MOUNTAIN GLACIERS ON MARS? CHARACTERIZATION OF WESTERN ARSIA MONS FAN-SHAPED DEPOSITS USING MGS DATA: James W. Head[1] and David R. Marchant[2], [1]Dept. Geol. Sci., Brown Univ., Providence, RI 02912 USA, [2]Dept. Earth Sciences, Boston University, Boston MA 02215 USA

Introduction: The most comprehensive treatment of the fan-shaped deposits of Arsia Mons is that of Scott and Zimbelman [1], who mapped the Arsia Mons region at a scale of 1:1,000,000. This mapping provided a firm and comprehensive definition of units, subunits and structures that make up the fan-shaped deposits as well as their relationships to the sequence of lava flow units that make up Arsia Mons as a whole (Fig. 1). On the basis of the fact that this regional map compiled from Viking data appears in our investigation to well characterize the units and major relationships, we adopt this unit definition and stratigraphy here, using it as a basis for further investigation and modifying and clarifying the definitions and relationships using the new MGS data.

Characterization: The basic units comprising Arsia Mons consist of lava flow members of the Tharsis Montes Formation [2; see also 3], and the oldest flows are Late Hesperian in age, and younger units span the Amazonian. Scott and Zimbelman [1] show that during the Amazonian, three lava flow members of the Tharsis Montes Formation and the three facies of the fan-shaped deposit were emplaced. The ridged facies of the fan deposit clearly overlies Member 5 and is thus considered to be Late Amazonian in age, but the ridged facies is overlain in places by Member 6. On the north side of the volcano, the knobby and possibly the smooth facies may be overlain by Member 5. Scott and Zimbelman [1] describe the smooth member of the fan-shaped deposit to be the youngest on Arsia, with the possible exception of Member 6. In summary, the fan-shaped deposits are largely contemporaneous with the latter phases of volcanism on Arsia Mons, postdating Member 5 and possibly predating or being contemporaneous with Member 6. We will return to these stratigraphic assignments in a later section.

Scott and Zimbelman [1] described the ridged facies of the fan-shaped deposit as a "broad, thin sheet marked by abundant ridges that extend over topographic barriers without apparent deflection. Individual ridges are about 1 to more than 10 km long, spaced a few hundred meters to several kilometers apart; ridges [are] connected in places by shorter crossribs." On the basis of their superposition on lava flows and a large impact crater (Fig. 2), they interpreted the facies as recessional moraines, resulting from the emplacement of "glacial drift deposited long the margins of an ice sheet during successive stages in its ablation and retreat."

The knobby facies of the fan-shaped deposit (Fig. 3) forms a "large area of chaotic terrain consisting of hills as much as several kilometers across that are subrounded to elongated downslope; chains of hills [are] aligned parallel to ridges in [the] ridged facies; individual hills and patches [are] interspersed in [the] ridged facies." Scott and Zimbelman [1] interpreted the hills and knobs of the knobby facies as having formed in a wastage zone of an ice sheet and to include landslide material. The transition of the knobby facies with Member 3 at high elevations on the volcano led them to suggest that part of the knobby facies may be related to parts of Member 3 displaced by landsliding. They interpreted terrain downslope from a distinctive scarp as being a gravity-driven mass of material which "largely contributed to the knobby unit and exposed the relatively smooth surfaces of underlying members 1 and 2." The scarp was thus interpreted as a detachment surface. Thus a major outstanding question in their interpretation is the relative significance of ice-sheet and landslide origins for the knobby facies.

The smooth facies of the fan shaped deposit (Fig. 4) consists of "smooth surfaces with arcuate lineations and diffuse to lobate margins. [It] overlies large areas of knobby facies...[and]...partly fills and appears to be extruded from faulted collapse depressions." Scott and Zimbelman [1] interpreted the smooth facies to have originated as a viscous flow from two large fault-bounded depressions and to be formed by ash-flow tuffs or lahars. They point out that "the margins of the smooth facies appear to be spread out and feather-edged, and thus the material more nearly resembles an ashflow."

On the basis of mapping of the fan-shaped deposit by previous workers, a number of outstanding questions remain and we outline these here to guide our analysis of the fan-shaped deposit with MGS data, and we then examine the nature of each of these facies.

