Methanol produced by natural radiation in metahane hydrate

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Methane hydrate, a clathrate compound of water molecule surrounding a methane molecules, exists in permafrost region and deep-sea floor sediments that usually contain natural radioisotopes such as ^{40}K, U and Th-series radionuclides as sources of alpha-, beta- and gamma- rays. These radiations detach hydrogen from methane and water molecules and form methyl radicals, hydrogen atoms and hydroxyl radicals. Methyl radicals and hydrogen atoms were observed in synthetic methane hydrate after gamma-ray irradiation at 77 K (Takeya et al. 2004). Methyl radicals, even in most stable radicals among them, decreased around 230 K at 10 MPa and changed into ethane by dimerization (Ishikawa et al. 2007). However, hydroxyl radicals, major radicals in ice after gamma-irradiation, were not detected in methane hydrate at 77K. Hydroxyl radicals may be mush unstable in gas hydrate and generate methanol by reaction with methyl radicals or methane molecules. In this study, we investigate whether methanol is formed in synthetic methane hydrate by gamma-ray irradiation.

Synthetic methane hydrate was irradiated by gamma-rays at 77 K and dissociated in a high pressure vessel. After methane gas was evacuated, the vessel was heated to 75^{o}C, which is over boiling temperature of methanol. Nitrogen gas was supplied into the vessel to degas small amount of methanol. Gas (mixture of nitrogen, water and methanol) was supplied into the gas cell settled in Fourier Transform Infrared (FTIR) spectroscopy. Methanol peaks are observed in gamma- irradiated methane hydrate, and are not in unirradiated one. Hydroxyl radicals change into methanol in methane hydrate even at 77 K, because they are not observed at 77 K by electron spin resonance (ESR).