IMPORTANCE OF TARGET PROPERTIES ON PLANETARY IMPACT CRATERS, BOTH SIMPLE AND COMPLEX. P.M. Schenk, Lunar and Planetary Institute, Houston TX 77058 (schenk@lpi.usra.edu)

Introduction: For 20 years, the issue of whether surface gravity or target properties control the shape of planetary craters has continued unabated. Periodic revisions to and questions about quality control of the planetary crater database have vexed the debate. Here I review the current status of the observations and our understanding of the results. The observational data fall into two related categories: crater depths, and morphologic transitions from one landform to another. As it turns out there is more than one way to measure these transitions. It would appear that both target gravity and properties are important.

Silicate Planets: Pike [1] made one of the first attempts to compare crater morphology on the silicate terrestrial planets, using data from the Moon, Mars and Mercury. The effort to sort out the relative importance of surface gravity and target properties (i.e., crustal strength) is complicated by the small number of such bodies for which we have data (5) and the influence of other forces. Three of these bodies (Earth, Venus, and Mars) have substantial atmospheres, which may couple to the ejecta curtain and alter landforms [2]. Earth and Mars have been subject to substantial surface erosion and modification, and crater data for Earth, which together with Venus represent the high-gravity end of the spectrum, is wholly unreliable. Magellan stereo allows depth measurements to be made [3] but the dense atmosphere prevents the formation of simple craters (by assuming lunar-like simple crater morphology, an estimate of transition diameters can be made).

Although there is clearly a general inverse trend of transition diameters with gravity from the Moon to the other higher-gravity bodies, the result of these competing forces is something akin to confusion. There appear to be major differences in morphology on Mercury and Mars, where surface gravity is otherwise similar. Pike [1] reports significant differences in the depths and transition diameters of craters on the lunar mare and on the highlands. This points to an important role for material properties, with the regolith rich highlands have a different strength than the less heavily cratered basaltic mare. Additional evidence for or against the influence of layering or rock type will be reviewed, including the latest MGS results.

Icy Satellites: The icy satellites of the outer planets are a different ball of ice. There are at least a dozen such moons for which we have data and which have complex craters. They are also of sufficiently different size that a large gravity range can be examined. Chapman and McKinnon [4] and Schenk [5] made the first satellites comparisons, suggesting that in fact there was a strong dependence of complex crater depths and transition diameters on surface gravity, but also, that these were significantly smaller than would be expected from comparison with silicate-rich planets. These observations were based on Voyager data, but subsequent Galileo data has shown that the Ganymede data was partially compromised by resolution insufficient to resolve simple craters. Callisto and Europa have also been added. The updated transitions and depths [6] clearly show that the icy satellites all fall on a g^{-1} trend. The only exceptions are Enceladus and Mimas. Enceladus craters are very irregular even by icy satellite standards and it is likely that these craters have been modified, possibly by volcanism [7]. Mimas remains to be explained, but unusually low internal porosity conditions may or may not be involved.

The unusual complex crater landforms on the larger icy satellites, especially Europa, may point to the importance of thin lithospheres and possibly liquid layers at shallow depths [6,8]. These morphologies and their dimensions provide key constraints that can be used to model icy satellite interiors [9].

Future Shock: On silicate bodies, additional data at the low end of the gravity spectrum is needed. All asteroids observed to date are too small to allow complex crater formation. The Dawn mission to Vesta and Ceres will be important for adding rocky bodies of low to moderate gravity to the data set, and indeed I will venture a prediction as to transition diameters on these bodies. Until then, the case of the silicate planets remains uncertain. For the icy satellites, a better understanding of the internal structure of Mimas is required. We might see something unexpected on two-faced Iapetus. There is also some scatter in the small saturnian satellite data which could use clearing up. Mapping of crater morphology on Titan, similar in size to Ganymede and Callisto, will be useful for comparison, although the atmosphere there may cloud the issue. Cassini beginning in 2004 should address these needs. It is curious that we do not see substantial differences between those satellites believed to be mostly water ice, and those with more exotic (and lower strength) ices such as ammonia, carbon dioxide and nitrogen (e.g., Ariel, Miranda and Triton). Pluto and other Kuiper Belt objects may be much richer in these ices and could behave differently. We have only a decade to wait (hopefully)!

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