VARIATION IN IMPACT CRATER MORPHOLOGY AND PRESERVATION ON THE SOUTH POLAR LAYERED DEPOSITS, MARS. M. E. Landis[1], A. M. Stickle[2], E. G. Rivera-Valentín[3], [1]Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, CO (margaret.landis@lasp.colorado.edu), [2]Johns Hopkins University Applied Physics Laboratory, Laurel, MD, [3]Lunar and Planetary Institute (USRA), Houston, TX.

Introduction: The South Polar Layered Deposits (SPLD) on Mars represent the larger of the two surface ice sheets that combined contain approximately the same volume as the Greenland ice sheet ([1], and references therein). This large volume of water ice is key to understanding the long-term water supply to the martian atmosphere, including changes in climate in the recent past (e.g., [2]). However, while the surface of the North Polar Layered Deposits (NPLD) provides evidence for clear climate changes or resurfacing events in the geologically recent past (e.g., [3-5]), the geologic history and, more fundamentally, surface age of the SPLD is not well constrained. Estimates range from a few hundred thousand years to Myrs, depending on the size of craters counted and crater production function used to interpret the results [6-8]. Recent small impacts on the SPLD also indicate that the upper few meters of the SPLD in some locations may be composed primarily of dust or very dusty-ice [9], suggesting that a long-term hiatus in accumulation may be occurring.

Here, we present initial morphology results from a larger project developing and interpreting a crater catalog for the SPLD. The impact crater size-frequency distribution from diameters alone is important for quantifying surface ages; however, our initial mapping of craters suggests that the morphologies of craters on the SPLD vary more widely than on the NPLD and may contain key data in understanding the geologic history of the SPLD's enigmatic surface.

Geologic Context: The SPLD surface was divided into two geologic units, Planum Australe 1 (Aa1) and Planum Australe 2 (Aa2) by [10]. Aa2 includes most of the SPLD surface, including in the region of interest from which we are presenting crater morphologies (Fig. 1). Aa1 underlies Aa2 and makes up the geologic unit containing the troughs near the South Pole Residual Cap (SPRC) and a significant portion of Promethei Lingula (~80-85° S, ~110° E). New small impacts into the SPLD [9] also occur in the Aa2 region, suggesting that the upper few meters of material in the Aa2 region are dominated by lower-albedo, dusty material.

Data and methods: We use Mars Reconnaissance Orbiter (MRO) Context Camera (CTX) data from solar longitude (Ls) 230° to 10° the subsequent Mars Year. CTX images were binned to 6 m/pixel resolution. CTX data covers most of the SPLD in this seasonal time frame, with gaps in coverage occurring outside the area from which we present craters (Figure 1).

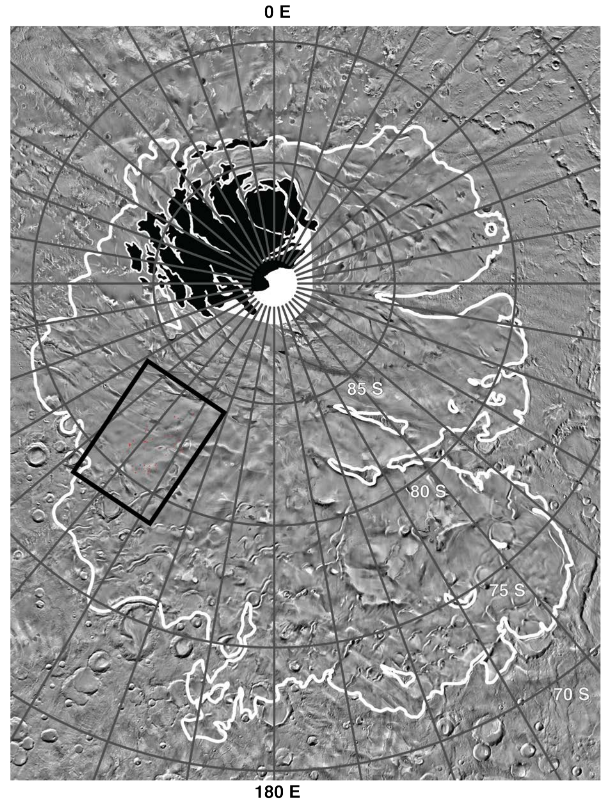

Figure 1. Map of the South Polar Layered Deposit extent (white line) from the Scott and Tanaka (1999) map of the polar regions of Mars, shown on the background of a THEMIS day infrared 100 m/pixel mosaic from [11]. The black box indicates the range of locations where example craters were selected from in Fig. 2

Crater Morphologies: The SPLD craters include simple craters, heavily modified craters with mass concentrations in the near-center regions, and craters where all but potentially the crater rims still exist. The fresher crater examples here tend to be smaller, which is expected given that most size-frequency distributions of impact craters in the inner solar system follow a power-law distribution as a function of diameter (e.g., [12]). Therefore, more small craters are generally expected, resulting in a wide distribution of crater ages and preservation states. One such example is shown in Figure 2a.

