SIMPLE-TO-COMPLEX CRATER TRANSITION DIAMETERS ON THE ICY SATELLITES OF URANUS AND SATURN; Paul M. Schenk, Department of Earth and Planetary Sciences and McDonnell Center for the Space Sciences, Washington University, Saint Louis, MO 63130.

The role of gravity in the crater modification process has been debated for some time [eg. 1, 2]. The most diagnostic indicator of crater modification is the transition diameter from simple bowl-shaped craters to complex craters with central peaks and wall terraces. Morphologic criteria for transition diameter include the deflection in crater depth/diameter (d/D) curves and the 50% occurrence of central peaks as a function of diameter, both of which can be determined on the icy satellites from Voyager images. Determination of transition diameters on the cratered intermediate-sized Uranian and Saturnian satellites permits testing of the inverse gravity trend of transition diameter for the silicate planets [1], on bodies with substantially lower gravity than previously studied.

Central peak transition diameters for Jovian and Saturnian satellites (Fig. 1) have been reported previously [3]. These data indicate an inverse trend of transition diameter with surface gravity. This trend is substantially below that of the terrestrial planets [1]. Ariel is the only Uranian satellite for which central peak statistics can be compiled (Fig. 1). Simple craters are not truly resolved on Umbriel, Titania and Oberon and complex craters are not seen on Miranda, so that only upper and lower limits, respectively, can be determined on these satellites (Fig. 1). Ariel, as well as the limits for the other satellites, are all consistent with the trend observed for Jovian and Saturnian satellites (Fig. 1). The apparent identification of a 90 km wide bowl-shaped crater on Amalthea ($g \sim 10$ gm/cc; [4]) is consistent with the trend of the terrestrial planets and hence a silicate composition for this satellite.

Transition diameters have been determined on Mimas, Rhea, Dione, and Ariel (Fig. 2) from d/D curves (see [5] for a description of these data). These are the only satellites for which reliable depth measurements of both simple and complex craters can be made. Transition diameters are inferred for Umbriel, Titania and Oberon by assuming the d/D curve of simple craters on Ariel. Because of differences in resolution between the data sets, these transition diameters are probably underestimated. These results confirm those based on central peak statistics (Fig. 1). d/D transition diameters are slightly smaller than central peak transition diameters, as is the case with terrestrial data [1].

The inverse gravity trend of transition diameters for the icy satellites, but at substantially lower diameters than the trend observed for the silicate planets, indicates that crater modification, while strongly controlled by gravity, is fundamentally different in ice and silicates. Complex crater formation on the icy satellites appears to be dominated by rebound (i.e., central peak development), rather than rim collapse (i.e., terrace formation) [5]. The degree of rebound of a crater is controlled primarily by the effective viscosity of the shocked material, according to [6]. The onset of central peak formation at substantially lower diameters than expected from simple extrapolation of the silicate planet trend indicates that the effective viscosity of shocked icy materials may be substantially lower than for shocked silicate materials. The similar but separate inverse gravity trend of transition diameters, coupled with the systematically shallow depths of simple craters and steep slope of complex crater d/D curves on the icy satellites [5] all indicate that differences in crater morphology and shape are most likely due not to projectile properties but to the inherently different mechanical and physical properties of ice relative to rock.

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TRANSITION DIAMETERS ON ICY SATELLITES

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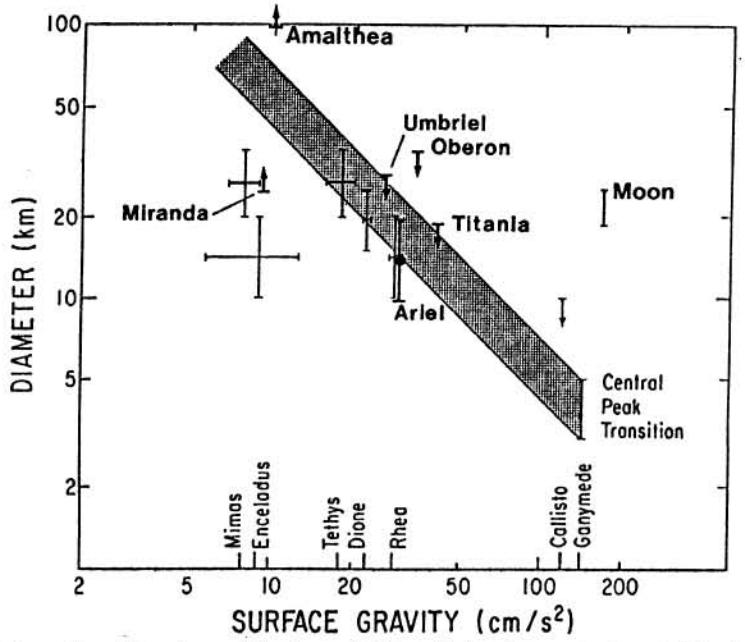

Figure 1. Central peak transition diameters of the icy satellites. Saturnian central peak data is from [3]. The stipled zone is the inverse gravity extrapolation of the Ganymede central peak data. The terrestrial inverse gravity trend [1] extends parallel to this through the Moon data point [1].

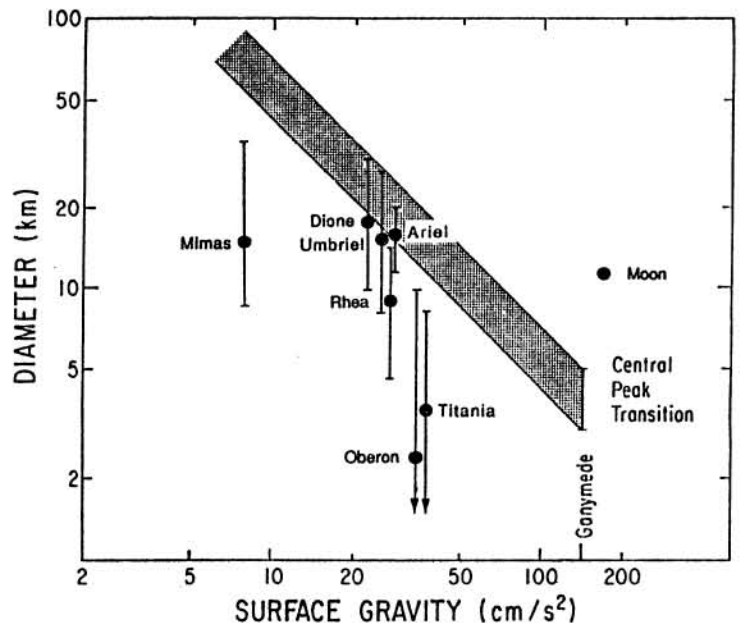

Figure 2. Depth/diameter transition diameters of the icy satellites. The stipled zone is the inverse gravity extrapolation of the Ganymede central peak data. The terrestrial inverse gravity trend [1] extends parallel to this through the Moon data point [1]. In both Figure 1 and 2, the transition diameters for Mimas (and Enceladus) are below the general trend, and are discussed in [3].