ARSIA MONS LAVA FLOWS: INSIGHTS INTO FLOW FIELD EMPLACMENT AND STRATIGRAPHY FROM CTX AND HiRISE IMAGES. David A. Crown[1], Daniel C. Berman[1], Ruben Rivas[2], and Michael S. Ramsey[3], [1]Planetary Science Institute, 1700 E. Ft. Lowell Rd., Suite 106, Tucson, AZ 85719; crown@psi.edu, [2]College of Engineering, University of Arizona, Tucson, AZ 85721 [3]Department of Geology and Planetary Science, University of Pittsburgh, Pittsburgh, PA 15260.

Introduction: Arsia Mons, the southernmost of the three prominent Tharsis shield volcanoes, exhibits well-developed lava flow fields with a multitude of individual flows and flow lobes. Recent imaging of the Martian surface now reveals small-scale characteristics of lava flow surfaces that provide new insights into flow emplacement processes, which are useful for understanding the styles and diversity of volcanism on Mars. Our current research focuses on lava flows south of Arsia Mons and utilizes new high-resolution images as well as topographic and thermal infrared data to examine the development of channel and levee systems, local sequences of flow emplacement, and degradation of flow field surfaces.

Arsia Mons. The Arsia Mons shield is 461 x 326 km across and 17.7 km high, with exposed relief of more than 11 km and flank slopes averaging ~5° [1]. Arsia Mons has a well-developed summit caldera [2-6] and exhibits two large aprons of flows that extend from alcoves on the lower NE and SW flanks of the volcano and postdate its main shield [1, 7]. 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. Our study focuses on lava flows in Tharsis Montes flow units and Arsia Mons flow units defined in previous 1:2M scale lava flow maps using Viking Orbiter images [8-10]. Recent studies of the Tharsis region, including the Arsia Mons shield, have utilized Mars Express High Resolution Stereo Camera (HRSC) images to examine evolutionary stages in effusive volcanism [11].

Flow Field Mapping and Flow Lobe Analyses. Our investigation includes the production of flow field maps showing small vents, channels, and flow lobe margins that provide a general characterization of flow field properties and that can be used to assess the effects of emplacement over different slopes. We are using all available datasets in a GIS database with a particular focus on the detailed morphology now revealed in MRO CTX and HiRISE images. We are also compiling morphometric parameters (length, width, thickness, surface slope, orientation, sinuosity) for individual flow lobes as well as detailed maps of select localities to document the development of channel and levee systems. Using HiRISE images, small-scale flow surface characterizations are being completed that document the relative areal coverages of exposed bedrock and mantling deposits, the occurrence of boulders, and the abundance and preservation states of small impact craters.

Results. Analysis of CTX and HiRISE images in our GIS database (also including THEMIS IR and VIS, MOC, and Viking images/mosaics and MOLA DEM) for the southern Arsia Mons region provides new insights into flow field development. The new high-resolution datasets allow identification of small circular to elongate vents, narrow lava channels, and different types and sizes of lava flows. Preliminary observations suggest that two main flow types are evident in the plains south of Arsia Mons: 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 array and diversity of volcanic features observed is similar to that found on the flanks of terrestrial basaltic shield volcanoes, such as Kilauea Volcano in Hawaii, and the downslope morphologic zonation within individual large flows is generally similar to Hawaiian basaltic flows [e.g., 12-13]. The flow types recognized are also consistent with the channel-fed and tube-fed units described by [11].

CTX images reveal important details regarding local sequences of flow emplacement that allow reconstruction of the complex flow field surfaces. Distinct embayment relationships are observed between and among both types of flows recognized. No systematic patterns have thus far been identified, and it appears that lava sources with different eruptive styles and magnitudes were distributed throughout the region and active contemporaneously. The analysis of [11] 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, where our current observations are concentrated.

