Evolution and collapse of gas hydrate system in the Joetsu basin, eastern margin of Japan Sea

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A series of gas hydrate cruises by T/R Umitaka-maru (Tokyo University of Marine Science and Technology) and R/V Natsushima (JAMSTEC) have recovered massive gas hydrate from surface sediments, observed massive and fractured gas hydrate exposed on the seafloor associated with bacterial mat and variable form of carbonate concretions, and have revealed that pockmarks are inactive, being filled by bioturbated and laminated muds, 600 m high methane plumes are composed of methane hydrate bubbles. The 2007 expedition has focused on mapping of methane seep and gas hydrate bearing fields on the Umitaka spur and Joetsu knoll. Methane plumes concentrate on and around mounds, 300-500 m in diameter and 20-30 m high on the crest zone of the spur and knoll. The mounds are considered to center the methane seep activities as gas hydrate bearing piston cores were often recovered from the mounds. Patchy bacterial mats and carbonates crusts and nodules usually cover the mounds. Seafloor on and around the hydrate mounds is classified into (1) monotonous mud flat with or without few benthos such as crabs and crams, (2) uneven mud flat with bacterial mats and occasional sponge and crams, (3) uneven, gently swelling mud flat with bacterial mats and carbonate concretions and crusts, and (4) mixed hard ground and uneven mud flat characterized by steep slopes and cliffs, crater-like depressions of 10-30 meters in diameter, thick pile of rubbles and cobbles of mud clast and carbonate concretions, and massive large block of gas hydrate exposed on steep cliff and slope. Class 1 covers wide zone around the mounds including the bottom of pockmarks, and Classes 2 and 3 on the slope and flanks of the hydrate mounds. Class 4 develop on the crest of the hydrate mounds. The rough topography of Class 4 has been formed by collapse and slope failure atop the hydrate mounds, triggered by break down and rising of gas hydrate deposits accumulated in surface sediments of the mounds. Massive blocks of gas hydrate are occasionally exposed on the wall of crater. Focused flow of methane and fluid migrations through gas chimney structures in the spur and knoll caused accumulation massive gas hydrate deposits in shallow sediments, and formed a domal mound by swelling hydrate deposits. Progressive accumulation of gas hydrate finally caused gravity imbalance in surface sediments, resulted in a break down and rising up of gas hydrate blocks into the water column. Development of Class 4 rough surface is not only an on-going process on the Umitaka spur and Joetsu knoll, but also ancient spectacular event in much bigger scale. Big pockmarks, 300-500 m in diameter and 30-50 m deep, must have been formed by collapse of the entire hydrate mounds probably caused by massive dissociation of subsurface gas hydrate due to the eustatic sea-level fall.