Methane Accumulation Contributing to Forming High Saturations of Methane Hydrate in Sandy Sediments

Takashi Uchida[1]; Amane Waseda[2]; Tetsuya Fujii[3]

[1] JAPEX Res Cntr; [2] JAPEX Research Center; [3] JOGMEC

Gas hydrates are widespread in many deep marine environments along continental margins worldwide as well as in several Arctic sedimentary basins associated with permafrost zone. The geological and geophysical evaluations have suggested world-wide methane contents in gas hydrate beneath deep sea floors as well as permafrost-related zones to about twice the total reserves of conventional and unconventional hydrocarbon.

In 1998 and 2002 Mallik wells were drilled in the Canadian Arctic that clarified the characteristics of gas hydrate-concentrated sandy layers at depths from 890 to 1110 m beneath the permafrost zone. Continuous downhole well log data, anomalies of chloride contents in pore waters, core temperature depression as well as visible gas hydrates have confirmed the highly saturated pore-space hydrate as intergranular pore filling, whose saturations are evaluated higher than 80% in pore volume. In the Nankai Trough forearc basins and accretionary prisms developed and BSRs (bottom simulating reflectors) have been recognized widely, where the multiple wells were drilled in 2000 and 2004, and revealed the presence of pore-space hydrate in sandy layers. It is remarked that there are many similar features in appearance and characteristics between the Mallik and Nankai Trough areas with observations of well-interconnected and highly saturated pore-space hydrate.

High concentration of gas hydrate may need original pore space large enough to occur within a host sandy sediment, and this appears to be a similar mode for conventional petroleum accumulations. The distribution of a porous and coarser-grained sandy sediments should be one of the most important factors controlling occurrences and distributions of gas hydrate, as well as physicochemical conditions. Supplying methane for forming deep marine gas hydrate is commonly attributed to microbial conversion of organic material within the zone of stability or to migration of methane-containing fluids from a deeper source area. Pore water flows are considered to a macroscopic migration through faults/fractures and a microscopic flow in intergranular pore systems of sediment.

Based on the geochemical and geological data, gas migration processes are estimated to be active flow to permeable sandy layers in the Nankai Trough, and long migration of thermogenic gas generated in deeper mature sediments through faults in the Mackenzie Delta. It should be noted that there are many similar features in appearance and occurrence between the terrestrial and the deep marine environments with observations of well-interconnected and highly saturated pore-space hydrate within sandy sediments. Distributions of porous and coarser-grained host rocks should be one of the important factors to control the occurrence of gas hydrate, as well as physicochemical conditions.

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