GEOLOGIC MAPPING OF ARSIA AND PAVONIS MONTES, MARS. W. B. Garry[1], D. A. Williams[2], and J. E. Bleacher[1] [1]Planetary Geodynamics Laboratory, Code 698, NASA Goddard Space Flight Center, Greenbelt, MD 20771, william.b.garry@nasa.gov, [2]School of Earth and Space Exploration, Arizona State University, PO Box 871404, Tempe, AZ 85287.

Introduction: Arsia and Pavonis Montes are two of the three large shield volcanoes that comprise the Tharsis Montes on Mars. Detailed mapping of a limited area of these volcanoes using HRSC images (13-25 m/pixel) revealed a diverse distribution of volcanic landforms within the calderas, and along the flanks, rift aprons, and surrounding plains **[1]**. We are funded by NASA's Mars Data Analysis Program to complete digital geologic maps of both Arsia and Pavonis Montes based on the mapping style defined by **[1,2]**. Here, we report on the progress from year 3 of the project **[3]**.

Data and Methods: We are mapping the two volcanoes in ArcMap 10 at 1:1,000,000 scale to produce two geologic maps for the USGS. A CTX mosaic serves as the basemap, supplemented by HRSC, THEMIS daytime IR, HiRISE, and MOLA data. Our primary objective is to show the areal extent, distribution, and stratigraphic relations of the different lava flow morphologies across each volcano to better understand their evolution and geologic history.

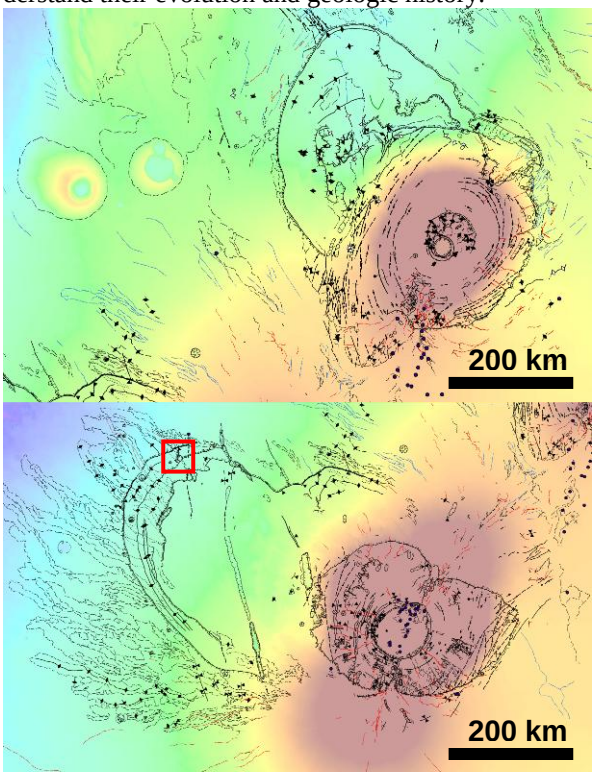

Figure 1. Current progress of the geologic maps of Pavonis Mons (top) and Arsia Mons (bottom). Basemap is MOLA colorized topography. Location of linear cones, shown in Figs. 2, 3, are marked by a red box.

Geologic Observations: Mapping objectives this year were to establish the contact between volcanic products from the two volcanoes and outline the boundaries of the morphologic provinces: calderas, shield, rift aprons, and fan-shaped deposits (Fig. 1).

Caldera. Arsia Mons has a series of small shields on the floor of the caldera, eruptions along the northwest rim that flow into the caldera, and flows that breach the northeast rim. The caldera floor on Pavonis is comprised of a series of sheet-like or ponded flows.

Main Shield. The eastern flank of Arsia Mons is comprised of channeled flows, ridged units with collapsed tubes along the crest, and lava fans, while the western flank is dominated by rille-like channels and surfaces affected by processes related to the surficial deposit. Pavonis Mons is relatively featureless surrounding the caldera, but several channels and lava fans are observed along the flanks, including eruptions that occurred after formation of the circumferential graben which produced flows that overlie and embay flows that emanate from the rift aprons.

Rift Aprons. Rille-like channels separated by smooth, featureless plains occur near the chasmata on the NE and SW flanks of each volcano. Flows with well-defined margins begin to develop further down slope on the rift aprons. Long lava flows extend for 100s of kilometers and embay or partially bury the main flank of each volcano. We are attempting to define the boundaries of the flow fields for each rift apron to determine their spatial extent. The SW rift apron on Pavonis Mons is comprised of a small shield field and an extensive series of flows that wrap counterclockwise around the base of the main flank toward Ascraeus Mons and truncate flows from the NE apron. An extensive series of flows have been mapped on the western side of Arsia Mons that have been partially buried by the fan-shaped deposits but it is unclear if they are related to initial eruptions from the main flank or the rift aprons (Fig. 2).

Fan-shaped Deposits. The deposits extend ~500 km away from the base of the main shield at Arsia Mons and ~200 km at Pavonis Mons. Three facies mapped within the deposits are ridged, knobby, and smooth **[4-6]**. The ridged units are found along the distal boundary of the deposits, the knobby units occurr within the central area, and smoother facies are near the base of the main flank. These are interpreted to be deposited during the retreat of cold-based glaciers **[4,5]**.

