Time-series analysis of pore waters collected by OsmoSampler from the perspective of gas venting strength in shallow gas hydrate field, Japan Sea

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Recent marine surveys using ROV, fishery echo sounder, and multibeam echosounder have observed that the location and strength of gas venting on the seafloor have changed over periods as short as a few days in the shallow gas hydrate fields of the Japan Sea. It suggests geochemical environment of shallow gas hydrate system including gas venting may change quickly relative to other processes which occur on a geological time scale. Gas venting sites are characterized from the point of view of density (number) and volume of venting activity, and bottom material. The former at Torigakubi Spur offshore Niigata are very high, where the seafloor is covered with carbonate clasts of >50 cm and muddy sediments trapping gas bubbles. Carbonates on the seafloor are evident of active methane venting in the past. The venting density at Umitaka Spur offshore Niigata is also high, however, the volume is less than Torigakubi Spur, and bottom materials are mainly mud with small carbonates (2~3 cm). There are no gas ventings during ROV investigations at Torimi Guri (reef) offshore Akita-Yamagata, where the bottom materials are mud.
To clarify how the difference of gas venting density and strength among sites have affected the geochemical environment including shallow gas hydrate system, we have collected interstitial waters at 30 cm below the seafloor for one year using a long-term osmotic fluid sampling system called OsmoSampler at three sites; significant venting site at Torigakubi Spur, venting site at Umitaka Spur and venting-free site at Torimi Guri, and have measured concentrations of dissolved ions and gases with a resolution of ~1 day.
All the major ion concentrations show synchronous increase and decrease repeatedly over periods of 3~5 days at all sites. Spiky changes are also present but appear irregularly. The range of synchronous change and frequency of spiky change are obviously different among sites. The largest synchronous change through one year is observed at Torigakubi Spur, which corresponds to high density and volume of gas venting. The higher density and volume of gas venting induces massive/rapid formation of gas hydrate, which may significantly control ion concentrations around gas hydrate deposits. The changes of methane concentration is also large at Torigakubi Spur, exceeding 10,000 mM, 5,000 times higher than other sites, the interstitial water may contain methane bubbles. There are no obvious correlations among methane concertation, venting density, and volume, this is because gas hydrate growth triggered by enhanced gas venting might have plugged the gas migration paths. We have clarified that the geochemical environments of interstitial water in shallow gas hydrate fields are constrained mainly by the density and volume of gas venting. Further investigations will clarify the relationship between venting strength and interstitial water geochemistry.
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Keywords: Gas venting, Shallow gas hydrate, Japan Sea, Long-term fluid sampling system, Interstitial water, OsmoSampler