MORPHOLOGIC AND CHRONOLOGIC STUDIES OF LAVA FLOW FIELDS IN THE SOUTHERN THARSIS REGION OF MARS. David A. Crown[1], Michael S. Ramsey[2], and Daniel C. Berman[1], [1]Planetary Science Institute, 1700 E. Ft. Lowell Rd., Suite 106, Tucson, AZ 85719, [2]Department of Geology and Planetary Science, University of Pittsburgh, Pittsburgh, PA 15260; crown@psi.edu.

Introduction: The current investigation examines the styles and sequences of volcanism in the southern Tharsis region of Mars using imaging, topographic, and compositional datasets. We are producing geologic and flow field maps of the region south of Arsia Mons and in Daedalia Planum in order to examine flow morphology as an indicator of emplacement processes [1-4] and to assess flow field development and stratigraphy [1-4]. Populations of small, superposed impact craters are used to derive relative and absolute age constraints for individual flows and flow sequences [3-4]. Related studies are evaluating thermophysical signature to determine composition and degradational history [5-6].

Geologic and Flow Field Mapping: Mars Reconnaissance Orbiter Context Camera (CTX; ~5 m/pixel) images imported into ArcGIS are the primary image base used to map southern Tharsis flow fields at 1:50,000-scale. In order to fully characterize the observed volcanic features, we also use the Mars Odyssey Thermal Emission Imaging System (THEMIS) global mosaic and infrared multi-band images (~100 m/pixel), High Resolution Imaging Science Experiment (HiRISE; ~1 m/pixel) images, and Mars Orbiter Laser Altimeter (MOLA; 128 pixel/deg) DEMs and profiles.

Study Area: The study area consists of 8 1:500K-scale MTM quadrangles between 22.5°-37.5°S and 120°-140°W, an area of 500,000 km^2 through which lava flows extend from south of Arsia Mons through Daedalia Planum to the southernmost extent of the Tharsis region. Along a ~1,375 km NE-SW transect of this area, surface slopes decrease steadily from 0-5° to < 0.5° and changes in flow morphology are evident.

Flow Field Morphology: To the south of Arsia Mons, numerous prominent, long, narrow, sinuous lava flows are observed. Analysis of CTX images allows identification of two main lava flow types: 1) large, relatively thick, higher albedo flows with rugged upper surfaces that display medial channel and levee systems and broad, distal flow lobes, and 2) small, relatively thin, lower albedo flow lobes with mostly featureless surfaces that are typically associated with narrow lava channels or lava tubes. To the SW in Daedalia Planum, wider, less well-defined flow units are evident and coalesce to form a vast volcanic plain. Further to the SW at the southern margin of Tharsis, large, ridged, and locally platy, sheet flows along with a series of presumed volcanic plains embay the cratered highlands. Along the margins of a large sheet flow in SW Daedalia Planum [7], smooth surfaced plateaus with steep margins are observed. These are interpreted to be the result of flow inflation as the front stagnates upon encountering the highlands; in some cases, small breakouts are observed along the edges of the inflated plateaus.

Flow Field Chronology: CTX images allow reconstruction of complex volcanic surfaces, including delineation of individual flow lobes and superposition relationships within a flow field. Flow field mapping reveals complex flow patterns and local interfingering and overlapping relationships.

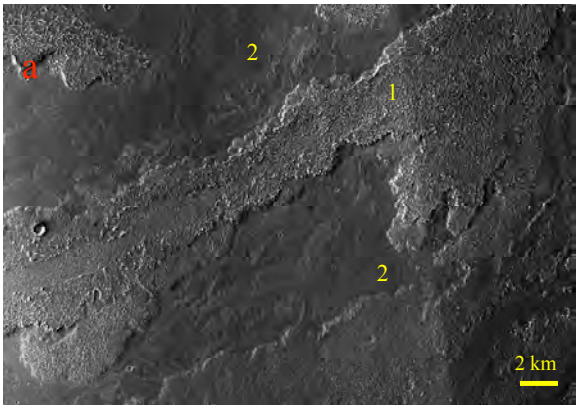
Using CTX images, populations of small impact craters superposed on lava flow surfaces have been analyzed to complement analyses of flow field stratigraphy. Crater size-frequency distribution statistics have been calculated using established methodologies [8-11]. All impact craters (primaries and isolated secondaries) on a given surface are counted while avoiding areas of obvious secondary chains or clusters. These data are then plotted on the isochrons defined by [9-11] to assess relative (Martian time-stratigraphic) age and estimate absolute age.

