A REVISED GEOLOGIC MAP OF THE SOUTH POLAR LAYERED DEPOSITS, MARS: YEAR 0 UPDATES.
M. E. Landis[1] and J.L. Whitten[2], [1]Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, USA (margaret.landis@lasp.colorado.edu), [2]Dept. of Earth and Environmental Sciences, Tulane University, New Orleans, LA, USA.

Introduction: The South Polar Layered Deposits (SPLD) on Mars are made up of ice and dust that show layering that may contain a record of martian climate history [e.g., 1]. One persistent issue in interpreting the climate record, if any, contained in the SPLD is understanding the age and geologic history of the deposit. Unlike the North PLD, there are indications of local, significant modification [2] and previous geologic mapping has described at least two distinct geologic units at the surface by Kolb and Tanaka [3] (Fig. 1c).

As part of the NASA ROSES 2020 Planetary Data Archiving, Restoration, and Tools call, our proposal was selected to remap the south polar region of Mars (70° S to 90° S) at a final map scale of 1:2,000,000 (1:2M) and produce a USGS Science Investigation Map (SIM). We will identify and describe the geologic units present in this region, map the SPLD, and publish the map through the USGS SIM process as part of the proposed work.

In this abstract we summarize in more detail our proposed work and work plan, and describe our first year goals of the project.

Why now?: Several lines of evidence suggest the SPLD is older and may have a more complex geologic history than the NPLD. The bulk dust content is higher in the SPLD than NPLD [4], suggesting long epochs of sublimation or being exposed to air-fall dust for significant periods of time. Additionally, there are more numerous, larger impact craters on the SPLD than the NPLD [e.g., 5, 6-10]. The preliminary model crater age results place a potential upper limit on the SPLD surface exposure age to be a few to ~10 Mya, though younger absolute ages are possible [10]. Work using protrusion profiles of PLD exposures in spiral troughs and signal analysis techniques has found similar patterns in multiple NPLD and SPLD trough exposures [e.g., 11, 12, 13], suggesting that there may be consistent climate signals preserved within each deposit.

Complexities also lurk below the SPLD surface. Radar data from the Shallow Radar (SHARAD) instrument indicates significant regions that lack any radar reflectors (referred to as either reflection free zones (RFZ) or low radar reflectivity zones (LRZ), they do not contain strong differences in the ice/dust mixing ratio, e.g., [14]). While the LRZ below the South Polar Residual Cap (SPRC) has essentially been confirmed to be CO_2 ice [14-17], the composition of the remaining LRZs is not currently known. A wealth of additional unusual radar properties compared to the NPLD also affect a spatially extensive portion of the SPLD [18]. In particular, the SHARAD signal is scattered in the uppermost portion of the SPLD, creating a "foggy" appearance in the subsurface that is caused by a process that prevents the focusing of subsurface reflectors [18]. The cause of this scatter is located just below the SPLD surface, meaning a geologic map may be able to elucidate the cause of the fog.

