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Onset of convection and differentiation in the hydrated cores of icy moons.

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The Galileo mission to Jupiter and the Cassini/Huygens mission to Saturn have revealed that the three large Jovian icy moons and Titan, Saturn's largest satellite, are at least partly differentiated. Their normalized moments of inertia are smaller than 2/5, which is the value for undifferentiated moons.

We present new simulations of the thermal evolution, dehydration process, differentiation, and onset of convection in the hydrated cores of large icy satellites. The motivation is to investigate whether convection can start before dehydration starts in the cores. Such a process would prevent differentiation.

The viscosity of antigorite, the hydrated silicate supposed to compose the hydrated cores, is strongly non-Newtonian and weakly temperature-dependent. The cores are volumetrically heated by natural radioactivity. We have adapted the theory developed for non-Newtonian fluids heated from below [1] to the case of volumetrically heated fluids. A recent review [2] of the physical parameters relevant to the thermal evolution of hydrated cores made of antigorite provides values quite different from those used in previous studies [3,4], which seriously modifies the results of previous simulations including the predicted present interior structure of the large icy satellites. The numerical simulations presented in this study suggest that the inner part of the hydrated core of icy moons would dehydrate for a large range of parameters, the most important of which is the amount of 40K. The outer core would remain hydrated. It is shown that convection could start in the outer core for large values of internal heating. Implications for subsequent thermal evolution are being investigated.

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