論文内容の要旨

Formation and dissociation processes of marine gas hydrate inferred from the geochemical anomalies of the interstitial waters of high methane flux area off Joetsu, eastern margin of Japan Sea

（日本海東縁上越沖の強メタンフラックスエリアで見られる間隙水の組成異常からガスハイドレートの生成・分解過程の解明）

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The Umitaka Spur and Joetsu Knoll in the Joetsu basin on the eastern margin of Japan Sea are characterized by features indicative of high methane flux such as a BSR and gas plumes rising through the water column. Exploratory wells at the spur revealed hydrocarbon source rocks and oil bearing sands. Similar geological settings are expected off Joetsu and they are likely linked to the presence of the rocks underneath the sediments. Unnamed Ridge just east of the spur has no gas plume, however, similar high methane flux is expected due to the short distance from the spur. The interstitial water chemistry off Joetsu, including the three anticlinal structures was measured in order to delineate the behavior and evolution of gas hydrate system across the region. The sulfate depth profiles indicate that the SMI depths become shallower toward the crest of the spur and knoll and are shallower than 200 cmbsf at any plume sites, suggesting that methane fluxes are the highest around the plumes. Depth profiles of Cl^- all fall into one of four distinguishable trends: Type-I where concentrations linearly increase with sediment depth, Type-II where concentrations linearly decrease with depth, Type-III where concentrations remain constant and Type-IV where concentrations exhibit negative spikes caused by dissociation of gas hydrate during core recovery and handling. Type-I cores commonly recovered at plume sites are characterized not only by steep Cl^- gradients (+13.2 to +64.3 mM/m), but also extreme depletions in D and ^{18}O (-1.20 to -0.54 ‰VSMOW/m for δD_{H2O} and -0.17 to -0.10 ‰VSMOW/m for $\delta^{18}O_{H2O}$) suggesting gas hydrate formation at shallow depth. The Cl^- gradients of Type-II cores recovered from all over the spur and northern land slide area of the knoll. The gradients tend to have little variation at the spur (-14.8 to -8.3 mM/m) and

knoll (-11.2 to -7.6 mM/m). Gas hydrate dissociation along base of gas hydrate stability zone best explains both the similar pattern of freshening with depth and the widespread distributions of Type-II cores. Although gas hydrate dissociation is known to release isotopically heavy water, Type-II cores show progressive depletions of both D and ^{18}O with downward depth. The apparent contradiction between Cl^- concentrations and the isotopic compositions of Type-II cores is likely due to strong burial diagenesis observed all over the Japan Sea sediments. Constant gas hydrate dissociation due to burial seems to be the origin of hyposaline water under the sediments. In conclusion, I identified two contrasting types of the evolution of the interstitial waters; hypersaline waters formed as a residual water of gas hydrate precipitation around strong seep sites, and hyposaline water formed by constant and regional dissociation of subsurface gas hydrate.