1. What is the detailed nature of the ridges in the ridged terrain and is material deposited between the ridges?
2. What are the stratigraphic relationships between the three facies and the lava flows of Arsia Mons?
3. Does the smooth facies have a different process of origin than that of the ridged and knobby facies?
4. What is the nature and origin of the outward-facing scarps on the upper flanks of Arsia Mons?
5. What is the origin and role of the graben-like structures within the fan-shaped deposit and their relationship to those outside this deposit?
6. What is the stratigraphic relationship between the ridged and knobby facies, and how does this relate to their origin?
7. Is there evidence for smaller landslide components within the fan-shaped deposit?
8. Is there evidence of melting and flow of water (channels, eskers, etc) within or adjacent to the fan-shaped deposit?
9. If the fan-shaped deposit was once ice-rich, is there any evidence for interaction between volcanic eruptions and ice?
10. Does the present day instability of water ice at equatorial latitudes rule out the origin of the fan-shaped deposits as related to glacial activity?
11. What key criteria can be used to distinguish among the three major hypotheses of origin for the fan-shaped deposits?

References: 1) D. Scott and J. Zimbelman, USGS Misc. Inv. Map I-2480, 1995; 3) J. Zimbelman and K. Edgett, PLPSC 22, LPI, 31, 1992; 3) D. Scott and K. Tanaka, USGS Misc. Inv. Map I-1802-A, 1986.

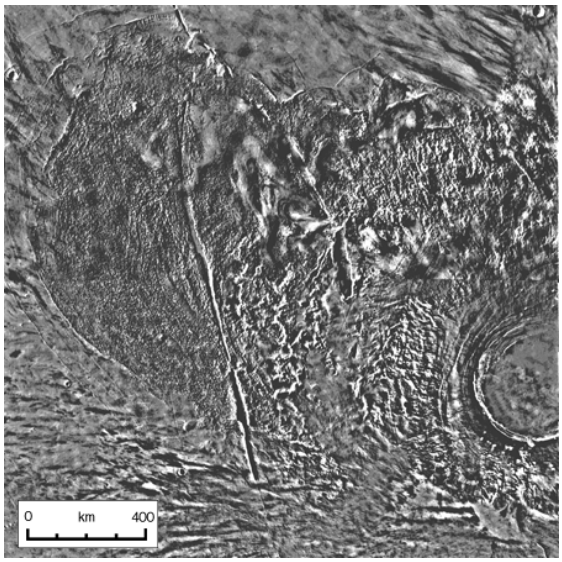

Fig. 1, Viking Orbiter mosaic of the fan-shaped deposits on the western flanks of Arsia Mons..

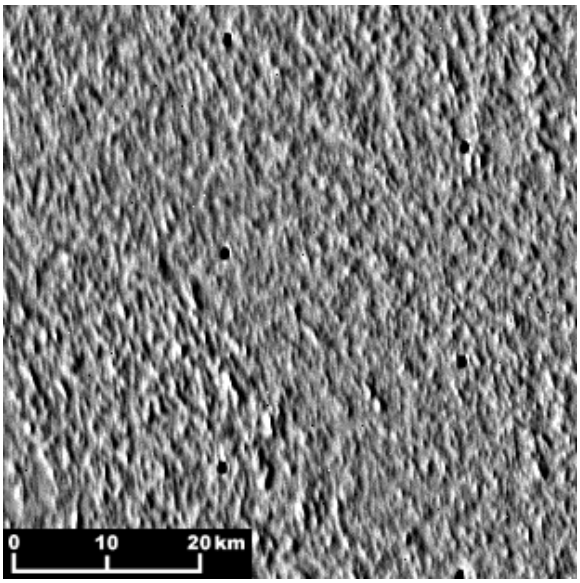

Fig. 3. Viking Orbiter image of the knobby facies of the fan-shaped deposit.

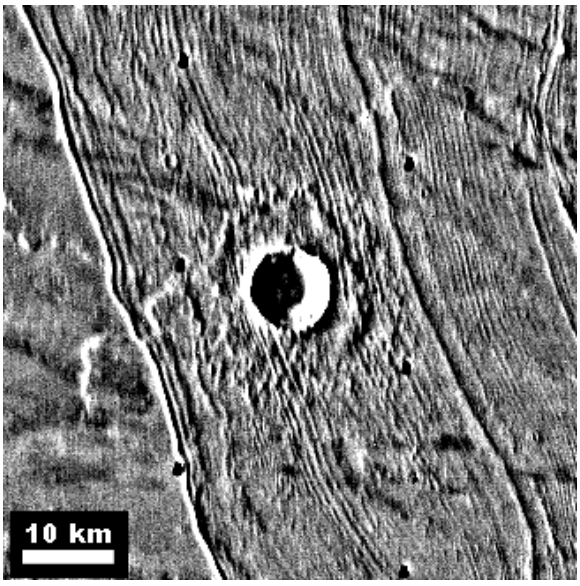

Fig. 2. Viking Orbiter image of the ridged facies of the fan-shaped deposit.

Fig. 4. Viking Orbiter image of the smooth facies of the fan-shaped deposit.