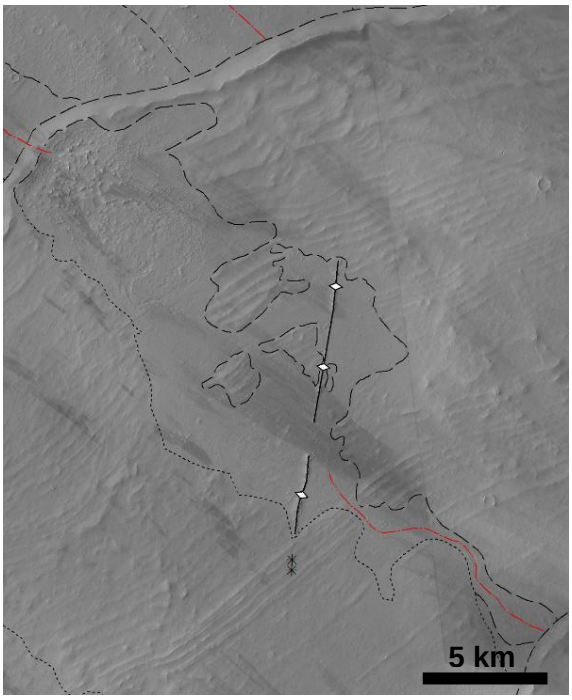

Figure 2. Linear cones and associated lava flows that appear to embay the ridged unit of the fan-shaped deposit on Arsia Mons. Basemap is CTX mosaic.

Discussion: Mapping reveals a similar sequence of events for the evolution of both volcanoes: 1) main shield forms, 2) eruptions from the NE/SW rifts emplace long lava flows that surround the main flank, 3) eruptions wane and build up the rift aprons and shield fields, 4) glaciers deposit surficial material, and 5) localized recent eruptions along the main flanks, in the calderas, and within the fan-shaped glacial deposits.

An example of recent volcanism occurs within the fan-shaped deposit at Arsia Mons (Fig. 2). Flows emanate from a narrow, linear chain of cones in the northern extent of the deposit (Fig. 1). The flows appear to embay the ridged unit (Figs. 2, 3) indicating they were emplaced after the interpreted periods of glaciation in the region. The fan-shaped deposits at Arsia Mons have a cratering model age of <100 Ma **[4]**. This suggests the volcanism associated with the linear cones occurred within the last several 10s of Ma. We do not have a cratering model age on the linear cones at this time. However, the recognition of post-glacial volcanism would agree with previous work that suggested volcanism occurred in the last 100-200 Ma within the calderas of Arsia and Pavonis Montes **[7]**.

Mapping of the different volcanic morphologic features has revealed a complex and diverse evolution of these volcanoes. We will continue to map the details of Arsia and Pavonis Montes and finalize the digital geologic maps in the 4th and final year of the project.

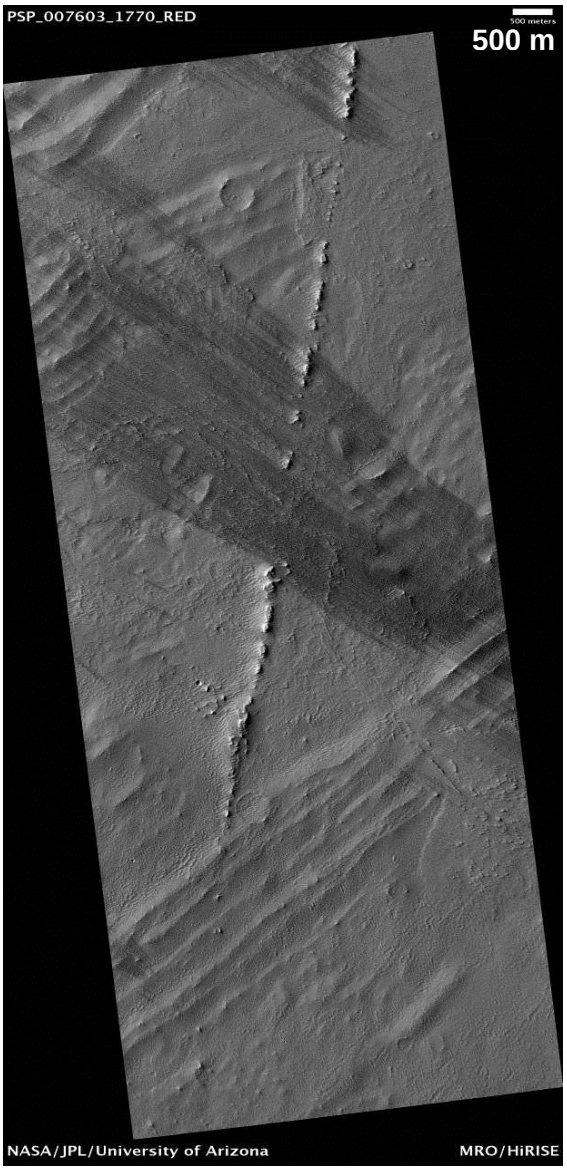

Figure 3. Linear cones and associated lava flows within the fan-shaped deposit at Arsia Mons. HiRISE Image PSP_007603_1770_RED [NASA/JPL/UofA].

References: **[1]** Bleacher J. E. et al. (2007) *JGR,112,* E04003, doi:10.1029/2006JE002826. **[2]** Bleacher J. E. et al. (2007) *JGR, 112,* E09005, doi:10.1029/2006 JE002873. **[3]** William D. A. et al. (2012) *LPSC 43,* Abstract 1528. **[4]** Shean D.E. et al. (2007) *JGR,112,* E03004, doi:10.1029/2006JE002761. **[5]** Shean D.E. et al. (2005) *JGR, 110,* E05001, doi:10.1029/ 2004JE002360. **[6]** Head J.W. and Marchant D. R. (2003) *Geology, 31,* 641-644. **[7]** Robbins et al. (2011) *Icarus, 1179-1203.*

Acknowledgements: This research is funded by a NASA Mars Data Analysis Program (MDAP) grant to D.A. Williams.