SURFACE AGES OF THE SOUTH POLAR LAYERED DEPOSITS, MARS. M.E. Landis[1*], S. Byrne[1], C.M. Dundas[2], K.E. Herkenhoff[2], J.L. Whitten[3], D.P. Mayer[2], I.J. Daubar[4], and J.J. Plaut[4] [1]Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ (*mlandis@lpl.arizona.edu), [2]U.S. Geological Survey, Astrogeology Science Center, Flagstaff, AZ [3]Center for Earth and Planetary Studies, National Air and Space Museum, Smithsonian Institution, DC [4]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA.

Introduction: The Polar Layered Deposits (PLDs) of Mars contain alternating layers of dusty ice widely thought to contain a climate signal. However, the relationship between the climate records possibly contained in the North PLD (NPLD) and South PLD (SPLD) is not well constrained. Based on crater counts using Viking [1], MOLA [2], and THEMIS [3] data sets, the surface age of the SPLD is thought to be on the order of 10s of Myr. This model age is orders of magnitude greater than the NPLD surface age estimates of ~10-20 kyr [4] or as young as ~1.5 kyr [5].

The SPLD has several additional complexities relative to the NPLD. Viscous relaxation plays a key role in the degradation of large craters on the SPLD [6], while this is neither observed [4,5] nor expected [7] on the NPLD. The SPLD has also been recently divided into two geologic units [8] that previous crater studies [1-3] have combined. The presence of large radar reflection free zones (RFZs) [12] in the SPLD suggests that there were epochs of accumulation where radar reflectors were not generated, due to CO_2 accumulation in the case of RFZ_3 [12].

Two major advances have occurred since the last published SPLD crater catalog. First, Mars Reconnaissance Orbiter's Context Camera (CTX) [9] has imaged most of the SPLD (Figure 1) at 6 m/pixel or better. Second, significant updates to the martian crater production functions [10,11] have occurred. In combination with the new geological mapping by [8], the additional data and refined understanding of martian cratering justify a new study of the SPLD. We can begin to compare the timing of the emplacement of the surface units of the SPLD in relation to each other, as well as in relation to the NPLD.

This abstract presents a preliminary crater size-frequency distribution (CSFD) from one area of the SPLD that overlies an RFZ. This is part of a larger effort to produce a CTX-image-based catalog of all craters on the SPLD to improve our knowledge of the surface age using higher-resolution image data, to determine if there is an age difference between the two surface geologic units described by [8], and to constrain the timing of the RFZ formation.

Initial Mapping Area and Crater Cataloging: Figure 1 shows the CTX image coverage over the SPLD, using images taken from solar longitude (L_s) 230-370°. The initial counting area is on the Aa_1 unit and overlies an RFZ [8,13]. This area is distant from the two documented secondary crater fields on the SPLD [14]. The morphology craters and surface terrain textures in this area are similar to the nearby non-RFZ-covering Aa_1 unit. While there are some gaps, the CTX image coverage is sufficient to yield statistically significant numbers of craters (210) for the $1.5x10^4$ km^2 initial region of interest (ROI) (Figure 1).

An image mosaic of the SPLD was generated from the >3000 CTX images that cover the SPLD, with a fixed resolution of 6 m/pixel. Craters were counted using the CraterHelperTools extension (available from the USGS: https://astrogeology.usgs.gov/facilities/mrctr/gis-tools) in ArcMap®.

