

**DETAILED GEOLOGIC ANALYSIS OF PART OF THE SOUTH POLAR LAYERED DEPOSITS, PLANUM AUSTRALE, MARS: PART II.** E.J. Kolb<sup>1</sup> and K.L. Tanaka<sup>2</sup>, <sup>1</sup>Arizona State University, Dept. of Geological Sciences, Tempe, AZ 85287, [eric.kolb@asu.edu](mailto:eric.kolb@asu.edu), <sup>2</sup>Astrogeology Team, U.S. Geological Survey, 2255 N. Gemini Dr., Flagstaff, AZ 86001, [ktanaka@usgs.gov](mailto:ktanaka@usgs.gov).

**Introduction:** At the 3<sup>rd</sup> International Conference on Mars Polar Science and Exploration we presented some of the first results of our MGS- and Mars Odyssey-based 1:1,500,000-scale geologic mapping of the south polar layered deposits (SPLD) of Planum Australe [1]. Those results described SPLD sequences that compose the southern extent of a radial trough system within the planum as well as the candidate modes of trough emplacement. In this abstract, we build upon this geologic mapping by describing our observations of the northern extent of the trough system (Fig. 1a). Within this region, the radial trough's western trough-enclosing wall marks the intersection between the radial trough and a system of spiral trough features. A key issue addressed in this study is the determination of the relative timing of formation of the radial and spiral trough features.

**Background:** The radial trough is located east of Chasma Australe between 82 and 87°S (Fig. 1a). Trough length is ~ 440 km, averages 85 km in width, and locally approaches 1 km in depth. Along the trough axis, the floor descends more than 500 m and in plan view, the trough exhibits similar curvature and size as that of Chasma Australe. The northern extremity of the trough intersects the eastern scarp of Chasma Australe.

The spiral troughs have alternately been interpreted as erosional features formed via aeolian stripping by Coriolis-deflected winds [2], and as climate-driven constructional features [3 and 4]. In the latter, the spiral trough's equator-facing scarps undergo preferential insolation-driven ablation, which is thought to result in the poleward migration of the scarps [4-9]; the newly sublimated material as well as atmosphere-entrained volatiles would thus be precipitated on the crests and poleward-facing flanks of the spiral troughs. This mechanism has been used to explain apparent layer unconformities seen in Viking images of the north PLD sequences of Planum Boreum [6]. Additional spiral trough formation models include glacial flow [10 and 11] and spiral troughs that within a given climate regime, may track poleward or equatorward in an escalator-like fashion on the back of a much thicker, older, and outwardly flowing basal ice sequence [12]. Bedding features predicted by this model includes flow-induced wavy layering and temporal discontinuities between layer sequences.

**Geologic and Morphologic Features:** Here we describe the SPLD sequences and morphological observations seen within Figure 1a-b. MOLA topography indicates that the equator-facing spiral trough scarps are composed of laterally continuous, uniformly thick SPLD sequences; bedding planes appear planar and do not show evidence of layer pinch-outs, angular unconformities, or wavy bedding sequences. Moreover, SPLD contacts within the radial trough can be traced into the spiral trough where they are seen to compose the spiral troughs' basal SPLD sequences (solid white line). Pitted remnants of south polar residual ice cap (RIC) material mantle the SPLD that make up the spiral trough floors and poleward-facing scarps (A); RIC material does not extend onto the radial trough floor. A 1-km-diameter impact crater has been emplaced into an equator-facing spiral trough escarpment (B).

Several erosional features are seen at the spiral trough/radial trough intersection. First, an elongated streamlined feature (C) occurs within a spiral trough. Second, a series of five enclosed depressions on the radial trough floor appear to have undercut and backwasted into the spiral trough's basal sequences (D). The depressions are positioned in series along the trend of the radial trough. In cross-section (Fig. 1b), the depressions are bounded by SPLD sequences and descend northward along the radial trough floor, forming a descending stair-step pattern of ridge-and-swale topography (ridges outlined by dashed white lines). This profile mimics the descending stair-step topography seen across many of the spiral trough features [13]. In planview, ridge-crest and circular-depression spacing coincides with the spacing of the adjacent spiral trough crests and floors, respectively, such that the SPLD that make up the ridge crests also form the basal sequences of the spiral trough crests and escarpments; the ridges are 100's of meters lower than the crests of their respective adjacent spiral troughs. Some of the depressions also appear elongated along the axial orientation of the radial trough. Third, closely spaced aeolian-formed ridges and grooves (forming Ridge-and-Groove Topography, RGT; [1]) that strike parallel to the radial trough trend have eroded into the spiral trough crests, trough escarpments and intervening floors, the RIC remnants, and the radial trough's ridge-and-swale topography (arrows).

**Discussion/Conclusions:** Contradicting the hypotheses for glacial-flow-induced spiral-trough migration [10-12] is the lack of model-predicted wavy SPLD bedding sequences within the spiral troughs upper/younger sequences or within SPLD that encloses the subjacent circular depressions. Geologic mapping of the radial trough's poleward regions indicates that >500 meters of SPLD has been removed by aeolian stripping [1]. The preserved impact crater seen on an equator-facing spiral trough scarp suggests that at least under current conditions, the rate of sublimation of sun-facing scarps may be relatively low. If the spiral troughs had undergone pole-or-equatorward migration, the undisturbed, continuous bedding contacts that extend from the radial trough into the spiral troughs indicate that (1) spiral trough development has not produced significant deposition on poleward-facing scarps since commencement of radial trough formation, and (2) lateral migration of the troughs is constrained by the width of the troughs. Also, if the spiral troughs included successively younger layers deposited on the trough crests and poleward-facing scarps and the current topography shown in Figure 1a represents the spiral troughs maximum lateral extent, then distal sections of the spiral troughs should exhibit the tapered "feather-edged" bedding sequences that typically characterize marginal sedimentary environments. Instead, MOLA topography and MOC and THEMIS images of the SPLD sequences that compose the spiral troughs' distal margins show SPLD sequences that exhibit uniform thicknesses and do not appear to pinch or grade outward.

