MARTIAN CENTRAL PIT CRATERS: CHARACTERISTICS, DISTRIBUTION, AND COMPARISON WITH CENTRAL PIT CRATERS ON GANYMEDE. N. G. Barlow, Department of Physics and Astronomy, Northern Arizona University, NAU Box 6010, Flagstaff, AZ 86011-6010. Nadine.Barlow@nau.edu.

Introduction: Impact craters with central pits are common on Mars and icy moons but are rare on volatile-poor bodies such as the Moon. Their presence on volatile-rich bodies has led to the theory that central pits form from explosive release of gases produced by shock vaporization of subsurface ice during crater formation [1]. Recent numerical modeling of impacts into ice-silicate mixtures reveals shock-produced temperatures in excess of the ice vaporization point near the crater center [2]. Release of the resulting gases could produce the observed central pit structures. However, many questions remain about central pit craters, including why craters with central pits are often adjacent to craters of similar size and preservational age which do not display a central pit In an attempt to gain a better understanding of the conditions under which central pits form, we are conducting a comparison study of central pit craters on Mars and Ganymede.

Martian Central Pit Craters: We have utilized THEMIS VIS and daytime IR data to identify central pits on Mars [3]. To date we have identified ~1500 central pit craters, which are divided into floor pits (pit lies directly on the crater floor) and summit pits (pit lies atop a central rise/peak) (Fig. 1). Floor pits are approximately twice as common as summit pits (67% vs 33%, respectively) based on morphologic analysis—we are just beginning to utilize MOLA topography to determine if floor pits lie on the flat floor or a central rise/dome.

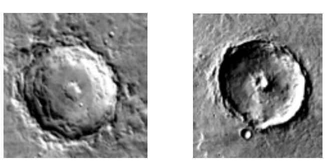

Figure 1: Examples of martian central pit craters. Floor pit (left) and summit pit (right).

We have seen no statistically significant difference in the latitudinal distribution of floor pit craters versus summit pit craters: floor pits are seen between 51°N and 69°S while summit pits occur between 46°N and 67°S (higher latitudes have not been completely surveyed yet). Most pit craters occur on Noachian-aged highlands units, although some are seen on younger terrains. Floor pits tend to dominate over summit pits on Hesperian and Amazonian terrains (Fig. 2)

There is no strong correlation between type of pit and crater diameter. Floor pits are found in craters ranging in diameter from 5 to 57 km. Summit pits are seen in craters over a similar diameter range: 6 to 49 km. Based on depth-diameter relationships, the lower diameter limit implies that these craters are excavating to depths of at least 500 m.

We have compared pit diameter (D_p) to crater diameter (D_c) (Fig. 3) and find that floor pits have D_p/D_c between 0.07 and 0.28, with a median of 0.15. Summit pits are smaller relative to their parent craters, with D_p/D_c ranging between 0.05 and 0.19 and a median of 0.11. We are currently using MOLA topography and shadow length measurements to estimate depths of these pits and determine a pit d/D relationship. This in turn will provide insights into the origination depth of the vapor producing the central pit, which will then be compared with numerical models.

Central pits are associated with craters in a wide range of preservation, indicating that conditions producing central pits have existed over most of martian history. Preservation class ranges from very degraded (2.0) to pristine (7.0), based on the preservation scale of [4]. Of those central pit craters still retaining an identifiable ejecta blanket, most are associated with a multiple-layer ejecta (MLE) morphology, suggesting that the process that produces MLE also preferentially produces central pits. However, many MLE craters do not contain a central pit, suggesting that additional conditions must be met for central pit formation..

Ganymede Central Pit Craters: Impact craters on Ganymede display similarities to martian impact craters in ejecta and interior features. In particular, some Ganymede craters display layered ejecta morphologies similar to those seen on Mars [5, 6] and many display central pits [7, 8]. Both of these features have been proposed to result from impact into volatile-rich targets. We are conducting a survey of Ganymede impact craters using Galileo SSI and Voyager imagery [9, 10]. We are comparing ejecta and central pit results between Ganymede and Mars to better understand the relative roles of ice versus ice-silicate targets in creating these features.

