TYPES AND FORMATIONAL MECHANISMS OF SOUTH POLAR TROUGHS, MARS. J.A.P. Rodriguez[1], K. L. Tanaka[2], T. Platz[3], [1]Planetary Science Institute, Tucson, AZ 85719-2395, USA (alexis@psi.edu); [2]U.S. Geological Survey, Flagstaff, AZ 86001, USA (ktanaka@usgs.gov) ; [3]Institute of Geological Sciences, Freie Universität Berlin, Berlin, Germany (thomas.platz@fu-berlin.de).

Introduction. We present the first morphologic classification of troughs in Planum Australe, the south polar plateau of Mars, and describe the likely processes and geologic conditions leading to the unique morphologic character of each trough type. We find three distinct trough morphologic types, namely the scalloped, spiral and cavi-type (Fig. 1).

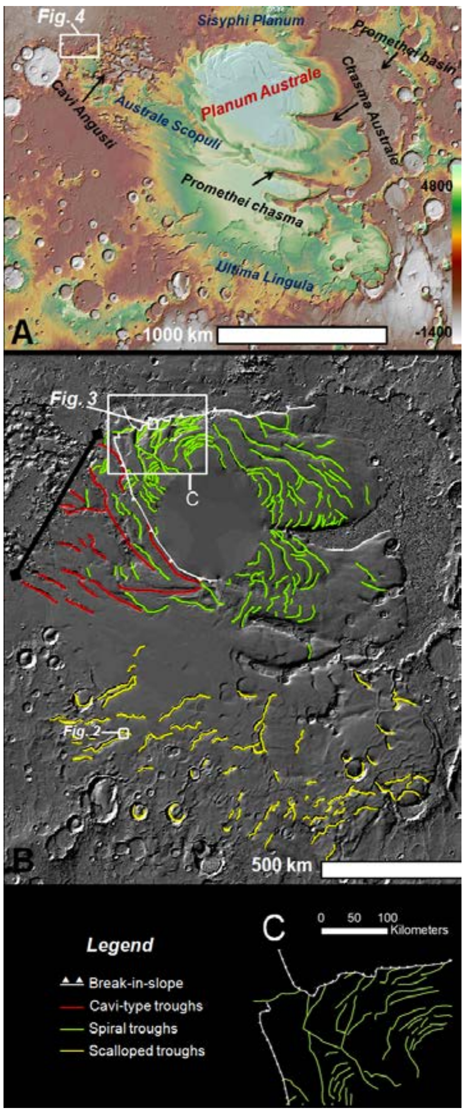


Fig. 1 (**A**, MOLA DEM 512 pixels per degree**)** Geographic context for Planum Australe. The extent of the proposed morphologic mapping includes the polar plateau and the region of Cavi Angusti outlined in yellow. **(B**, MOLA-derived shaded relief 512 pixels per degree**)** Mapping of 4 morphologic types of troughs. Close-up view **(C)** shows spiral troughs truncated by break in slope. Black line shows the coincidence in the maximum width of resurfacing within Australe Scopuli and Cavi Angusti.

The scalloped troughs. These troughs occur exclusively within Ultima Lingula, where polar deposits overlie known densely cratered terrain (Fig. 1B). They consist of moats oriented parallel to the equator-facing slopes of scalloped ridges, which interconnect scattered impact crater rims (Fig. 1B). Examination of a scalloped trough shows stacks of convex layers along its equator-facing slope (Fig. 2), indicating that this particular trough has migrated upwards through time [1]. We propose that trough development and migration would have resulted as ice deposits along the equator-facing slopes were repeatedly removed or thinned by sublimation, which impeded trough infilling during otherwise regional SPLD constructional stages. These troughs show distribution patterns reflecting relatively steep aspects of the subsurface basement topography (e.g., crater margins), which can be explained by the fact that sublimation rates increase with steepening surface inclination.

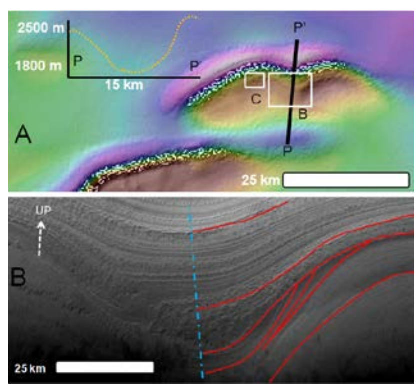


Fig. 2 Scalloped trough (**A**, MOLA DEM, 512 pixels per degree centered at 78°91' S., 248° W., context and location in Fig. 1B, south pole toward top**)** where the equator-facing slope reflects the topography of a sequence of exhumed stacked troughs **(B)**.

