

Study on the methane flux, seafloor gas hydrates and methane-derived carbonates off Naoetsu eastern margin of Japan Sea

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1. Introduction

The Umitaka (UT) spur in Japan Sea is characterized by methane-derived features such as bottom-simulating reflectors (BSRs), pockmarks and mounds. These features seem to indicate active fluid and/or gas venting on the UT spur. Neogene strata under the UT spur are enriched in organic carbon, and are considered as hydrocarbon source rocks for oil and natural gas fields of Niigata area (JOGMEC, 2005).

2. Result and Discussion

Methane Plumes: Quantitative echo sounder has revealed approximately 600-m high plumes in the water column (Aoyama et al., 2005). Plumes are concentrated in central and north part of UT spur. Gas hydrates have been recovered from the plume sites and Hyper Dolphin dives in 2005 recognized gas hydrates on the sea floor in active plume region.

Chemistry of the interstitial water: Sulfate concentration decreases linearly with depth at every coring site except for the hydrate bearing sites. Alkalinity increases rapidly downward to SMI (sulfate-methane interface), showing somewhat mirror image of sulfate decrease. This patterns strongly indicate coupled anoxic oxidation of methane and sulfate reduction in shallow sediments. SMIs are very shallow, within 1.5mbsf, around the plume sites. Therefore, plumes must be related with methane. The methane flux calculated from the depth profile of sulfate is about 4.0 times stronger than Blake.

Chloride concentration in some cores linearly increase or linearly decrease with depth. It is safely assumed that the diffusion between bottom sea water and fresh or brine pools is the primary causes of the depth profile of chloride. Formation and dissociation of gas hydrate are considered to be responsible for the formation of unusual saline or fresh water pools in sediments, because gas hydrate exclude chloride from their structure. Gas hydrate formation increase the salinity of the surrounding water (Ussler 3 and Paull, 2001) and dissociation decrease the salinity.

Carbonate geochemistry: Calcitic nodules were recovered close to north plume site whereas aragonitic nodules were recovered at active plume sites. C-13 depleted carbon isotopic composition of aragonites (-28.3~-6.6-permilVPDB) and calcites (-41.1~-9.8-permilVPDB) indicate that these carbonates contain methane-derived carbon. However shell fragments (-1.3~2.8-permilVPDB) have the isotopic composition of marine DIC. Considering that the age of the carbonates has been measured to be within 40ka, the temperature of formation of carbonates could not be higher than the present temperature. Assuming the temperature of 0 to 1 degC, the oxygen isotopic composition of waters for the precipitation of aragonite with 3.2~3.4-permilVPDB are calculated to be 0.1~0.5-permilVSMOW, which are identical to the present seawaters. Applying the equation to carbonate nodules, aragonites (2.9~5.2-permilVPDB) and calcites (1.8~4.5-permilVPDB corrected for Mg content following Tarutani et al., 1969) are estimated to have been precipitated from heavy oxygen water (0.3~2.3-permilVSMOW) and light oxygen water (-2.9~-1.8-permilSMOW), respectively. Such an anomalous heavy and light oxygen waters were supplied from the dissociation and formation of gas hydrates, respectively, because gas hydrate is about 3 permil heavier than the ambient waters.

3. Conclusions

Methane flux at plume sites is stronger than the other sites. Therefore, plume is related with methane. At the active plume sites, gas hydrate is currently formed in sediments and chloride concentration is increased, because chloride concentration linearly increases with depth. The Oxygen isotopic compositions of carbonate nodules indicate that the calcites were formed during high methane flux and gas hydrate formation whereas aragonites, during dissociation.