The Influences of Clay Minerals on Methane Hydrate Formation

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Natural gas hydrates exist in sediment, either filling sediment pores or locally aggregated as nodular or massive hydrate. The elucidation of the role of the sediment matrix on gas hydrate formation is crucial to understanding the formation mechanism and accumulation of gas hydrate in natural environments. Clay minerals are common constituents of natural sediments. From the results of field and laboratory investigations, as well as theoretical studies, clay minerals are likely to play an important role in controlling the occurrence of natural gas hydrate. However the mechanism of how clay minerals affect hydrate formation is still not well understood. Present research aims at elucidating the role of clay minerals in hydrate formation through experimental investigations.

Three types of clays typical of natural sediments have been selected as the test materials: Na-montmorillonite, Ca-montmorillonite, and Kaolinite. Na-montmorillonite and Ca-montmorillonite are 2:1 types, among which interlayer distances (d-spacing) of Na-montmorillonite and Ca-montmorillonite can increase when soaked in water, while the former has much stronger swelling ability than the latter. Kaolinite is 1:1 type, not able to expand its interlayer distance. For the purpose of comparison, quartz was also tested.

The results of the P-T stability conditions of methane hydrate in various water-saturated clay minerals, indicated that Ca-montmorillonite and kaolinite are thermodynamic inhibitors for methane hydrate formation, shifting the stability conditions to a regime of relatively lower temperature and higher pressure, while in situ observations on methane hydrate formation in clay minerals by MRI (Magnetic Resonance Imaging) found that clay minerals are kinetic promoters of methane hydrate formation, shortening the induction time greatly as compared to quartz sand.

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