# Experimental study on the stability and decomposition mechanism of methane hydrate under high pressure and high temperature

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Methane hydrate (MH) is thought to be an important constituent of icy planets and their satellites, such as Neptune and Titan. It is a clathrate compound composed of hydrogen-bonded water cages (host) and molecules or atoms (guests) included in the cages. MH has an sI cage structure at low (< 0.8 GPa) pressures and room temperature. It transforms to an sH cage structure at approximately 0.8 GPa, which further transforms to a filled-ice Ih structure at approximately 1.8 GPa. The Ih structure consists of an ice framework similar to ice Ih and voids that are filled with methane molecules [1,2]. Although the sequence of the phase transitions with pressure have been studied well at room temperature, there are only a few studies that addressed the stability of MH under high pressure and high temperature [3,4].

In this study, we carefully investigated the stability and decomposition mechanism of MH in an externally-heated-diamond anvil cell in the range of 2-51 GPa and 298-653 K using in-situ Raman spectroscopy. The results show that MH decomposes to ice VII and solid methane at temperatures considerably lower than the melting curves of solid methane and ice VII in the pressure range of 2-51 GPa. The present results are important not only for understanding the physicochemical properties of gas hydrate but also for investigating the internal structure of icy bodies.

[1] Loveday *et al*., *Nature*. **410**, 661 (2001)[2] Shimizu *et al*., *J. Phys. Chem. B*. **106**, 30 (2002)[3] Bezacier *et al*. *Phys. Earth Planetary interior*s **229**, 144 (2014) [4] Kurnosov *et al*. *Z. Naturforsch*. **61b**, 1573 (2006)