We postulate that the spiral troughs had previously transected former SPLD material now occupied by the radial trough. The descending stair-step elevation of the radial trough's ridge-and swale topography mimics the spacing of the adjacent spiral troughs such that the ridges are interpreted here as basal enhancements in radial trough sculpturing that were guided by pre-

existing spiral trough sections, which are extant in the adjacent topography. These features do appear displaced southward, indicating poleward migration of this sculpturing. In addition, the enclosed circular depressions, the apparent in-situ erosion of a spiral trough, and the overprinting of RGT on the spiral troughs and radial trough floor indicate that significant aeolian deflation and erosional stripping has occurred within various troughs. Potentially, spiral trough formation has been a relatively longer-lived process, whereas radial-trough formation has been relatively recent. RIC presently within the spiral troughs may indicate that they are not deflating within the present climate regime.

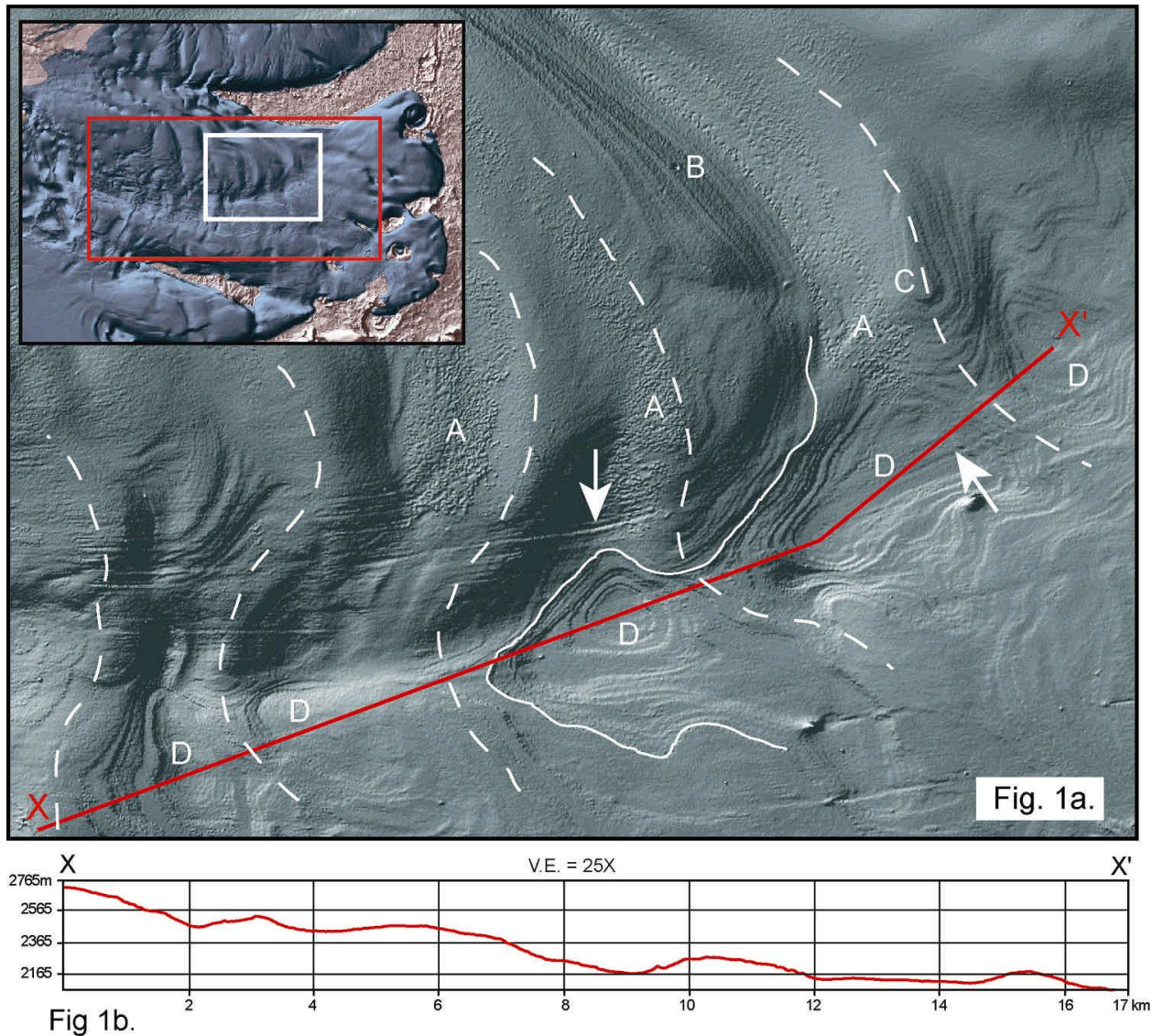


Figure 1. Part of radial trough in south polar layered deposits (SPLD) within Planum Australe, east of Chasma Australe, Mars. (a) Shaded relief of radial trough centered at  $\sim 83.5^{\circ}\text{S}$ ,  $120^{\circ}\text{E}$  from MOLA DEM ( $\sim 115$  m/pixel). X-X' = profile line, dashed lines = broad ridge crests, solid line = marker bed in SPLD, arrows = location of aeolian-formed Ridge-and-Groove Topography (RGT). See text for discussion of A-D. Inset shows context region of study area: red rectangle = extent of radial trough, white rectangle = extent of Fig. 1a, blue unit = SPLD. (b) Topographic profile of X-X'.

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