



## **Stability and structure of methane clathrate hydrates under pressure: implications for Titan's cryovolcanism.**

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Intense photochemistry within Titan's atmosphere does not allow methane to remain stable over a few tens of Myrs, therefore implying replenishment processes. Methane clathrate hydrates (MH) are the most likely internal methane reservoir. Accurate experimental constraints on MH structure and on dissociation processes are needed for understanding cryovolcanic processes on Titan.

New high pressure experiments on the  $\text{H}_2\text{O}-\text{CH}_4$  system have been conducted for investigating MH structure and stability under pressure. They were performed on an optical sapphire-anvil cell within a nitrogen-cooled cryostat, which allows real-time observation of the sample and in-situ Raman spectroscopy measurements. Pressure and temperature of exploration are within the range [0-1.5 GPa, 77-320 K], relevant to cryovolcanic processes.

This experimental study focuses mostly on the unexpected structure II (sII) MH, which was reported in previous works. New results on MH Raman signature and structure were obtained. They show that sII MH generally crystallize when amounts of methane are too high to allow crystallization of sI MH, the latter having higher water contents.

It will be shown that metastable HP phases of methane clathrates can ascend up to the surface of Titan. In methane-rich zones in cryovolcanoes sII MH could be generated instead of the expected sI, for example during cryomagmas ascent and on the surface. Further studies are now in progress to investigate the effect of ammonia compound on MH stability. Indeed, this compound may be responsible for MH dissociation during the ascent in cryovolcanoes. Preliminary results on the ternary system  $\text{H}_2\text{O}-\text{CH}_4-\text{NH}_3$  as well as theoretical considerations on the role of the ammonia compounds will be presented.