MAPPING ARSIA MONS LAVA FLOW FIELDS: INSIGHTS INTO FLOW EMPLACEMENT PROCESSES AND FLOW FIELD DEVELOPMENT. 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; crown@psi.edu, [2]Department of Geology and Planetary Science, University of Pittsburgh, Pittsburgh, PA 15260.

Introduction: Arsia Mons, the southernmost of the Tharsis shield volcanoes, exhibits well-developed lava flow fields with a multitude of individual lava flows [1-5]. The current study utilizes high-resolution images combined with topographic and thermal infrared data to produce detailed flow field maps that provide new insights into flow emplacement processes and flow field development. Previous work has focused on channel and levee systems, characteristics of flow margins, and degradation of flow surfaces [5]. A related analysis of the thermophysical and spectral variability of Arsia Mons lava flows is presented by Ramsey and Crown [this issue].

Study Area and Datasets: Arsia Mons is 461 x 326 km across and 17.7 km high, with exposed relief of 11+ km and flank slopes averaging ~5° [6]. Arsia Mons has a well-developed summit caldera [7-11] and exhibits two large aprons of flows that extend from alcoves on the NE and SW flanks of the volcano and postdate its main shield [6, 12]. The current study focuses on lava flows on the southern flanks of the Arsia shield, on the SW apron, and in the plains surrounding Arsia Mons to the south, an area roughly between 10 and 30°S and 110 and 140°W. We utilize the Mars Odyssey Thermal Emission Imaging System (THEMIS) global mosaic (230 m/pixel) and infrared multi-band images (~100 m/pixel), Mars Reconnaissance Orbiter Context Camera (CTX; ~5 m/pixel) and High Resolution Imaging Science Experiment (HiRISE; ~1 m/pixel) images, and Mars Orbiter Laser Altimeter (MOLA; 128 pixel/deg) DEMs for our analyses along with ArcGIS software.

Southern Arsia Flow Field Characteristics: CTX and HiRISE images reveal small circular to elongate vents that commonly occur in clusters, long, narrow channels, and two main lava flow types. The flow types observed south of Arsia Mons are 1) large, relatively thick, bright flows with rugged upper surfaces that display medial channel and levee systems and broad, distal flow lobes, and 2) small, relatively thin, dark flow lobes with mostly featureless surfaces that are typically associated with narrow lava channels. The bright, rugged flows display patterns of small high-standing bedrock exposures that indicate local flow direction and levee structure. Their planform shapes and margins can be complex due to flow branching and complicated sequences of lateral spreading and breakout. Individual flow lobes are more difficult to discriminate in regions dominated by dark, smoother flows, whose margins are also not as distinct and suggest both primary and eroded morphologies.

The array and diversity of volcanic features observed is similar to that found on the flanks of terrestrial basaltic shield volcanoes. The downslope morphologic zonation within individual large flows and development of prominent medial channel and levee systems is also generally similar to Hawaiian basaltic flows [e.g., 13-14]. The flow types recognized are consistent with channel-fed and tube-fed units described in previous work [4] that showed consistent embayment of tube-fed flows by channel-fed flows on the main flanks of Arsia Mons but less consistent relationships in the plains to the south.

Flowfield Stratigraphy: CTX images imported into ArcGIS are the primary image base used to map parts of the southern Arsia flow field at 1:50,000-scale. Results show that distinct embayment relationships are observed between and among both types of flows recognized (Figures 1 and 2). The prominent and distinct margins of the bright, rugged flows are key indicators of flow lobe superposition, with loss of sinuosity and small-scale breakouts at their embayed margins. The darker flows are typically observed to be deflected by the thicker margins of the bright, rugged flows, but in some cases dark flows are observed extending onto and partially to completely burying the rugged levees of bright flows. Darker flows are also observed to inundate and be topographically controlled by central channels within bright flows. In several locations, lateral breakout lobes from bright, rugged flows are observed to flow over darker flow surfaces and cover narrow channels associated with the darker flows. Contact relationships between flows of similar brightness are also observed, although it can be difficult to confidently interpret relative ages in some of these cases. Given the observed complexity of flow interactions and lack of systematic stratigraphic patterns, it appears that lava sources with different eruptive styles and magnitudes (and possibly compositions) were distributed throughout the region and active contemporaneously. CTX-based flow field mapping reveals important details regarding local sequences of flow emplacement that allow reconstruction of complex flow field surfaces.

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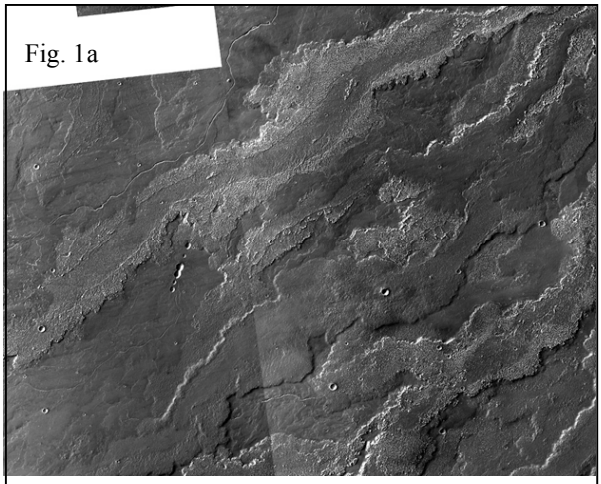

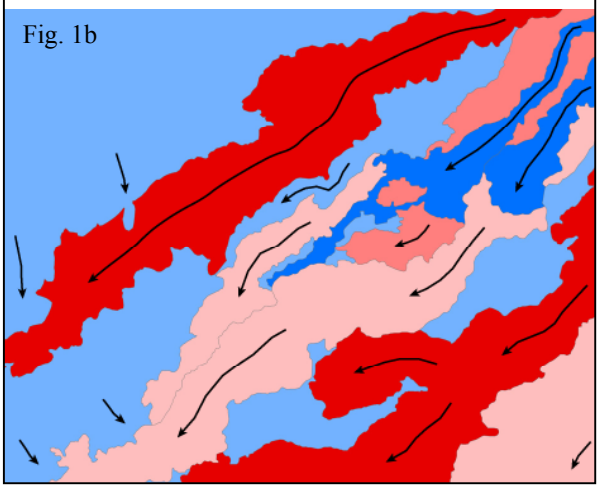

Figure 1. CTX image mosaic (a) and corresponding flow map (b; 58 km wide; center 121.68°W, 24.2°S; north to top) of part of southern Arsia flow field showing flow types and stratigraphy (bright flows in reds, dark flows in blues). Within a given flow type, relative age is given by the intensity of the color (i.e., dark blue flows are younger than light blue flows). Most bright, rugged lobes in this region are embayed by darker flows, although some bright flows appear to both cover and be buried by dark flows in different locations. Note capture of the youngest dark flows by central channels in bright, rugged flows at upper right.

Figure 2. CTX image mosaic (a) and corresponding flow map (b; 47.5 km wide; center 122.41°W, 22.83°S; north to top) of part of southern Arsia flow field showing flow types and stratigraphy (bright flows in reds, dark flows in blue, and unmapped region in tan). Sequence from oldest to youngest interpreted to be: remnant bright flows (pink), embayed bright flow (light red), 2 stages of dark flows (mapped together in blue), and bright flow with channel/levees (bright red).