GEOLOGIC MAPPING OF THE WESTERN FLANK OF ALBA MONS, MARS. David A. Crown[1], Daniel C. Berman[1], Stephen P. Scheidt[2], and Ernst Hauber[3], [1]Planetary Science Institute, 1700 E. Ft. Lowell Rd., Suite 106, Tucson, Arizona 85719 (crown@psi.edu); [2]Lunar and Planetary Laboratory, University of Arizona, Tucson, Arizona 85721; [3]Institute of Planetary Research, German Aerospace Center, Berlin, Germany.

Introduction: This investigation is designed to provide new constraints on the volcanic history and geologic evolution of the western flank (230-245°E, 37.5-47.5°N) of Alba Mons. We are using imaging and topographic datasets to produce a 1:1M-scale geologic map that documents the distribution and character of the lava flow fields that extend from the volcano's summit region to the Martian northern plains. Age constraints for volcanic, tectonic, and fluvial processes are being derived from detailed mapping of cross-cutting relationships combined with compilation and assessment of crater size-frequency distributions.

Background: Alba Mons is a large, low-relief volcano (1015 × 1150 km in planform; ~6 km relief) with low flank slopes (~1°) [e.g., 1-5]. Studies using Viking Orbiter images described the summit caldera complex, extensive lava flow fields, and prominent sets of circumferential graben [6-15]. Diversity in Alba Mons' lava flows was recognized in Viking Orbiter images, with a series of different morphologies described [6-7, 14-15]. Dendritic valley networks are observed on Alba Mons' northern flank [8**,** 16-17]. Coupled with Alba's low relief, the valley networks have been interpreted to indicate the presence of pyroclastic deposits, suggesting that Alba Mons may be a transitional form from the ancient highland paterae to the prominent shield volcanoes of the Tharsis region [8].

Data Sets and Mapping Methodology: Geologic mapping of Alba Mons utilizes THEMIS, HRSC, CTX, and HiRISE images supported by HRSC and MOLA topography. GIS software and analysis tools are being used for the production of digital and hard copy USGS map products. The map base includes 6 1:500,000-scale Mars Transverse Mercator (MTM) quadrangles.

Geologic Mapping: Analyses of CTX and THEMIS IR images have resulted in the production of a preliminary geologic map of the study region, showing the distribution and types of volcanic, tectonic, fluvial, and impact features [18-20]. Mapped volcanic features on the western flank of Alba Mons include lava flow margins and lava tube segments. Lava flows are recognized throughout the western flank, with trends predominantly radial to the summit region, though flow paths are observed to be deflected by local topographic obstacles including pre-existing craters and volcanic flows. Lava flows are typically elongate with relatively constant widths, although variations in width, flow branching, and broader lobes are also observed. No clear source vents have been identified, presumably because those on the flanks could have been buried and because numerous flows appear to extend from the summit region outside the map area. The preservation of flow margins varies both along individual lobes and across the study region, which exhibits clusters of well-defined lobes. Some margins are distinct, appearing as prominent lobate scarps with preserved fine-scale sinuosity that reflects differential lateral spreading during flow emplacement. Other flow margins have subdued exposures in terms of relief and/or sinuosity. Central channels within flow lobes are not typically observed; this is attributed to lack of formation of distinct central channels during emplacement and/or degradation and mantling of the flow surface. Typical flow widths are ~2-10 km and numerous flow lobes extend 100 km or more in length.

Lava tube systems also occur throughout the western flank, are concentrated in some locations, are generally radial in orientation to Alba Mons' summit, and can extend for hundreds of kilometers. Lava tubes are typically discontinuous and delineated by sinuous chains of elongate depressions, which in many cases are located along the crests of prominent sinuous ridges [20]. Lava tube systems occur as both these ridged forms with lateral flow textures and more subtle features denoted by a central distributary feature within the flat-lying flow field surface.

Tectonic deformation is recognized across Alba Mons' western flank, primarly in the form of graben. The parallel walls of the large and distinctive circumferential graben in the eastern part of the map area are mapped as individual faults. The remainder of the map area contains scattered graben and troughs, with dominant N-S (central) and NW-SE (west) trends. Some of the longest (50 to more than 200 km) and best defined features exhibit parallel bounding faults with interior pit chains along portions of their lengths.

Mapping of erosional valleys indicates significant fluvial dissection of the western and northwestern flanks of Alba Mons [20]. Elongate drainage systems radial to the summit extend for distances of more than 300 km. Trunk valleys are variably defined along their lengths and exhibit discontinuities. In general, mapped valley segments exhibit variable morphologies (e.g., width, depth of incision, and sinuosity). The sinuous groove or channel symbol is used to represent features of uncertain origin; in many cases these may be poorly

defined segments of valley networks. Dendritic patterns characterize some of the upper reaches of valley systems and adjacent terrains with relatively higher local slopes exhibit sets of parallel valley segments and erosional grooves, suggesting more broadly defined watersheds.

Current mapping also includes the rims of impact craters with diameters ≥ 2 km and crater materials, which include crater ejecta, rim, and floor deposits. We have also compiled a database of more than 12,000 impact craters ≥ 250 m in diameter to be used for deriving relative and absolute ages.

