EPSC Abstracts
Vol. 10, EPSC2015-803, 2015
European Planetary Science Congress 2015

Enceladus' internal ocean constrained from Cassini gravity and topography data

Lefèvre, A (1), **G. Tobie** (1), G. Choblet (1), O. Cadek (2), G. Mitri (1), M. Massé (1), M. Behounkova (2); (1): Laboratoire de Planétologie et Géodynamique, Université de Nantes, CNRS, France (gabriel.tobie@univ-nantes.fr) (2) Department of Geophysics, Charles University in Prague, Czech Republic

Abstract

The intense activity at the south pole of Enceladus hints at an internal water reservoir. The detection of sodium and potassium salts (about 1%) in icy grains emanating from Enceladus' south polar faults [1] indicates that the plume source is most likely connected to a salty subsurface ocean. The recent discovery of silicon-rich particles originating from Enceladus further indicates that hydrothermal interactions is currently occurring at the base of the ocean, and that hydrothermal products are quickly transferred to the plume source [2]. Based on topography and gravity data collected by the Cassini spacecraft [3, 4], this depth of ice/ocean interface is estimated to about 30-40 km underneath the South Pole. However the depth of ocean/rock interface as well as the extension of the ocean still remains unconstrained.

In order to provide further constraints on the ocean configuration, we develop an interior structure model consisting of a rock core, an internal ocean and an ice shell, which satisfies simultaneously the observed gravity and shape data [3, 5]. Our modelling approach is comparable to the approach we used to interpret the data of Titan [6]. However, as large-amplitude deflections of the ice/ocean and ocean/rock interfaces are required to explain the data, we employ here a full (non-linearized) description of the gravity potential [e.g. 7]. By assuming that the gravity disturbance due to surface topography is compensated by ice/ocean and/or ice/rock deflection, we map the depth of the ice/ocean interface and constrain the size and shape of the rock core, thus providing constraints on the total volume and lateral extension of the internal ocean. Possible correlations with main geological units as well as implications for the thermal history of Enceladus will be discussed at the conference.

Acknowledgements

This research received funding from the European Research Council under the European Community's Seventh Framework Programme FP7/2007-2013 grant agreement 259285 and from the Région Pays de la Loire, JUPILOIRE, Connect Talent programme.

References

[1] Postberg F. et al.: A salt-water reservoir as the source of a compositionally stratified plume on Enceladus, Nature, 474, 620-622 (2011).

[2] Hsu, H-W. et al.: Ongoing hydrothermal activities within Enceladus, Nature, 519, 207-210 (2015).

[3] Iess, L. et al.: The gravity field and interior structure of Enceladus, Science, 344, 78-80 (2014).

[4] McKinnon, W. B.: Effect of Enceladus' rapid synchronous spin on interpretation of Cassini gravity, Geophys. Res. Lett., in press.

[5] Nimmo, F. et al.: Geophysical implications of the long-wavelength topography of the Saturnian satellites, J. Geophys. Res., 116, E1101 (2011).

[6] Lefevre, A. et al. Structure and dynamics of Titan's outer icy shell constrained from Cassini data, Icarus, 237, 16-28 (2014).

[7] Martinec, Z.: The density contrast at the Mohorovicic discontinuity, Geophy. J. Int., 117, 539-544 (1994).