The spiral troughs. These troughs (Fig. 1B) resemble those in the north polar plateau and are arranged concentric to the highest part of Planum Australe. They are particularly well-developed south of Sisyphi Planum, relatively subdued within SLPD materials overlying the Promethei basin floor, discontinuous in the region of Australe Scopuli, and absent in Ultima Lingula. Rodriguez et al. [2] observe that the trough floors are compartmentalized into coalesced systems of depressions, which display layers that can be traced along their margins. They suggest that these observations support the existence of a large population of troughs developed *in situ*, predominantly by surface ablation. Instead of systems of nested elliptical depressions as observed in Planum Boreum, on

Planum Australe we observe nested systems of elliptical depressions and trains of linear/curvilinear depressions (respectively blue and yellow arrows in Fig. 3), which is consistent with previous investigations suggesting that polar trough development was the result of a combination of katabatic wind erosion and ablation [1,2]. However, we propose that wind erosion played a more important role in south polar trough development than it did in the formation of the north polar counterpart. This hypothesis is supported by our finding of yardangs in alignment with trough orientations (Fig. 3, red arrows), some of which cut into the margins of depressions that comprise prominent topograhic divides, indicating that the degree of topographic compartmentalization generally decreased over time due to topographic subdual by wind erosion.

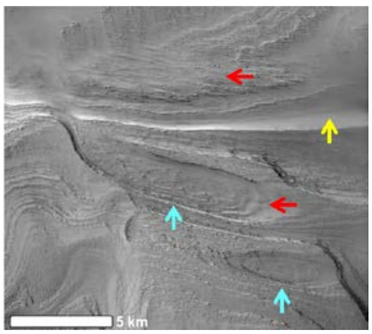
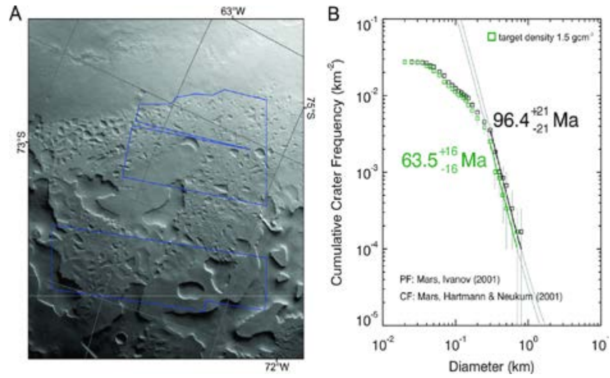


Fig. 3 Part of CTX image B08_012598_0958_XN_84S033W, 5 m/pixel**)** Close-up view reveals extensive wind erosion.

The cavi-type troughs and Planum Australe slope breaks. The most prominent slope break in Planum Australe marks an abrupt drop in surface elevation of ~1 km. This slope break extends radially from a location where the rim of the Promethei basin has been hypothesized to be buried underneath the central part of Planum Australe [3] to the margin of the polar plateau adjacent to Cavi Angusti, a cluster of depressions within the regional circum polar terrains (Fig. 1). The slope break separates a zone of spiral trough development and a lower zone of cavi-type trough occurrence known as Australe Scopuli (Fig. 1). The slope break, which hereafter we refer to as the scopuli slope break, ends at a location in close proximity to where the most prominent slope break marking the margin of Planum Australe extends south of Sisyphi Planum (Fig. 1B). This slope break, hereafter refered to as the Sisyphi slope break, terminates at the Promethei basin's rim. The Sisyphi slope break has a maximum relief of ~1500 m truncates numerous spiral troughs (Fig. 1C) .The cavi-type troughs comprise nested depression systems that typically have their lengths oriented parallel to the scopuli slope break (Fig. 1) and in some places their floors include pockets of exhumed basement bedrock. We observe that the maximum widths of Cavi Angusti and the outer margin of Australe Scopuli coincide (Fig.1B), suggesting at least a partly shared resurfacing history.The formation of the Cavi Angusti depressions has been hypothesized as having resulted from regional volcanism during the Late Hesperian and prior to the emplacement of the SPLD [4]. We counted craters on CTX images and our surface dating points to regional resurfacing occurring ~96 Ma, or 64 Ma when adjusted for an icy target (i.e., Late Amazonian, Fig. 4).

Fig. 4 (A) Crater counting area (blue) shown on HRSC nadir image from a region of collapse within Cavi Angusti and derived model ages. **(B)** Results adjusted to a target density of 1.5 g cm^{-3} are shown in green. Location shown in Fig. 1A.

This finding does indeed open the possibility for



some Cavi Angusti development having postdated the formation of Planum Australe. The development of the cavi-type troughs has been attributed to katabatic wind erosion [5] or the control of ridged basement topography [6]. We propose an alternative hypothesis that links the development of the cavi-type troughs to the formation of the Sisyphi and scopuli breaks-in-slope. As previously suggested we concur with the hypothesis that the Cavi Angusti resulted from volcanic activity, but we also suggest that volcanism must have occurred during the Amazonian. In the apparent absence of relatively young volcanic landforms, resurfacing may have occurred in association with high heat flow from intrusive magmatic bodies causing large-scale polar ice removal by the enhanced ablation effect of relatively warmer anabatic winds. Polar ice removal resulted in the exhumation of circum-polar surfaces, SPLD thinning. and modification of pre-existing spiral troughs into cavi-type troughs.

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