STRENGTH IN THE LITOSPHERE OF A SMALL ICY SATELLITE

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The satellites of Saturn underwent different thermal and structural histories. The presence of an internal activity acting on a long time scale is revealed by the different types of geological processes that have modeled the surfaces of the satellites. The differences among the surfaces of the Saturnian satellites can be related to the duration of subsolidus convection in their interior with the possible melting of minor volatile constituent. Parameterized convection has up to date been used to investigate the thermal and structural evolution of the Saturnian icy moons (1)(2). Christensen (3,4,5,6,7) has shown that the use of parametrized convection when the medium is characterized by large viscosity contrast can produce not realistic results. Moreover through this approach no information can be obtained on stress intensities and distribution, that have to be known if the possibility of fracturing and rifting the lithosphere has to be investigated. Here we briefly report some results on the thermal history of a Dione-like icy satellite of Saturn, with a radius of 560 km. In obtaining these results, we have used a finite element method to model 2D convection of an incompressible fluid in a spherical object of infinite Prandtl number, Boussinesq fluid with variable viscosity. The global flow structure and heat transfer as well as the stress intensities have been estimated. The body is a homogeneous mixture of ice and rock and the heat sources include gravitational energy released during satellite formation (accretional heat) and radioactive decay of long lived radionuclides (U, Th, K). We have selected a Dione-like satellite because its mass and density imply a reasonable amount of radioactive sources. We have mainly focused our attention on the thermal and stress histories. In that way we hope to explain some of the geological features that have been observed on satellites like Dione. During the growth, the satellite is heated up because in an impact a fraction of the impact kinetic energy is irreversibly trapped in the growing embryo (2),(8). Melting temperature of water ice is not reached but initial temperatures above the eutectic temperature of ammonia hydrate (about 175 K) are reached. The model we run has a 'Newtonian analogue' viscosity whose values in the range of temperature and pressure of our interest are also in agreement with recent results on the relaxation of impact basins on icy satellites (9). It is to be noted that the choice of the viscosity critically influence the value of the stresses. In any case it is interesting to have some insight on the behaviour of the stress trajectories. The horizontally averaged temperature profiles at different times are such that as the time goes on, the inner temperatures rise and a