Detailed mapping of volcanic, tectonic, fluvial, and impact features allows rigorous evaluation of cross-cutting relationships for deciphering the geologic history [Figures 1]. Analyses to-date suggest tectonic deformation post-dates volcanic and fluvial activity in the map area [19, 21]. Mapped crater ejecta blankets clearly superpose lava flows in a number of locations, and distinct examples of flows embaying crater materials are lacking. Craters clearly truncate valley segments in a number of locations; in some cases valleys dissect ejecta, suggesting incomplete burial or renewed dissection along a previous erosional path. Valley segments are observed to dissect volcanic flank materials; limited examples of dissection of specific lava flow surfaces and embayment of drainage networks are also apparent. Valleys frequently follow flow margins indicating control by the local relief. In the NE part of the map area, the topography associated with adjacent ridged lava tube systems appears to both define drainage basins or subbasins and create the local relief that promotes dissection.

The distribution of lava flows and lava tube systems, including their elongate forms and radial patterns, can be attributed to the large-scale topography of Alba Mons' western flanks. Although this promotes the occurrence of adjacent parallel features, interactions between volcanic features are observed and stratigraphic relationships can be determined. In general, the planform shapes of lava flows exhibit evidence for deflection of lobes by ridged lava tube systems, but there is at least one clear example of tube-fed flow lobes burying the margin of an elongate flow. Within clusters of elongate flows, overlapping and interfingering relationships are evident and can be used to define local sequences of flow emplacement. Ongoing analyses [18-20] of imaging and topographic datasets combined with crater size-frequency distributions will be used to further unravel the complex geologic history of Alba Mons.

References: [1] Pike RJ (1978) *Proc. LPSC 9th*, 3239-3273. [2] McGovern PJ et al. (2001) *JGR 106*, 23,769-23,809. [3] Plescia JB (2004) *JGR 109*, E03003. [4] Whitford-Stark JL (1982) *JGR 87*, 9829-9838. [5] Watters TR and DM Janes (1995) *Geology 23*, 200-204. [6] Carr MH et al. (1977) *JGR 82*, 3985-4015. [7] Greeley RG and PD Spudis (1981) *Rev. Geophys. 19*, 13-41. [8] Mouginis-Mark PJ et al., (1988) *Bull. Volc. 50*, 361-379. [9] Cattermole P (1990) *Icarus 83*, 453-493. [10] Schneeberger DM and DC Pieri (1991) *JGR 96*, 1907-1930. [11] Mouginis-Mark PJ et al. (1992) in *Mars*, Univ. Arizona Press, 424-452. [12] Hodges CA and HJ Moore (1994) *USGS Prof. Paper 1534*, 194 pp. [13] Crumpler LS et al. (1996) in *Geol. Soc. Spec Publ. 110*, 307-348. [14] Lopes RMC and CRJ Kilburn (1990) *JGR 95*, 14,383-14,397. [15] Peitersen MN and DA Crown (1999) *JGR 104*, 8473-8488. [16] Carr MH and FC Chuang (1997) *JGR 102*, 9145-9152. [17] Lehnigk KE (2016) https://publish.wm.edu/honorstheses/934. [18] Crown DA et al. (2017) *LPSC XLVIII*, Abstract #2301. [19] Crown DA et al. (2017) *3rd Planet. Data Workshop*, Abstract #7034. [20] Scheidt SP et al. (2018) this volume. [21] Karimova R et al. (2017) *EPSC 2017*, Abstract #EPSC2017-207.

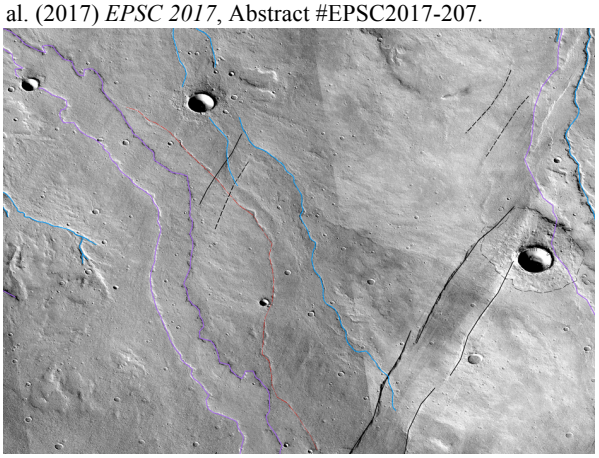

Figure 1. *Geologic mapping of western flank of Alba Mons showing relationships between volcanic, fluvial, tectonic and impact features. Image base is CTX mosaic; scene widths are ~57 km; lava flow margins (purple), lava tube segments (red), fluvial valleys (blue), and faults (black). Top) At right, impact crater (3 km diameter) overlies lava flow margin and NE-SW trending graben. At center, lava flow extends from S to NW along western margin of lava tube system. Bottom) At right, graben with interior pit chain truncates valleys. At left, impact crater (6 km diameter) truncates flow margin and valley. Note valleys along flow margins and on flow surface.*