Chloride anomaly in interstitial waters at gas hydrate zone, eastern margin of Japan Sea

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The Umitaka spur (UT spur) and Joetsu knoll (JK) of the Joetsu basin, eastern margin of Japan Sea, is characterized by methane-induced features such as gas plumes, BSRs and pockmarks. Neogene strata under UT spur are known as hydrocarbon source rocks for oil and gas in north western Japan. These features indicate active gas venting in this study area. Furthermore seafloor survey by ROV and piston coring at plume sites in UT spur and JK revealed existence of gas hydrate on the seafloor and in shallow sediments. Chemistry of interstitial water (I.W.) at UT spur JK has delineated the behavior and evolution of gas hydrate system here.

Depths of sulfate-methane interface (SMI) become shallower toward the both crests of the spur and JK. The depths become shallowest (within 200 cmbsf) at any plume sites, suggesting that the methane fluxes are highest around the plume sites.

The depth profiles of Cl^- are grouped into 4 types, (A) linear increase with depth, (B) linear decrease with depth, (C) with negative spikes at gas hydrate bearing part, (D) no change throughout.

Type A cores recovered at plume site in UT spur and JK linearly increase with depth. Cl^- of PC403 increases from bottom sea water value (about 540 mM) to 746 mM at 461 cmbsf. Delta D and delta O^{18} of PC403 are progressively depleted in D and O^{18} with increasing depth (-5.3 and -0.51 permil VSMOW at 461 cmbsf respectively). These chemical anomalies are due to gas hydrate formation in shallow depth at plume site.

Type B cores are recovered from south part of UT spur, north of UT spur and north of JK. Any type B piston cores exhibit similar downhole profiles of Cl^-. The gradients are between -14.8 to -8.3 mM per meter. These similar freshening depth profiles mean that same mechanism inputs fresh water at different coring sites. Gas hydrate dissociation along base of gas hydrate stability zone (BGHS) well explains these similar freshening depth profiles.

Gas hydrate dissociation is expected to cause positive anomalies in delta D and delta O^{18}. Delta D and delta O^{18} of type B cores, however, are depleted in D and O^{18} with increasing depth. Similar lowering profiles of the delta D and delta O^{18} with depth have been reported from several ODP sites in Japan Sea. These isotopic profiles are due to burial diagenesis of silicates and volcanics. The apparent contradiction between Cl^- and isotopic compositions of type B cores are ascribed to strong and overwhelming depletion in D and O^{18} of Japan Sea sediments.

Regional dissociation of gas hydrate is likely to have been triggered by eustatic sea level drop which destabilized gas hydrate along BGHS.