A working hypothesis on the accumulation of methane hydrate in gas chimneys developed in the eastern margin of Japan Sea

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A lot of gas chimney structures are identified by a sub-bottom profiler as acoustic blanking in the eastern margin of Japan Sea. The acoustic blanking is caused by hard stuff such as carbonate nodules and gas hydrate that develop usually on the seafloor or very shallow depths. Therefore, the deeper part of the acoustic blanking or gas chimney structure was remained unknown. The coring of gas chimney structure of three topographic highs by R/V Hakurei in 2014 clarified that gas hydrate occur from the surface to the deep in the gas chimneys.
A series of observation of the recovered cores by necked eyes, X-ray CT photography and experiments such as sieving of carbonate nodules from mud clarified the close association of carbonate nodules and gas hydrate in the sediments of gas chimneys. This combination of carbonate nodules and gas hydrate occurs periodically and the calculated cycles are around 15 ky.
Preceding studies clarified the following subjects.
1. Carbonate nodules in the gas hydrate field of Japan Sea are interpreted to be formed in the sulfate-methane interface (SMI).
2. The carbon and oxygen isotopic ratios of the carbonate nodules demonstrated the thermogenic methane from the deep largely contributes the formation of the nodules.
3. Active faults and folds develop in the mobile belt of the eastern margin of Japan Sea and form many topographic highs.
Combining the above-mentioned preceding studies and acquired data, we propose the following working hypothesis: Methane gas has been periodically supplied from the depth by the movements of active faults, and the gas repeatedly formed both carbonate nodules and methane hydrate at around the depth of SMI that existed at or in the shallow depth of the seafloor.
Further studies are required if the proposed mechanism of the accumulation of shallow gas hydrate would be applied generally to the other gas hydrate-bearing topographic highs that distribute in the eastern margin of Japan Sea.
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