Other craters show examples of extensive modification, as well as some that reflect modification that also superposes surrounding terrain. In Figure 2b, where ridges cross-cut the rim of the crater. This indicates that this crater formed before modification of the SPLD surface generally stopped. These linear ridges are not completely consistent with those produced by araneiforms, colloquially known as “spiders” (e.g., [13]), though textures from araneiforms are present. Linear ridges on the North Residual Ice Cap (NPRC) have been attributed to direct sublimation/condensation patterns due to sublimation [14]. However, the older total surface age of the SPLD (while revised absolute ages would require a complete crater catalog, the 100s of m to km scale craters present here argues for an orders of magnitude older relative age than the NPRC) begs the question of how much active resurfacing is occurring at the SPLD surface.

Circular depressions without clear rims and with interior modifications are also common (Figure 2c&d), with various levels of preservation of potential ejecta.

Finally, “ghost” craters are present, which due to their highly eroded state only preserve a circular rim (Figure 2d). For “ghost” craters, it is difficult to determine if they were in fact true impact craters and what their initial diameters were before extensive erosion. Their presence does indicate that some record of surface modification that spans a potentially significant fraction of geologic time is also preserved in the near-surface region of the SPLD.

We will also present initial statistics on these objects in our starting counting regions, to see if preservation state and morphology is linked to emerging statistical patterns in the crater catalog data.

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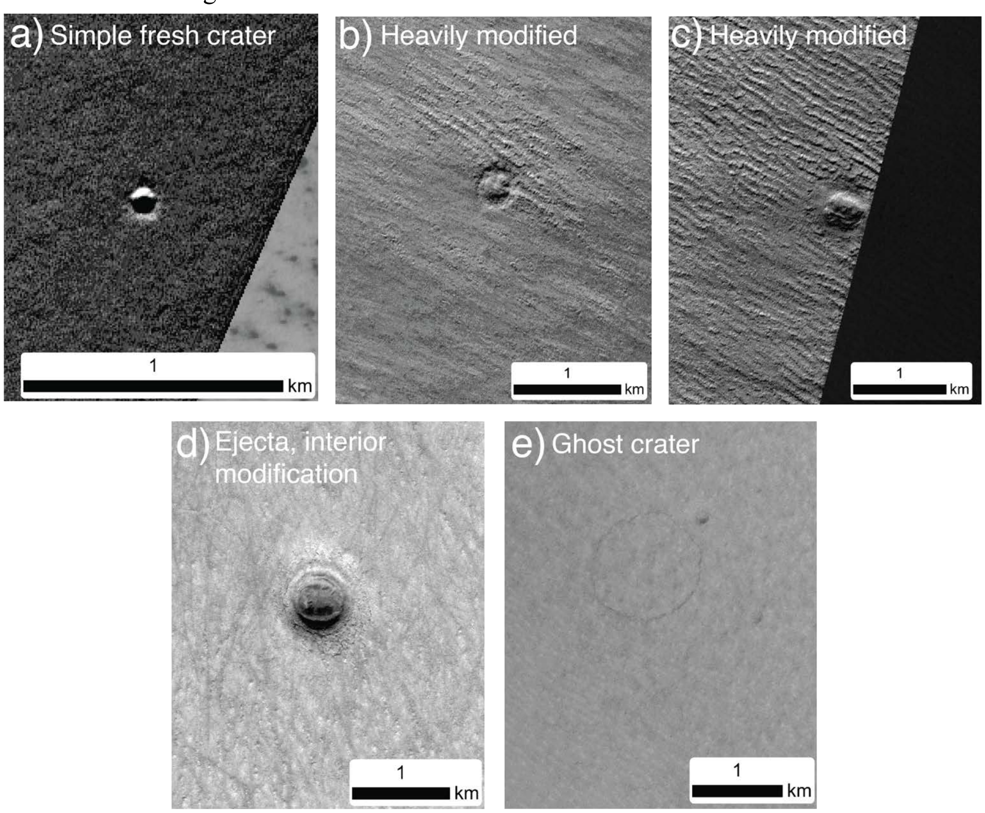

Figure 2. Five examples of crater morphology from the surface of the SPLD. Approximate locations from upper left to lower right are:
a) 82°S, 224°E;
b) 80.6°S, 212.8°E
c) 81.0°S, 213.1°E
d) 79.8°S, 230.6°E
e) 80.0°S, 215.7°E