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Geologic Mapping of the Pavonis Mons Fan-Shaped Deposit

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Abstract

The Tharsis Montes fan-shaped deposits are Amazonian-aged indicators for climate development on Mars and are currently being geologically and geomorphologically re-mapped (Arsia Mons is completed, [11]) and compared to and evaluated against earlier Viking-Orbiter- and THEMIS-based map data and unit definitions, extents and surface-unit characteristics. This work presents first results of a high-resolution geologic mapping approach of the Pavonis Mons fan-shaped deposit based on Mars Reconnaissance Orbiter (MRO) Context Camera (CTX) data.

1. Background

Pavonis Mons is the central volcano of the three Tharsis Montes (Arsia Mons, Pavonis Mons and Ascraeus Mons) and is located at 0.8°N/246°E. Each of the three shield volcanoes has an Amazonian-aged fan-shaped deposit [1] which consists of three characteristic facies: a ridged facies (Ar), a knobby facies (Ak) and a smooth facies (As) [1-5, 9-10] as well as two transitional units (Ark and Ask). This fan-shaped deposit (figure 1) extends 250 km northwest of the Pavonis Mons shield flank along a N27°W trend [1] and has been described in detail by e. g. [1-5]. Various hypotheses were made with respect to the origin of the fan-shaped deposits including landslides [6-7], glacial processes [8], pyroclastic flows [2] and a combination of glacial and volcanic processes [3]. Recent studies [1, 4-5, 9] suggest that the fan-shaped deposits of the Tharsis Montes are the depositional remains of cold-based glaciation. For the Pavonis Mons fan-shaped deposit, the ridged facies was interpreted as recessional moraines, which were formed along the distal margins of a glacier during its retreat [3, 8]. In recent studies [1, 4-5, 9], the authors assumed the ridges to be drop moraines and draw comparisons to terrestrial cold-based glaciers of the Antarctic Dry Valleys, whose climatic conditions are similar to those of cold and hyperarid regions on Mars [10]. The knobby facies, interpreted as sublimation till, is assumed to be debris, which was deposited during sublimation and down-wasting of glacial ice [1, 4-5] and it shows similarities to the sublimation tills of the glaciers of the Antarctic Dry Valleys as well [1, 4, 10]. The smooth facies was interpreted as remains of a large and continuous smooth deposit of a debris-covered ice sheet of the most recent glacial activity of Pavonis Mons [1, 4, 9]. The last complete mapping of the Tharsis Montes was done by [2]. In the context of geologic mapping work focused on specific topics, the Arsia Mons fan-shaped deposit has recently been re-mapped by [11]. Mapping results showed several differences when compared to earlier mappings. In this context it is of special interest if and to what extend the stratigraphic picture and unit correlations of the other two fan-shaped deposits at Pavonis and Ascreaus Montes have changed after being re-mapped at larger scale.

2. Data

The study area is located northwest of the Pavonis Mons shield flank between 0.1°N to 7.4°N and 242.2°E to 247.7°E and covers an area of 75,000 km^2. Mapping is based on 58 high-resolution images of the MRO CTX experiment with map scales of 5.3 meters/pixel to 6.6 meters/pixel. Mapping was conducted at a map-scale of 1:200,000 by making use of ESRI's ArcGIS Desktop 9.3 environment.

3. First Results

The results of this mapping exercise compiled thus far show significant differences when compared to the first mapping work of [1-3]. In particular, the distribution of the smooth facies shows several differences: two outliers west of the main smooth deposit unit are now mapped as a single unit. Furthermore, south of the main smooth deposit a unit mapped by [1, 3] as knobby facies is superimposed by the smooth facies which continues further towards the southeast. [2]

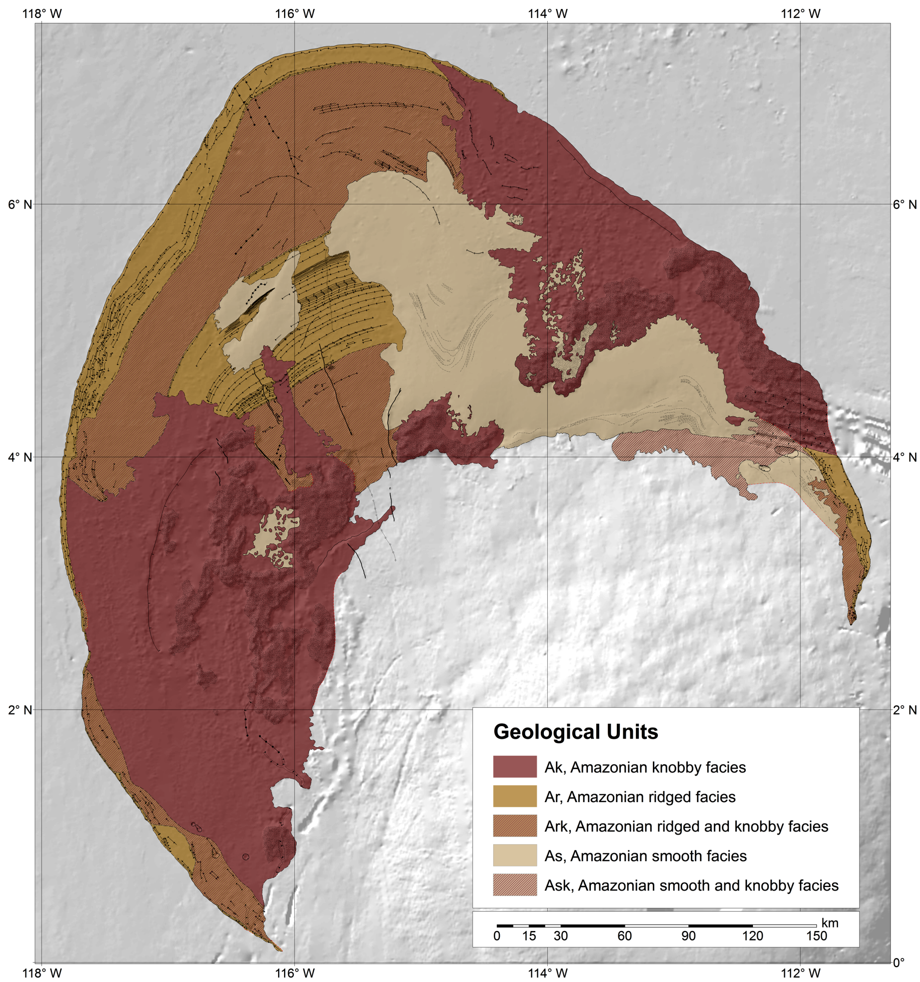

Figure 1: Map compilation of the facies distribution and relationships of the Pavons Mons fan-shaped deposit units.

mapped a transitional *ridged and knobby* unit in which both facies are partly mixed and share a common boundary. Such superpositions are currently treated differently to reflect their correct depositional environment in the map representation. Rather than defining a mixed unit, the original ridged unit is treated as primary one which is superimposed by smoother deposits (secondary unit). Such an approach allows to correlate units more efficiently and allow to trace characteristic crater-size distributions in order to establish an absolute relation to the Martian chronostratigraphy. Additional boundary constraints are introduced by characteristic structural landmarks (such as pit chains) which allow to define boundaries for volcanic activity.

References

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