INITIAL SURVEY OF WELL-PRESERVED MARTIAN CRATERS IN THE SOUTHERN HEMISPHERE IN THE SIMPLE-TO-COMPLEX TRANSITION.

R. R. Herrick, Geophysical Institute, University of Alaska Fairbanks, Fairbanks AK 99775-7320 (rrherrick@alaska.edu).

Introduction: For a given planetary surface, examining a family of impact craters of similar diameter is empirically the closest one can come to holding impact energy constant in order to test for the effects of varying target and impact conditions on final crater morphology. The variation in crater morphology can be maximized by examining differences between craters at diameters coincident with a global key morphological transition. In previous work, Herrick and Hynek [1] surveyed craters with $7 < D < 9$ km, a diameter range within the global transition from simple to complex craters. That work found no evidence that an impactor property (e.g., velocity, density) other than impact angle affects Martian crater morphology. Instead, we found a strong correlation between geologic setting and crater morphology. For example, deep, simple craters are located in areas with homogeneous, cohesive, near-surface lithology. Craters located in layered volcanic terrains have pseudoterraces, flat floors, and central pits.

The work of Herrick and Hynek [1] mostly focused on craters located in the northern hemisphere at low latitudes, which are predominately lightly cratered plains and volcanic provinces. Here I discuss initial results from a survey that I am conducting of $7 < D < 9$ km craters in the Martian southern hemisphere, a region dominated by highlands that are mostly older and more heavily cratered than northern terrains. Our starting point is the global database of Robbins and Hynek [2], which has 220 southern hemisphere craters with $7 < D < 9$ km in Preservation State 4 (most pristine). As is discussed in [1], because the database of [2] was compiled using a 100 m/pixel mosaic of daytime IR THEMIS images, certain aspects of a crater's classification are often revealed as incorrect when craters in this size range are examined with higher resolution images, such as the ~6 m/pixel CTX images. I have begun by using JMARS to reexamine these craters using CTX and HiRISE images. So far I have looked at about a quarter of these craters, sampling the full geographical extent of the southern hemisphere.

Results: Figure 1 shows examples of the crater forms that I have observed so far. A summary of my observations:

Tectonic control of crater shape – Only ~20% of the craters sampled have circular rim forms, and about half of those are in the portion of Tharsis that extends into the southern hemisphere. The other 80% have at least a portion of the rim that is straight and apparently tectonically controlled by some near-surface lateral discontinuity (Figure 1A,B,D). For about 1/3 of the craters,

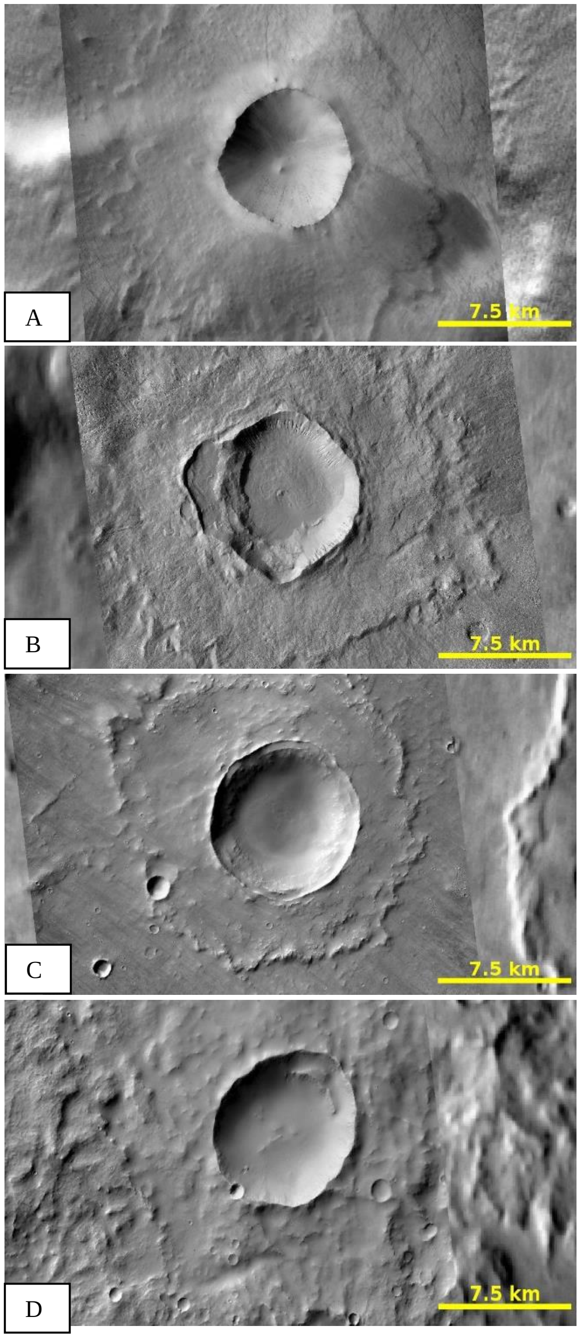

Figure 1 CTX frames of well-preserved southern hemisphere Martian craters with $7 < D < 9$ km in [2]. A) 115.694° W, 70.507° S. B) Talu, 20.1° E, 40.348° S. C) 69.494° W, 14.71° S. D) 130.131° E, 7.398° S.