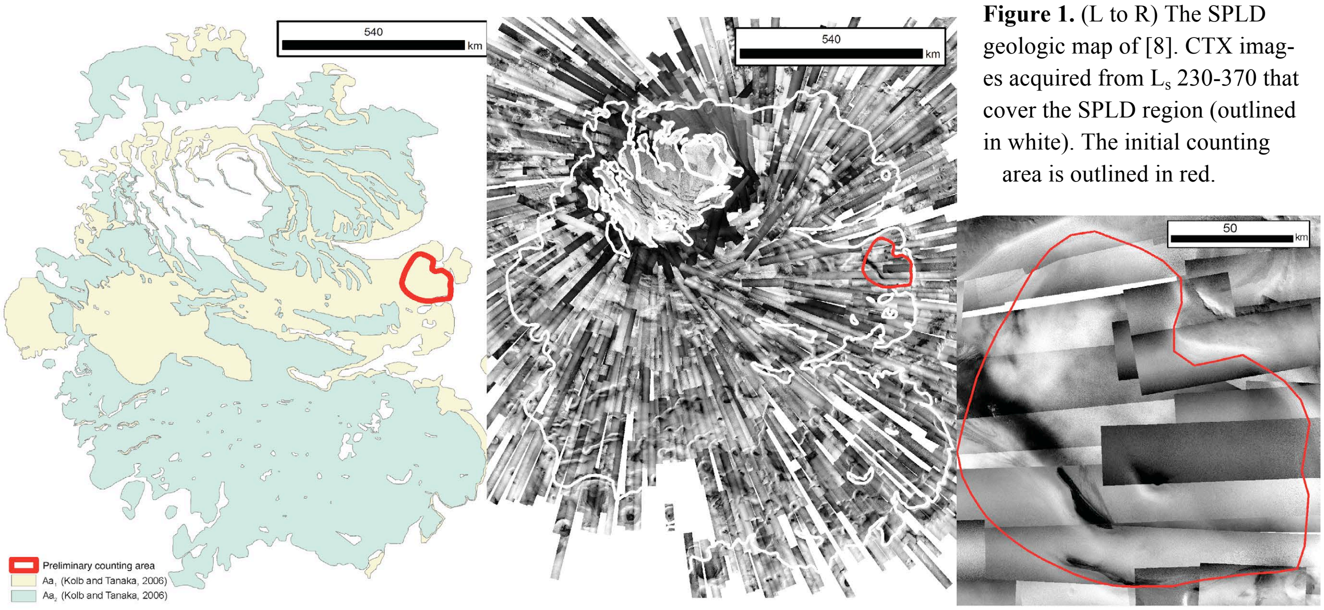

Figure 1. (L to R) The SPLD geologic map of [8]. CTX images acquired from L_s 230-370 that cover the SPLD region (outlined in white). The initial counting area is outlined in red.

Crater Statistics and Model Ages: The 210 impact craters in the initial ROI range in diameter from 26 m to 7 km. Most craters in this region have diameters <400m, and the median diameter is ~70 m. The largest crater (*D* ~7km) shows clear signs of degradation, significant viscous relaxation, and is possibly being exhumed. Therefore, we do not include it in the population of craters used to date the SPLD's current surface.

The differential SFD plot for this ROI is shown in Figure 2. A roll-off occurs around 50-60 m diameter due to incomplete crater detection. This is due in part to image resolution (based on CTX resolution and assuming 10 pixels are needed for a definitive detection, the minimum reliable detection diameter is ~60 m, though [4] argue that their identifications were complete to ~6 pixels) and partly to surface circular pitting and patterning common the PLDs [e.g. 4, 5] that complicates crater identification. We do not take into account the effects of material strength, so the reported ages are likely overestimates by a factor of a few [5].

We utilize the Hartmann [10] and Daubar et al. [11]-based isochrons. The argument is made in [5] that the Daubar et al. [11] isochrons are more appropriate for the small craters on the NPLD surface, both in terms of crater size and crater formation time-scale. The model surface ages for the initial SPLD ROI are on the order of 100s of kyrs to 50 Myrs old, depending on the isochron used. Future work will explore additional isochrons [e.g. 15] that may be more appropriate for this impact crater diameter range, where the two isochron systems are very different.

In this preliminary study area, the crater SFD cuts across multiple Hartmann [2005] isochrons and therefore a maximum age of ~50 Myr can be determined. The slope of the best-fit line to the crater SFD is similar to that of the Daubar et al. [2013] isochrons, and closely follows the 200 Kyr isochron. While these model ages represent only the outlined area in Figure 1, the Hartmann [2005] based age fits in the range of 10-100Myr surface ages derived in [1-3] whereas the Daubar et al. [2013]-based isochron ages are an order of magnitude younger [1-3].

This younger age determination could be due to several factors. Previous studies [1-3] did not distinguish between the Aa_1 and Aa_2 units, thus giving an average age, though this would affect results from both production functions. There could also be unrecognized field secondaries in the counting area, which are not included in the Daubar et al. [11] isochrons. This may lead to an underestimation of surface age, but may not outweigh the advantages of using a PF based on observed new impacts as argued in [5].

The hypothesis that the SPLD surface is orders of magnitude older than the NPLD surface is supported by these new data. Future work will expand the crater catalog to encompass all RFZs identified by [12,13] as well as both Aa_1 and Aa_2 geologic units.

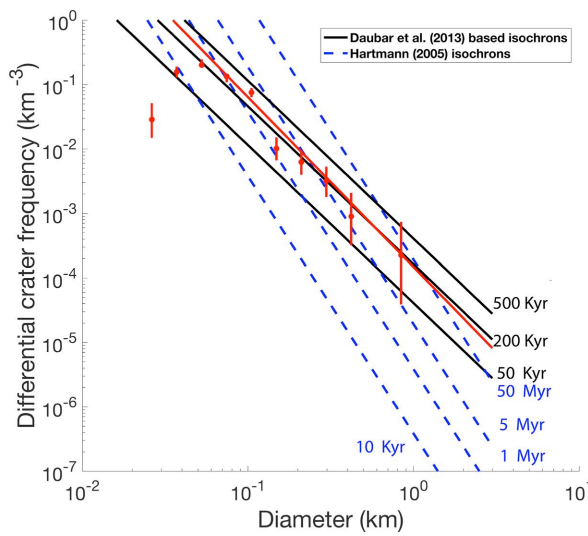

Figure 2. Differential crater size-frequency distribution (SFD) plot for the initial ROI is shown in Figure 1.

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