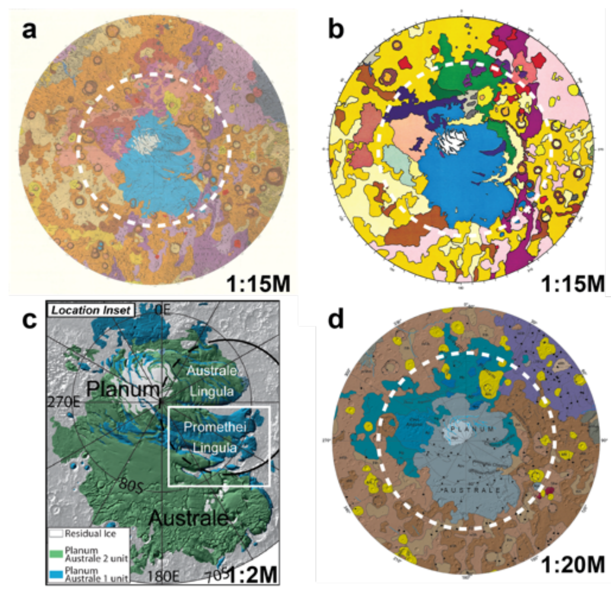

Fig. 1 *Sample of published south polar geologic maps. (a) Tanaka and Scott [19] USGS 1:15M global geologic map of Mars. (b) Tanaka and Kolb [20] revision of the Tanaka and Scott [19] geologic map (c) Kolb and Tanaka [3] map published as an inset to Figure 1 in their paper. Currently, this is the only publicly available version of an SPLD map that separates the surface into more than one geologic unit, and documents a history of partial resurfacing. This proposal seeks to refine this mapping with the THEMIS image mosaic. (d) Recently revised global geologic map of Mars from [21]. Dashed white circle in panels a, b, and d indicate the boundary of the proposed geologic map.*

Another unusual subsurface observation of the SPLD is a putative sub-glacial lake [22], where there are unusually bright basal Mars Advanced Radar for Subsurface and Ionospheric Sounding (MARSIS) radar reflectors. Geologic context, including the relative surface roughness of units, location of unit contacts, and the chrono-stratigraphy of the SPLD is essential in placing these intriguing radar observations into context as well as providing additional data to aid in their interpretation.

The last major mapping effort of the SPLD was completed by Kolb and Tanaka [3]. Their map made significant progress on identifying and quantifying the geological complexity of the SPLD's surface, but this map is unavailable in GIS format. Additionally, significant new results have further emphasized that untangling the history of the surface of the SPLD relies on a geologic map and the stratigraphic relationships it records. Therefore, revisiting an SPLD geologic map will both provide an accessible map product as well as re-assess conclusions about the number and character of the SPLD geologic units.

Proposal Objectives: In order to complete a new SPLD geologic map, we will divide the mapping effort into three tasks to be completed by the proposal team, including two graduate students. We have selected this strategy due to analysis of team-mapping strategies for other geologic features, in particular impact craters, that demonstrates that identifications or mapping done by a team can increase reliability of the overall map [e.g., 23].

Task 1: Identification of Geologic Units. We will do a preliminary analysis in order to understand what the dominant geologic units are at the surface of the SPLD, agree on common mapping principles, and set up the mapping file structure at both institutions collaborating on this project.

Task 2: Mapping of South Polar Region. We will map the region of 70° S to the pole (covering the SPLD and surrounding regions of Planum Australe) as a team, completing individual maps and having periodic teleconferences to discuss unit definitions and any needed modifications. To complete this task, we will exchange maps within the team to produce a consensus map product generated by the entire proposal team.

Task 3: Integration, Map Review and Publication. For this task, we will prepare, submit, and revise the map based on feedback from the technical reviewers. Publication of the geologic map as a SIM will fulfill the archiving requirement of this project. We will also prepare manuscripts for publication in order to provide detail in addition to the map pamphlet text.

Basemap data: We will primarily rely on the 2001 Mars Odyssey Thermal Emission Imaging System (THEMIS) daytime infrared (IR) mosaic, with 100 m/pixel resolution. The mosaic data values are a visual representation of daytime temperatures. The THEMIS Daytime IR mosaic is of sufficient resolution to produce a geologic map at the 1:2M scale; mapping will be completed at the 1:500k digital map scale as per the recommended map vs. digital scale resolution relationship [24]. The mosaic process involved the hand examination of images to ensure the amount of seasonal CO_2 ice was minimized [25]. The daytime data are conducive for morphologic studies [e.g., 21, 25], which is the main purpose of this data set for geologic map production.

We will use the Murray Lab Context Camera (CTX) and Mars Global Surveyor (MGS) Mars Orbiter Laser Altimeter (MOLA) south polar 115 m/pixel as supplementary data products for the geologic map.

Year 1 Goals: During the course of the first year of mapping, our goals are to identify and characterize the geologic map units we will use as well as set up the project and project workflow. The mapping team will iterate on unit definitions and work on mapping several sub-areas of the SPLD together in order to improve and standardize mapping techniques and unit definitions. One central logistical question for the first year is: Do two unique geologic units sufficiently characterize the SPLD surface (e.g., Kolb and Tanaka [3]), and if not, how many distinct units are there?

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