nearly the entire perimeter of the rim is irregular and clearly structurally controlled. Only about 15% of the tectonically controlled craters look to have impacted onto a surface with a large topographic discontinuity (e.g., a basin rim), and often there is no obvious surface expression of a lateral discontinuity.

No simple craters – Traditionally a "simple" crater has a parabolic interior shape and a rim-floor depth of ~1/5 the crater diameter. For D = 8 km, this would be a rim-floor depth of 1.6 km, and craters this deep are common in portions of Utopia Planitia. So far I have not observed a single crater in the southern hemisphere with with $7 < D < 9$ km that has a rim-floor depth that exceeds 1 km, and the typical depths of these craters are 700 – 900 m. The craters for which the interior morphology could be clearly determined were a mix of transitional crater types, with ~40% having a central peak (Figure 1A,B), ~40% having a rugged topographically flat floor (Figure 1C), and ~20% having a central pit in the floor (Figure 1D). About 20% of the craters showed no obvious wall slumping or terracing (Figure 1A), and most of these smooth-walled craters had a central peak. About 25% of the craters had incipient terracing (slumped material that moved as a discrete block), and the remainder showed some slumping of wall material to the crater floor.

Lots of dust – Even though all of the craters examined are in the best-preserved degradation classification of [2], at CTX resolution they often appear to have more dust obscuring their features than northern hemisphere craters. Around 20% of the craters had enough interior fill that that I did not think the interior morphology could be adequately described, and these dust-filled craters were also generally shallow with rim-floor depths < 500 m.

Glacier-filled craters – About half of the craters that we observed between 30° and 40° S seem to have a younger, textured material filling the interior. This fill type has previously been studied and characterized as ice-rich material [3] that was proposed to have been deposited after crater formation through climatological processes. Figure 2 shows a stratigraphic sequence that illustrates that this fill postdates crater formation. A fresh-appearing crater excavated material that was deposited on the floor of a connected, older but reasonably well-preserved crater of similar size. The "glacial" fill then buries the floor of both craters, including the ejecta from the younger crater that is in the older crater.

Initial conclusions: I have identified no areas in the southern hemisphere with near-surface lithology well-enough consolidated or homogenous enough for impacts to produce a simple crater in the $7 < D < 9$ km size range. Lateral and vertical heterogeneity plays a major role in shaping the interiors of these craters. Patterns and associations with regional geology are emerging, and part of future analysis will be to evaluate the extent to which regional subsettings (e.g., proximity to Hellas basin) control final crater form. So far I have found little correlation between interior structure and the appearance of the ejecta blanket.

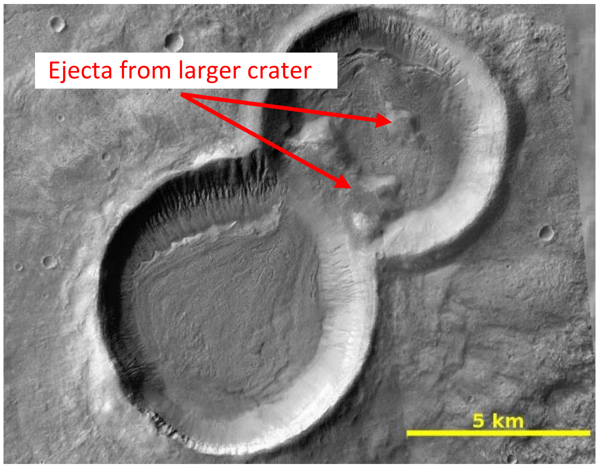

Figure 2 Crater pair at 157.361° W, 39.42° S. Floors of these relatively well-preserved craters have been covered by textured deposits interpreted as ice-rich by [3]. Larger, SW crater postdates the adjacent crater and deposited ejecta onto its floor. This ejecta is then superposed by the proposed ice-rich deposits, implying that the ice-rich deposits must postdate both craters.

References: [1] Herrick R. R. and Hynek B. M. (2017) *MAPS, 52*, 1722-1743. [2] Robbins S. J. and Hynek B. M. (2012) *JGRP, 117*, E05004. [3] Shean D. E. (2010) *GRL, 37*, L24202.