Analyses of individual large, rugged flows show some large-scale branching into sub-lobes as well as locations where breakouts from a widened zone extend the flow downslope. These could have occurred due to temporary stagnation of the flow front (resulting from changes in topography and/or supply) and then renewed advance. Medial channel and levee systems are common in large, rugged lobes, with small high-standing bedrock exposures of the flow surface forming patterns that indicate local flow direction and levee structure. Channels are typically bound by a sharp, linear to curvilinear inner levee and display relatively constant widths. Channel surfaces are typically depressed from the surrounding flow surface and mantled by dark fine-grained material. Levee systems commonly make up much of the flow width and consist of coalesced lobes that have spread laterally from the inner channel. Small, potential late-stage breakout lobes define the outer, lateral flow margins. Some large, late-stage lobes appear to disrupt the main flow levee and form small side lobes. The morphology of the channel and levee systems suggests a complex spatial and temporal history within a given flow. Therefore, the flow cross-section at any given point, changes in flow cross-section downslope, and the overall flow shape record a delicate balance between supply history, advance of the flow front, and lateral spreading and levee development.

HiRISE images of Arsia Mons flows show clusters of small, often streamlined, bright rocky outcrops with dark, fine-grained materials in the locally low-lying regions surrounding them. The bedrock exposed appears to be highly wind-eroded remmants of the flow surface with aeolian sediments accumulated around them. Groups of boulders are evident adjacent to some bedrock exposures as well as surrounding small impact craters with relatively pristine morphologies. HiRISE images provide information on flow surface degradation that can be used to support interpretations of local flow stratigraphy, as preliminary observations show consistency between embayment relationships and the degree of mantling and erosion of the flow surface. Our ongoing work will include quantitative analyses of the thermophysical properties of the flow surfaces as an additional means of flow field characterization.

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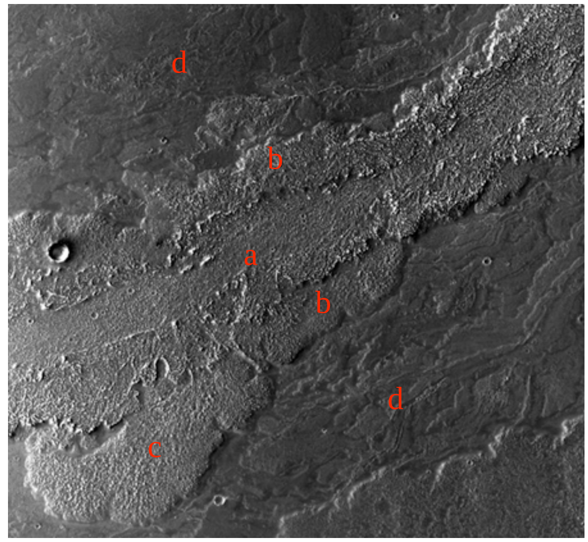

Figure 1. CTX image (P04_002500_1563) of lava flow (~5 km wide at its narrowest location) south of Arsia Mons showing a) the central channel, b) lateral levees, c) breakout lobe, and d) adjacent smaller, dark flows that are clearly overlain by the bright, rugged flow along its northern margin.

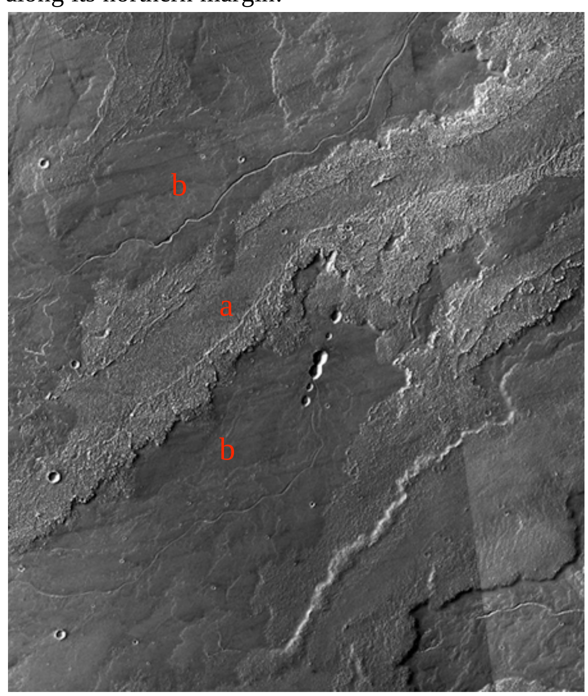

Figure 2. CTX images (P01_001524_1569 and P01_001590_1567) of lava flows south of Arsia Mons showing bright, rugged flow with a) central channel and lateral levees and b) dark flow fields containing narrow channels and aligned circular vents. Note that the dark flows embay the ~5 km wide, bright channelized flow.