Geophysical Research Abstracts
Vol. 12, EGU2010-11661, 2010
EGU General Assembly 2010


# Effect of Ice Anelasticity on Europa's Tidal Response

Julie Castillo and Torrence Johnson

Jet Propulsion Laboratory / CalTech, 3224 M/S 79-24, Pasadena, United States (Julie.C.Castillo@jpl.nasa.gov)

Most models of Europa's tidal response have been based on the assumption that Europa behaves as a Maxwell body. However, the Maxwell model is inadequate at reproducing the response of planetary material to cyclic stressing because it does not account for anelasticity. For the conditions of temperature, and cyclic stressing and frequencies affecting planetary satellites, material anelasticity may dominate tidal response.

The attenuation spectrum of silicates has been much studied by means of laboratory experiments and theoretical models of ice microphysics. These studies indicate that the Andrade model provides a better representation for silicates viscoelastic and anelasticity. Research on planetary ices attenuation properties has received less support, especially from experimental work. However, available literature, relevant to terrestrial studies, suggests that the Andrade model also provides a good match to experimental measurement of ice attenuation properties. The present study will apply the Andrade model to the modeling of Europa's tidal response. This model will explore the range of possible parameters available on ice and rock properties, available in the literature. For the ice, the range of parameters will also be constrained by experimental work developed in the *Planetary Tides Simulation Facility* (PTSF – JPL). In that framework, the tidal response depends on cyclic stress, viscoelastic structure, and two parameters that account for the nature, density, and geometry of the material defects and the relaxation time of the material. Empirical relationships between these different parameters are being constrained with the PTSF experiment for dislocation-and grain boundary sliding- driven anelasticity.

From ranging a wide parameter space, we have determined conditions for which anelasticity becomes the dominant mechanism accommodating tidal stress and driving internal dissipation (tidal heating). Our survey of the parameter space indicates that ice anelasticity significantly impacts Europa's tidal response when the icy shell is thicker than 30 km. The amplitude of the added contribution is especially a function of the defect density, which in turns depends on the microstructural history of the planetary material. These preliminary modeling and experimental results highlight the importance of better quantifying the age of the icy shell, i.e., as a result of mechanical history, annealing processes, recrystallization, impurities segregation, etc. Although much insight can be gained from terrestrial studies, dedicated experiments on Europa-specific compositions need to be undertaken in order to decrease the space of possible parameters and increase the science return from future measurements by the *Europa and Jupiter System Mission.*

Acknowledgements: This work has been conducted at the Jet Propulsion Laboratory, California Institute of Technology, under contract with NASA. Government sponsorship acknowledged.