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# Models of Titan's Evolution Constrained by Cassini Observations and Laboratory Experiments

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Photochemistry in the stratosphere of Saturn's moon Titan would remove the present-day atmospheric inventory of methane there in a time span of a few tens of millions of years. The first Cassini-Huygens observations ruled out the presence of extensive exposures of liquid hydrocarbons [1, 2, 3, 4], which means that methane must be derived from another source over Titan's history. Evolution models indicate that the destabilization of methane clathrate reservoir stored within Titan's crust and methane outgassing would naturally result from the cooling of Titan's interior, and may explain the present atmospheric abundance of methane [5]. The first High-resolution IR images taken by the VIMS instrument a few tens of minutes before closest approach on October 26th 2004 revealed the presence of a mesoscale structure interpreted as a cryovolcanic dome [1]. This observation supports the idea that methane is released from the interior through eruptive processes. Models of the internal dynamics of Titan's icy crust are currently developed to relate the observed geological structure, especially at high-resolution, to the thermal state of Titan's interior. The preliminary results suggest that thermal instabilities within the icy crust could induce dissociation of methane clathrate and would be favour by the presence of ammonia. Experimental and modelling work is now in progress to constrain the effect of ammonia on the dissociation of methane clathrate and on the thermal state of the crust. Ammonia is especially known to reduce the crystallization point of water and should help maintain part of the icy mantle liquid [6, 7]. The composition of Titan's surface can be retrieved from Huygens observations and VIMS, ISS and radar observations from the Cassini spacecraft. So far, the composition is still unknown [4]. Analysis of spectral data is actually in progress to possibly correlate the geological setting of the observed cryovolcanic region with any surface composition variation. This analysis includes the correction of the atmospheric contribution to the observed spectra and the acquisition of laboratory IR spectra of mixtures of potential surface materials (hydrocarbon ices, tholins, water ice, clathrate, hydrate etc.). More VIMS images will be acquired during 2006 and will allow us to provide new and useful information on Titan's surface evolution. The objective of our approach is to provide background supports to interpret the data collected by the Cassini-Huygens mission. In particular, our model and experimental data will allow interpreting the gravity measurements that will be performed later in the mission. The long term goal of our synergetic effort is to reconstruct the evolution of Titan's interior, surface and atmosphere and especially the fate of methane from the interior to the atmosphere. References:
[1] Sotin C. et al. (2005), Nature, 435, 786-789. [2] Elachi, C. et al. (2005) Science, 308, 970-974. [3] Porco C. C. et al. (2005), Nature 434, 159-168. [4] Tomasko, M. et al. (2005) Nature, 438, 765-778. [5] Tobie G. et al. (2006), Nature, in press; [6] Grasset O and J. Pargamin (2005), Planet. Space Sci. 53, 371-384. [7] Tobie, G et al. (2005) Icarus, 175, 496-502.