THE IMPORTANCE OF AN ELASTIC LITHOSPHERE FOR CRATER RETENTION ON ICY BODIES. Valerie J. Hillgren and H. J. Melosh, Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721.

The images returned by the Voyager spacecraft of the Galilean satellites provoked speculation as to whether viscous relaxation was an important process in the modification of impact basins on these bodies [1,2]. This previous work involved extrapolations of the flow law for ice from terrestrial conditions to the lower temperatures of the outer solar system. However, recently Kirby *et. al.* [3] have actually measured the viscous properties of ice at temperatures appropriate to the Galilean satellites.

The flow law parameters determined by Kirby *et. al.* make ice, even at extremely low temperatures, very soft, and when Thomas and Schubert [4] used these values to numerically model the relaxation of a 300 km basin on Ganymede, they obtained an unrealistically short relaxation time on the order of 10^7 years. In their model Thomas and Schubert treated ice as a purely viscous substance and ignored its elastic properties.

We have also numerically modeled the relaxation of basins on Ganymede. However, we have used a fully maxwell viscoelastic finite element code, and thus, have accounted for the elastic properties of ice. We modeled basins ranging in diameter from 50 km to 300 km, and using the flow law parameters defined by Kirby *et. al.* for at temperatures less than 195 K.

We also used a variety of different temperature gradients in order to determine the importantance of this factor compared to the presence of an elastic lithosphere in crater retention. The temperature profiles were conductive, with surface temperatures of 120, 130 , and 140 K, and heat production rates of either 50% or 70% chondritic. In addition linear temperature gradients of 10 K per kilometer with surface temperatures of 120 and 130 K were also used. All temperature profiles were held constant once they attained a value of 163 K (.6 of the melting temperature of ice) under the assumption that convection would begin.

Finally, we used a Young's modulus of 1×10^{10} Pa which is appropriate to ice at very low temperatures. In order to investigate the role of the elastic lithosphere in viscous relaxation, we also performed calculations in which the Young's modulus was 1×10^9 and 1×10^8 Pa.

Figure 1 shows a plot of basin depth divided by original depth versus time for a 160 km diameter basin. In the these calculations, the heat source for the temperature gradient was 50% chondritic, and the surface temperature was 120 K. Each curve represents the results of a calculation for a different Young's modulus. The crater with a Young's modulus of 1×10^{10} Pa has relaxed very little at the end of 4 Ga. While in sharp contrast, the crater with a Young's modulus of 1×10^8 Pa has relaxed significantly after 4 Ga. This relationship holds true for basins of all sizes. Thus, the elastic properties of ice play a significant role in crater retention.

Figure 2 illustrates that the temperature gradient has little effect on the relaxation history. The plot shows basin depth divided by original basin depth versus time for a 300 km diameter basin with a Young's modulus of $1\text{x}10^{10}$ Pa subjected to a variety of temperature gradients. Very little difference exists between the curves. This holds true for all basin sizes, and demonstrates that the the elastic properties of ice are more important than temperature gradient in crater retention.

These results indicate that no appeal to special circumstances need be made to explain the observed crater populations on Ganymede and Callisto. Instead, an elastic lithosphere can easily account for the existence of large basins on these bodies.

Refences: [1] Passey,Q.R. and E.M. Shoemaker (1982) in Satellites of Jupiter, U of Az Press, Tucson, pp. 379-434. [2] Croft, S.K. (1983) *Abstracts of LPSC XIV*, pp. 136-137. [3] Kirby, S. H. et. al. (1987) *Journal De Physique,* 48, pp. 227-232. [4] Thomas, P. J. and G. Schubert (1988) *JGR*, 93, pp. 13,755-13,762.

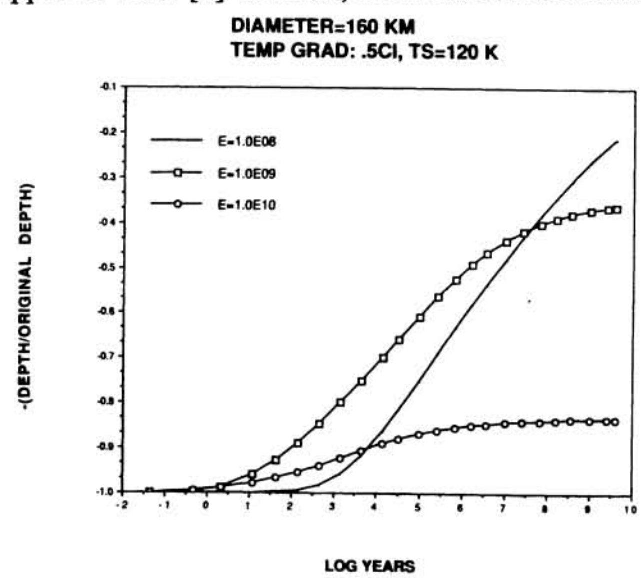

Figure 1: See text for explanation

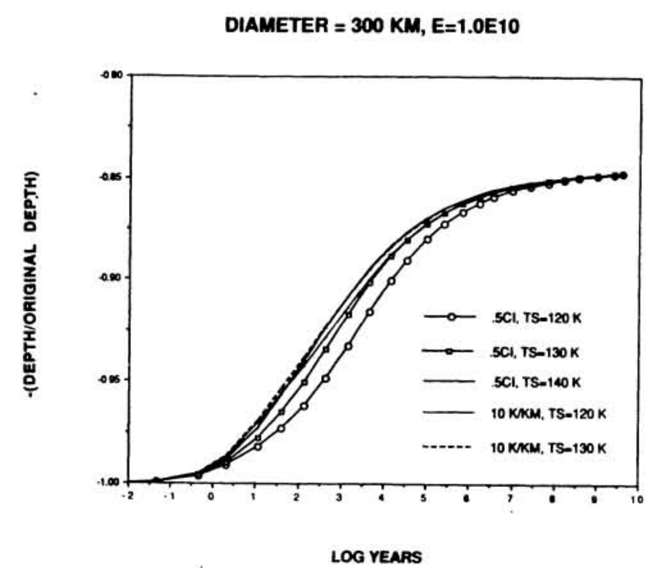

Figure 2: see text for explanation