Geophysical Research Abstracts
Vol. 19, EGU2017-4455, 2017
EGU General Assembly 2017

Heat transport in the high-pressure ice mantle of large icy moons

Gael Choblet (1), Gabriel Tobie (1), Christophe Sotin (2), Klara Kalousova (2), and Olivier Grasset (1)

(1) UMR - CNRS 6112 LPGN, Nantes, France (gael.choblet@univ-nantes.fr), (2) et Propulsion Laboratory, Caltech, Pasadena, CA, USA

While the existence of a buried ocean sandwiched between surface ice and high-pressure (HP) polymorphs of ice emerges as the most plausible structure for the hundreds-of-kilometers thick hydrospheres within large icy moons of the Solar System (Ganymede, Callisto, Titan), little is known about the thermal structure of the deep HP ice mantle and its dynamics, possibly involving melt production and extraction. This has major implications for the thermal history of these objects as well as on the habitability of their ocean as the HP ice mantle is presumed to limit chemical transport from the rock component to the ocean. Here, we describe 3D spherical simulations of subsolidus thermal convection tailored to the specific structure of the HP ice mantle of large icy moons. Melt production is monitored and melt transport is simplified by assuming instantaneous extraction to the ocean above. The two controlling parameters for these models are the rheology of ice VI and the heat flux from the rock core. Reasonable end-members are considered for both parameters as disagreement remains on the former (especially the pressure effect on viscosity) and as the latter is expected to vary significantly during the moon's history. We show that the heat power produced by radioactive decay within the rock core is mainly transported through the HP ice mantle by melt extraction to the ocean, with most of the melt produced directly above the rock/water interface. While the average temperature in the bulk of the HP ice mantle is always relatively cool when compared to the value at the interface with the rock core ($\sim$ 5 K above the value at the surface of the HP ice mantle), maximum temperatures at all depths are close to the melting point, often leading to the interconnection of a melt path via hot convective plume conduits throughout the HP ice mantle. Overall, we predict long periods of time during these moons' history where water generated in contact with the rock core is transported to the above ocean.