ ratios so far reported for Hawaiian basalts, indicating that the present samples represent some earlier stage of Loihi activity with lesser contributions from helium in the upper mantle reservoir. The sample with the highest $^{3}He/^{4}He$ ratio of 35Ra also yielded non-atmospheric xenon isotope ratios; about 13% excesses in ^{129}Xe and ^{136}Xe are the largest among those so far reported for plume-related samples (Poreda and Farley, 1992; Harrison et al., 1999; Trieloff et al., 2000) and comparable to the largest excesses found in MORBs (Staudacher and Allègre, 1982). This is probably the first unambiguous occurrence of non-atmospheric xenon from the glass rim of pillow lava from Loihi with very primitive helium signature. This finding indicates that excess radiogenic xenon is also present in the plume mantle region as predicted by steady state model for mantle noble gases.

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