To date our analysis has identified ~350 central pit craters [8, 10]. Our early results, focused around the Galileo Region region, suggested that pit craters were concentrated on low-albedo units, suggesting that some proportion of silicates needed to be mixed into the ice to produce the pits [8]. However, our more extensive survey does not replicate this initial trend. For example, we have surveyed the western part of the Perrine (Jg-2) quadrangle (0°-51°N, 45°-90°W) using Galileo imagery. We identified 38 central pit craters within this region, of which 21 were on bright terrain and 17 were on dark. Although this is a small sample, it suggests that the high concentration of central pit craters on low-albedo Galileo Region may not be indicative of the entire moon.

Thus far our analysis suggests that central pits occur in larger craters on Ganymede than on Mars. Our analysis of the pit craters in the Perrine Quadrangle reveal that smaller craters can contain central pits on darker terrain (diameter range 28.8 to 84.1 km) than on bright terrain (41.5 to 92.7 km, but in neither case do we see central pits in craters as small as on Mars. However, this may be a resolution effect.

Central pit craters on dark terrain display similar D_p/D_c ratios to those on bright terrain (Fig. 4). On dark terrain, D_p/D_c ranges between 0.13 and 0.26, with an average value of 0.19. D_p/D_c for bright terrain ranges between 0.12 and 0.33, with an average value of 0.19.

Discussion of Preliminary Results for Central Pit Craters on Mars and Ganymede: Although our study of central pit craters on Mars and Ganymede is still in its early stages, we are already beginning to see some interesting differences. To date, we have not identified any obvious summit pit craters on Ganymede. However, most Ganymede pits occur on domed floors. This may result from floor rebound in the purer ice target on Ganymede.

Central pit craters are generally larger on Ganymede than on Mars, although resolution may be affecting these results at the smaller crater diameter end. Nevertheless, central pit craters are more common at larger crater diameters on Ganymede than on Mars. This may be due to ice extending to greater depths in Ganymede's crust. Average D_p/D_c values are slightly higher for Ganymede central pits than for Martian central pits, indicating that Ganymede pits tend to be slightly larger relative to their parent crater. The purer ice target, lower gravity, and/or thinner atmosphere on Ganymede are being investigated as possible explainations for this observation.

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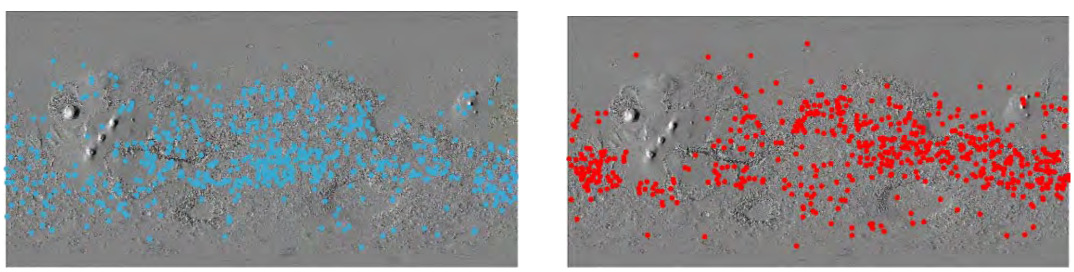

Figure 2: Distribution of floor pit craters (left, in blue) and summit pit craters (right, in red) on Mars.

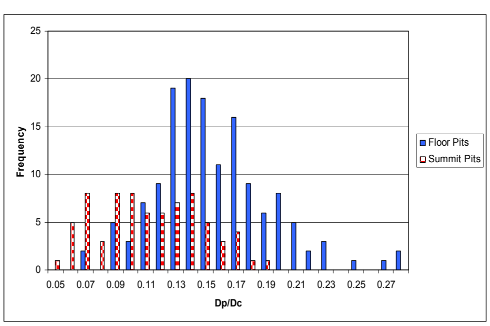

Figure 3: Comparison of pit diameter (D_p)-crater diameter (D_c) ratios for floor pits and summit pits on Mars.

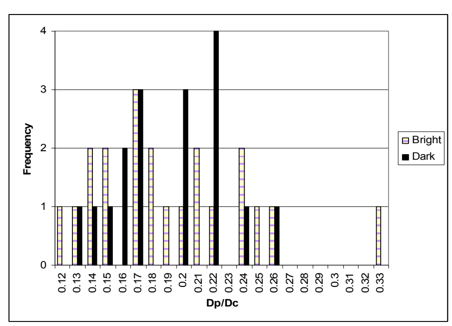

Figure 4. Comparison of D_p/D_c for bright and dark terrains on Ganymede.