RECONCILED UNITS FROM PRELIMINARY GEOLOGIC MAPPING OF THE SOUTH POLAR LAYERED DEPOSITS J. García-Cajiao\textsuperscript{1} and S. Cartwright\textsuperscript{2}, J. L. Whitten\textsuperscript{3} and M. E. Landis\textsuperscript{3, 4} \textsuperscript{1}Tulane University, New Orleans, jgarcia15@tulane.edu, \textsuperscript{2}University of Colorado-Boulder (full mailing address and e-mail address). \textsuperscript{3}Center for Earth and Planetary Studies, National Air and Space Museum, Smithsonian Institution, \textsuperscript{4}Laboratory for Atmospheric and Space Physics, Colorado

Introduction: The south polar layered deposits (SPLD) are one of the most enigmatic features of Mars. These alternating layers of ice and sediment \cite{1} were formed during variations in the planet's orbital obliquity \cite{2} and eccentricity \cite{3} and are therefore thought to preserve a record of the Martian climate cycle. Compared to their north polar counterpart, the SPLD have a higher bulk density \cite{4} and a higher concentration of superposed impact craters, indicating that they preserve a signal from a potentially older climate than in the north polar layered deposits \cite{5}. Overlying the SPLD is a CO\textsubscript{2} ice cap called the South Polar Residual Cap (SPRC) that persists even during the Martian summer.

The surface of the SPLD is shaped to this day by dynamic processes such as the advance and retreat of CO\textsubscript{2} frost and the sublimation of water ice. This has led to the diverse morphology of landforms such as araneiforms and quasicircular pits \cite{1}. Aeolian processes further shape and modify the landscape of the SPLD by redistributing material \cite{6}. Together, these processes create and expose distinct layers within the SPLD, providing valuable insights into the geologic history and climate variability of Mars.

However, most published geologic maps (1:5M to 1:20M) only categorize the SPLD as a single unit distinct from the SPRC \cite{7-11}. This mapping approach does not convey the diversity of geologic processes that are or have been active in the south polar region of Mars. Therefore, to provide an accessible tool for researchers in the Mars community, we aim to produce geologic maps at a scale of 1:500,000 in a polar stereographic projection. The primary base-map is the Thermal Emission Imaging System (THEMIS) daytime IR mosaic \cite{12}. THEMIS is a multiwavelength camera, with a resolution of 100 m/pixel, designed to capture both physical and thermal properties essential for identifying surface mineralogy and thermophysical surface properties. Variations in pixel brightness enable the mappers to define and identify geologic units.

Topography can lead to localized differences in temperature. Therefore, to understand the brightness variations observed in THEMIS, we carried out a comparative analysis of supplementary data. These included a hillshade map derived from Mars Orbiter Laser Altimeter (MOLA) data \cite{13}, which provides insight into surface morphology at a resolution of ~200 m/pixel. In addition, Context Camera (CTX) \cite{14} images (5 m/pixel) provide high-resolution views of surface texture, morphology, and visual albedo.

Our mapping effort was conducted following the guidelines outlined in the USGS Astrogeology Mapping Protocol of 2022 \cite{15}. By following these guidelines we ensure consistency and quality in our mapping and data interpretation, and align our work with the most up-to-date standards in the field of planetary geologic mapping.

Results: With three ROIs mapped, the cartographers have agreed on 14 geologic units (Fig. 1) and organized them into six groups:

Residual Cap units: Near the geographic south pole and characterized by low THEMIS brightness is the Residual CO\textsubscript{2} Ice Unit. In ROI 1 (Fig. 1), the Residual CO\textsubscript{2} Ice Unit occurs at the highest elevation of the SPLD and extends from 0\textdegree S to ~87\textdegree S, largely overlapping the SPRC. Underlying it is the Residual H\textsubscript{2}O Ice Unit, which is found at an elevation of ~1.7 km.

Layered Material units: SPLD layers exhibit alternating THEMIS brightness values, indicative of diverse thermal properties arising from the varying proportions of ice and dust. The amount of layering exposed may be correlated to variable erosion, which leads then to two additional geologic units: the U-Shaped Valleys Unit with steep slopes and the Terraced Valleys Unit with exposed layers on shallower topography. The thickness of the exposed layering varies within both units.

Plains-forming units: The majority of the SPLD is covered by extensive plains at an elevation of approximately ~3 km: (1) the Flat Plains Unit and (2) Eroded Plains Unit. The Flat Plains Unit has a smooth surface with occasional small craters. It is also partially covered by a surface modification we provisionally name the Undae Terrain. This surface modification is characterized by clusters of small ridges and troughs. The Eroded Plains Unit exhibits an undulating topography and features semi-circular depressions. The Wire Brush Terrain, a unit defined by \cite{5}, was mapped as a
surface modification having striations that cut through the surface and expose SPLD layers. The Wire Brush Terrain has been found overlaying the Flat Plains Unit and the Eroded Plains Unit in ROI 1 and 2.

**Circumpolar units:** These three units occur in the low-lying SPLD material in ROI 2: (1) the Dissected Terrace Unit, characterized by a terrain that is broken into polygonal slabs, (2) the Knobby Terrain Unit, a chain of steeply sloping mountains/knobs, and (3) the Smooth Terrain Unit, which shows smooth topography and a constant intermediate brightness in THEMIS data.

**Basement units:** A topographic break of ~2 km separates the SPLD from the rest of the South Polar region. Two geologic units were determined to underly the SPLD and are referred as the Basement Units. Of these units, the Ridged Basement Unit, found within ROI 1 and defined by the presence of sinuous ridges, may be associated with the Dorsa Argentea Formation. In ROI 3, the Rough Basement Unit is located immediately north of the SPLD boundary. Both basement units have also a high density of superposed impact craters compared to other identified geologic units.

**Crater units:** Some of the impact craters are large enough to identify several geologic units at a 1:500,000 mapping scale. These include the Crater Ejecta Unit, the Crater Rim Unit, the Crater Floor Unit, and the Ridge Fill Unit. The latter unit is identified on crater floors and has a large number of ridges (e.g., 143°E, 71.5°S).

**Defining the SPLD and SPRC:** Supplementary data were required to map the outlines of these larger units, in particular MOLA and CTX. MOLA topography was largely used to determine the boundary of the SPLD. On the other hand, high-resolution CTX images were used to distinguish CO2 from H2O ice present in the SPRC. In THEMIS data the CO2 ice has a lower relative brightness and the H2O ice has a higher relative brightness. This is reversed in the CTX data: CO2 ice has high brightness (visible albedo) while H2O ice has lower brightness.

**Future Work:** The cartographers are currently working on a fourth ROI (extends from 0°S to 120°E, 70°S and 165°E, 70°S, see dashed black triangle in Fig. 1) that, aside from new surfaces, it includes areas from two of our ROIs that are already mapped. The goal is to begin reconciling old geologic units between ROIs while identifying new geologic units. We are also working on producing a correlation of map units, which will be aided by the completion of mapping in ROI 4.

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