Preliminary results for parts of four lava flow lobes south of Arsia Mons show consistent results. The crater size-frequency distributions match the isochrons for crater diameters between ~70 and ~250 m, with a downturn at smaller sizes. These data suggest ages of ~100 My in the Late Amazonian Epoch.

Preliminary results for the large sheet flow in SW Daedalia Planum suggest an earlier phase of volcanism than for the narrower flows to the NE. The crater size-frequency distributions for 2 sub-regions of the sheet flow match the isochrons for crater diameters between ~200 and ~500 m, with a downturn at smaller sizes. These data suggest emplacement during the Middle Amazonian Epoch (0.5-1 Gy). Comparison with the lobes to the NE suggests a decrease in age of southern Tharsis volcanism toward Arsia Mons.

Summary: Detailed geologic and flow field mapping using recently acquired high resolution datasets provides a critical tool for interpreting the styles and timing of volcanic processes on Mars. Future work will synthesize morphologic and morphometric analyses of lava flows, mapping and stratigraphic studies, and constraints on chronology from impact crater populations to decipher the volcanic evolution of the Tharsis region of Mars.

References: [1] Crown, D.A. et al. (2009), *LPSC XL*, abstract 2252. [2] Crown, D.A. et al. (2010), *LPSC XLI*, abstract 2225. [3] Crown, D.A. et al. (2011), *LPSC XLII*, abstract 2352. [4] Crown, D.A. et al. (2011), *AGU*, abstract V31A-2514. [5] Ramsey, M.S. and D.A. Crown (2010), *LPSC XLI*, abstract 1111. [6] Ramsey, M.S. and D.A. Crown (2011), *AGU*, abstract P42C-06. [7] Crown, D.A. and D.C. Berman, this issue. [8] Berman, D.C. and Hartmann, W.K. (2002), *Icarus*, 159, 1-17. [9] Hartmann, W.K. (2005), *Icarus*, 174, 294-320. [10] Hartmann, W.K. (2007), 7th Intl. Conf. on Mars, abstract 3318. [11] Hartmann, W.K. (2007), *Icarus*, 189, 274-278.



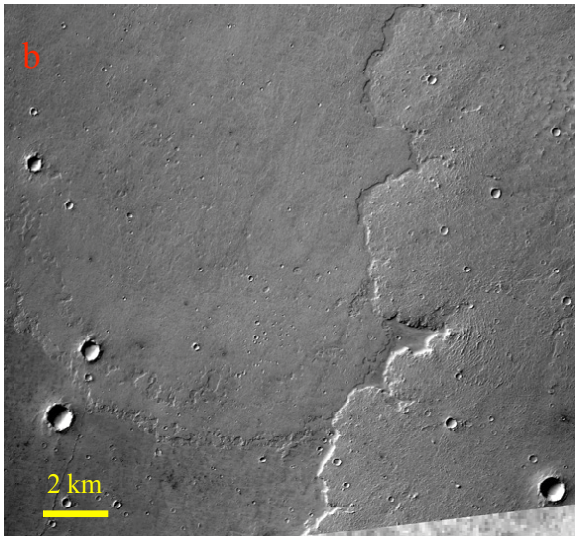


Figure 1. a) Region south of Arsia Mons showing (1) bright, rugged flow with central channel and complex lateral levees and (2) dark, small lobes associated with small channels/lava tubes; b) surface of Daedalia Planum consisting of wider lobes that coalesce to form plains; and c) sheet flows in SW Daedalia Planum with ridged surfaces. Note smooth plateau (p) adjacent to highlands that may be inflated margin of sheet flow with possible late-stage breakouts at plateau edge. Figures are CTX images from GIS mapping database.

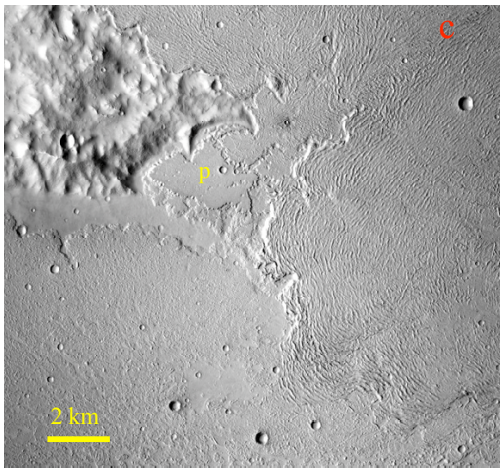


Figure 2. Crater size-frequency distributions for lava flows in Arsia Mons/Daedalia Planum study area. a) lava flow lobe south of Arsia Mons and b) two regions within sheet flows in SW Daedalia Planum. See text for discussion.