ARSIA MONS FAN-SHAPED DEPOSIT: SPATIAL AND TEMPORAL RELATIONSHIPS AMONG COLD-BASED GLACIAL FACIES FROM HRSC DATA.

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Introduction: Recent reexamination of the fan-shaped deposits on the NW flanks of the Tharsis Montes and Olympus Mons has revived earlier interpretations [e.g., 1-3] that these deposits could have a glacial origin. New spacecraft data and improved understanding of cold-base glacier behavior has led to the interpretation that these features are the depositional remains of cold-based tropical mountain glaciers of Amazonian age [e.g., 4-11]. The fan-shaped deposits were subdivided into an outer ridged facies (interpreted to be drop moraines derived from advance and retreat of an ice sheet), an intermediate knobby facies (interpreted to be sublimation tills predominantly due to vertical downwasting of an ice sheet), and a smooth facies (interpreted to be debris-covered glacial deposits and/or rock glacier deposits representing some of the last phases of ice-sheet activity) [4-11]. Here we examine new synoptic high-resolution HRSC (High Resolution Stereo Camera) data to analyze some of the key questions raised in previous analyses [4-11] concerning the characteristics of the fan-shaped deposit facies and their age relationships.

Nature of the Smooth Facies: Although initially interpreted to represent late-stage glacial deposition at Arsia Mons, Viking data were of insufficient resolution to confidently determine the detailed nature and age relationships of the smooth facies. Recent THEMIS data provide insight into the proximal portions of this facies [10], showing that it is very similar to debris-covered glaciers in the Antarctic Dry Valleys and that the deposits are relatively very young and appear to have undergone recent advance and retreat. The new HRSC data provide important insight into the nature and age relationships of the more distal portions of the smooth facies (Fig. 1-3). Fig. 1 shows the stratigraphic relationships between a lobe of the smooth facies (top left) and its superposition on the knobby facies (bottom right). The contact between the two facies includes concentric, moraine-like ridges and unusual knobs that suggest recent smooth facies retreat (Fig. 1). Other occurrences of the smooth facies (Figs. 2, 3) show their arcuate structure in detail that was not readily visible in previous data. Ridges seen here are broadly similar in scale and morphology to the ridges on debris-covered piedmont glaciers such as the Malaspina on Earth and around the base of the Olympus Mons scarp [e.g., 9]. These data support and complement earlier interpretations [e.g., 4]; they show that the smooth facies may consist of a combination of broader, debris-covered piedmont-like glaciers in the distal zones, and smaller, debris-covered alpine-like glaciers in the proximal zones.

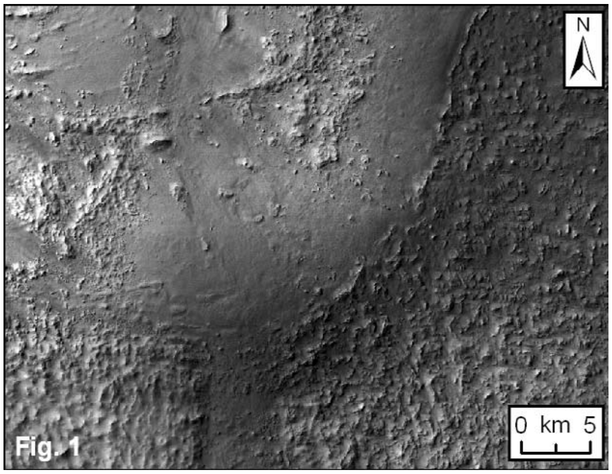
Cold-Based Glacial Deposit Extent and Age Relationships in the Outer Ridged Facies: Although Viking and THEMIS data clearly show most of the deposit boundary (the large ridge at the distal edge of the ridged facies), this relationship is not clear on the northern flanks of the edifice where the deposit interacts with summit and flank lava flows. HRSC data provide new information about the northeastern margins of the deposit (Fig. 4) showing evidence for moraines among the lava flows that enable the contact of the deposit to be mapped to elevations as high as 6.5 km on the northern flank of the edifice.

