Bulletin of Glaciological Research 26 (2008) *23–32*

Simulation of cryovolcanism on Saturn's moon Enceladus with the Green-Naghdi theory of thermoelasticity

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(Received April 7, 2008; Revised manuscript accepted August 10, 2008)

Abstract

In 2005, the Cassini spacecraft proved the existence of cryovolcanism, *i.e.,* the icy counterpart of volcanism on Earth, on Saturn's moon Enceladus during its close fly-bys. In particular, water-rich plume venting was discovered in the south polar region. Thus, Enceladus was found to be one out of three outer solar bodies to be geologically active. This contribution is concerned with the modelling and computation of this phenomenon. For the underlying thermoelastic description of ice at cryogenic temperatures, we resort to the Green-Naghdi approach. The Green-Naghdi theory includes the classical Fourier approach, but, in addition to that, it is a lot more general as it also allows for other types of heat propagation. The numerical implementation is carried out with the help of the finite element method. Results show that lateral spreading of internal and surface warming away from an active volcanic vent increases strongly with increasing contribution of the non-classical heat flux. Agreement with available high-resolution surface temperature data based on infrared spectrometry seems to be best if the non-classical heat flux contributes significantly to the total heat transport. Complementary laboratory studies would be required in order to strengthen this speculative, yet promising idea.