Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

MIS24-01 Room:101B Time:May 27 16:15-16:30

Types and distribution of gas chimneys: host structure of shallow gas hydrates

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Gas chimney is defined as a subsurface columnar structure of a few 100 m to a few km in longest diameter, characterized by well-developed acoustic blanking down to more than a km. Gas chimney is a major host structure of shallow gas hydrates in Japan Sea, often capped by hard ground as recognized by strong back-scatter image of a side scan sonar, indicating surface exposure of massive gas hydrate, carbonate concretions and bacterial mats and related chemosynthetic communities. Intensive acoustic surveys such as MBES and SBP confirmed 971 gas chimneys over 30,000 km2 areas during the reconnaissance survey in 2013-2014 .

Based on the occurrence and distribution pattern of gas chimneys, three morphological types have been identified in survey areas. Type A: Single, cylinder shaped chimney with about 200 to 400 m in diameter, randomly scattered on basin floors. Type A is common on the basin floor of the Oki trough, which is characterized by thick organic rich sediments. Gases are predominated by microbial methane. Type B: Composite, irregularly shaped blanking zone with horizontal area of about 500 m x 3,000 m, often occur in transition from slope to basin floors. Type C: Single to composite, cylinder shaped chimney with about 400 to 600 m in diameter, occurs on the crest zone of ridges and spurs along the faults. Type B has been identified by high-resolution AUV surveys on the slope area of the Oki trough, and is suspected to occur in the Tsushima basin and off Hidaka. Hydrate gases have not been collected and analyzed yet. Type C is characteristic in the Toyama (off Joetsu) and Mogami trough, which developed along the mobile belt of the eastern margin of Japan Sea. Inversion tectonics at around 5 to 2 Ma caused folding and reverse faulting to provide conduits for upward migration of deep seated thermogeni gases. Hydrate gases are either thermogenic or variable mixture of thermogenic and microbial. Distribution of the types and size of gas hydrate-bearing gas chimney structures provide fundamental constrains for the resource assessment of shallow gas hydrates.

Keywords: shallow gas hydrates, gas chimney, Oki trough