Among the outer ridged facies occurrences, those in the northern part of the deposits show arcuate, convex-outward patterns, suggesting that the ice sheet was composed of individual lobes in different places or at different times. The new HRSC data (Fig. 5) provide sufficient resolution to show that these ridges are locally superposed on top of each other, suggesting temporal differences in lobe emplacement.

Relationship Between Volcanism and Glaciation: The edifice on which the fan-shaped deposit was emplaced (Arsia Mons) is of obvious volcanic origin. This raises the question of whether there was ever interaction between the two processes. Geologic mapping using Viking data has suggested that there was some interleaving of deposits from these two processes [12]. Evidence for subglacial dike emplacement and volcanic eruptions has been documented at adjacent Pavonis Mons [8, 13]. The new HRSC data show additional evidence of steep-sided flow-like features (Fig. 6) similar to those seen at Pavonis Mons [8]. Their distinctive morphology, steep scarps, and relationship with the overlying knobby facies are all consistent with sub-glacial eruptions [14] and strongly suggest that subglacial volcanism occurred periodically during the time that the ice sheet was present at Arsia Mons.

Summary: New HRSC high-resolution, synoptic images are providing important data to test and modify hypotheses for the origin of the fan-shaped deposits on the flanks of the Tharsis volcanoes.

References: [1] R. Williams (1978) *GSA Abs*., 10, 517. [2] B. Lucchitta (1981) *Icarus*, 45, 264. [3] J. Zimbelman and K. Edgett (1992) *PLPS* 22, 31. [4] J. Head and D. Marchant (2003) *Geology*, 31, 641. [5] D. Shean et al. (2004) *LPSC 35*, #1428. [6] J. Head and D. Marchant, (2003) *LPSC 34*, #1247. [7] R. Parsons et al. (2005) *LPSC 36*, #1776. [8] D. Shean et al. (2005) Origin and evolution of a cold-based tropical mountain glacier on Mars: The Pavonis Mons fan-shaped deposit, *JGR-P*, in press. [9] S. Milkovich and J. Head (2003) *6th Int. Mars Conf.*, #3149. [10] D. Shean et al. (2005) *LPSC 36*, #1339. [11] J. Head et al. (2005) Arsia Mons fan-shaped deposit: A cold-based tropical mount glacier, to be submitted to JGR-P. [12] D. Scott et al. (1998) *USGS Map I-2561*. [13] L. Wilson et al. (2005) *LPSC 36*, #1189. [14] L. Wilson & J. Head (2003) *Geol. Soc. London*, SP-202, 5.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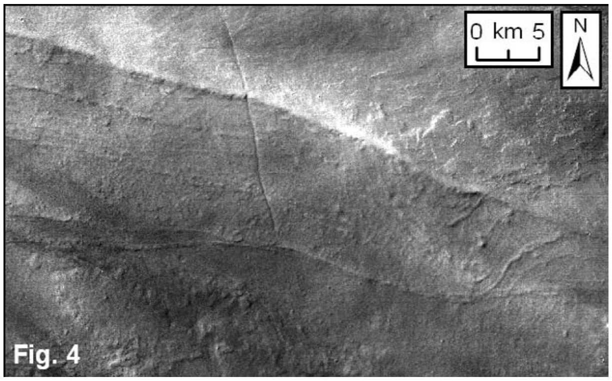
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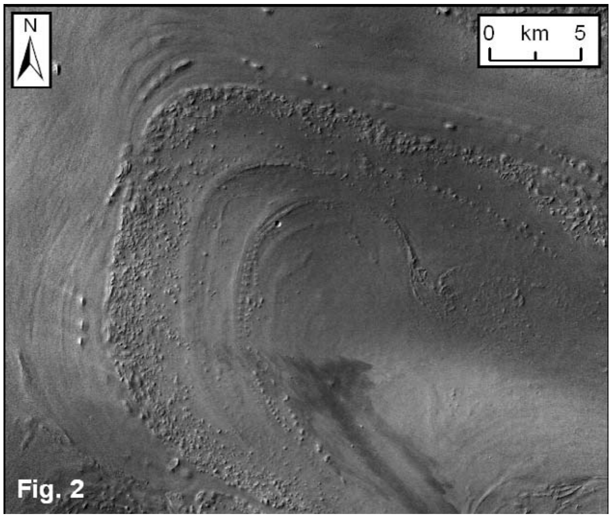
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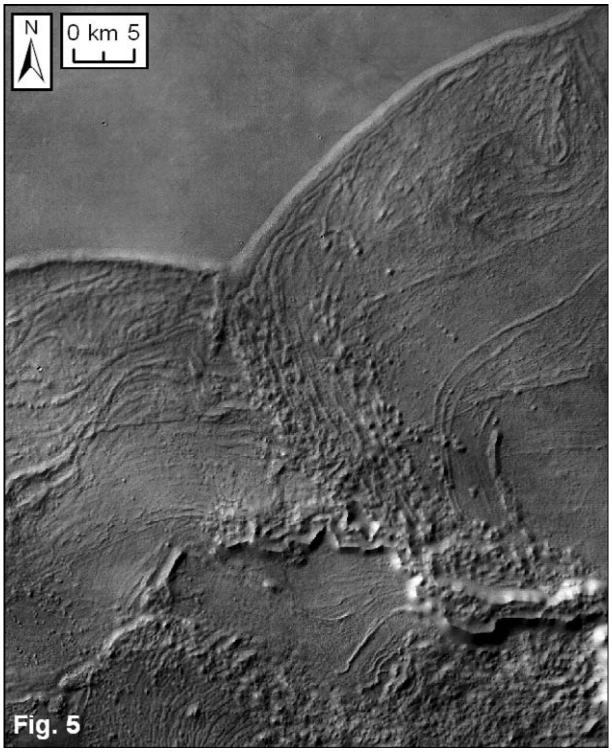
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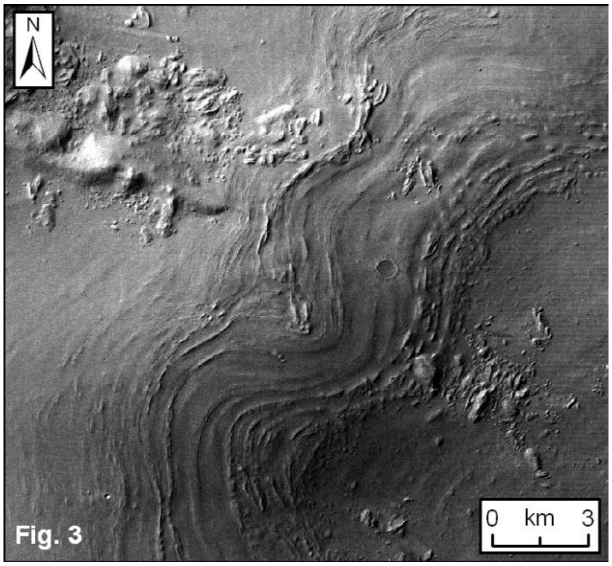
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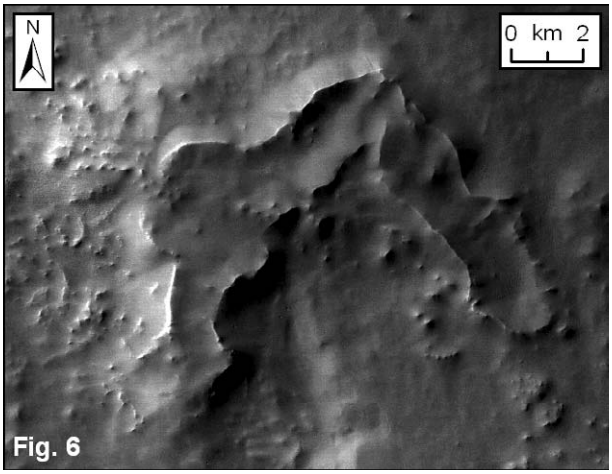
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