GEOLOGIC MAPPING OF ALBA MONS, MARS: CONSTRAINTS ON SUMMIT EVOLUTION AND ERUPTIVE HISTORY. David A. Crown[1], Daniel C. Berman[1], Thomas Platz[1,2], and Stephen P. Scheidt[3], [1]Planetary Science Institute, 1700 E. Ft. Lowell Rd., Suite 106, Tucson, Arizona 85719 (crown@psi.edu); [2]Max Planck Institute for Solar System Research, Göttingen, Germany; [3]Lunar and Planetary Laboratory, University of Arizona, Tucson, Arizona 85721.

Introduction: Geologic mapping of Alba Mons is providing new constraints on the distribution, styles, and timing of volcanism in the northern Tharsis region of Mars, as well as on regional tectonic and degradational processes. This investigation employs imaging and topographic datasets for generation of two 1:1M-scale geologic maps covering the Alba Mons summit region (245-255°E, 32.5-47.5°N) and western flanks (230-245°E, 37.5-47.5°N). Age constraints 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 x 1150 km in planform; ~6 km relief) with low flank slopes (~1°) [e.g., 1-5]. Viking Orbiter analyses of Alba Mons discussed the summit caldera complex, extensive lava flow fields on its flanks and in the surrounding plains, and prominent sets of graben (Tantalus and Alba Fossae) that extend around the volcano from the south and into the northern plains [6-13]. A series of dendritic valley networks is found on the flanks of Alba Mons; coupled with the volcano's low relief, the valley networks have been interpreted to indicate pyroclastic deposits at the base of the volcano, 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 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 bases each include 6 1:500,000-scale Mars Transverse Mercator (MTM) quadrangles. The geologic maps are being compiled at 1:1M scale but digitial map layers at 1:200,000-scale will include detailed representations of volcanic, tectonic, and erosional features.

Alba Mons Summit Region: Science objectives for the summit region include documenting the collapse and tectonic history of Alba Mons' summit region and caldera complex, assessing sequences of lava flow emplacement, and a search for eruptive vents and pyroclastic deposits. Initial mapping has focused on the caldera region to develop a preliminary unit and symbol scheme [14-16], focusing on intra-caldera flows and flows on the upper flanks of the volcano extending from the caldera complex. Continued geologic mapping will progressively extend down the flanks to incorporate additional units and features and fully categorize the diverse flow types evident, as well as document cross-cutting relationships between lava flow margins, tectonic features, and erosional valleys.

Alba Mons' summit region exhibits several overlapping depressions [9, 13], suggesting a complex history of eruptive activity and collapse. The caldera complex is 190 x 110 km, with variable preservation of its rim, and contains a smaller depression with a well-defined but scalloped rim (Fig. 1a) [3]. Depression depths are <500 m [3], significantly less than observed for other Tharsis volcanoes [e.g., 17]. The main caldera rim is well-defined on its western side as prominent, terraced scarps and subdued to the east where it is distinguished by arcuate graben. Lava flows are evident within the caldera, and Mouginis-Mark et al. [8] identified a low shield interpreted to be a vent for late-stage eruptions. Cattermole [9] mapped a number of volcanic features within or near the summit caldera, including sinuous rilles, volcanic pits, linear spatter ridges, and a low shield.

Based on recently mapped flow lobe patterns [15-16], multiple sequences of lava flow emplacement have occurred from a series of vents within the summit region. Based on cross-cutting relationships, the ~65 km-across collapse depression on the southeast edge of the caldera complex represents the last stage of collapse (Fig. 1a). The rim of this depression shows diverse morphologic expression. To the south, scalloped, steep-walled areas presumably represent discrete, late-stage collapse events. Graben and scarps aligned with the eastern and western margins show the larger extent of deformation in summit materials related to this depression. Analyses of the morphology and topography of the depression floor indicate: a) the most recent eruptive activity formed small constructs to the southeast; b) flows extended from southeast to northwest across the depression floor; and c) floor materials are obscured by mid-latitude mantling deposits and the effects of aeolian activity.

Alba Mons Western Flanks: Science objectives for mapping the western flanks include expanding the total area and geologic settings over which cross-cutting relationships between volcanic, tectonic, and erosional features will be analyzed and characterizing the types, ages, and sequences of lava flows in order to document the volcanic evolution of Alba Mons.

Diversity in Alba Mon's lava flows was recognized in Viking Orbiter images. Tube-fed, sheet, tube-channel, and undifferentiated morphologies were identified on the volcano's flanks and attributed to various styles of basaltic volcanism [6-7, 18-19]. Four flow types were described, with a general progression in age, dominant morphology, and flow volume from the flanks to the summit region (where younger, shorter, and narrower flows are observed) [9]. Observed flow lengths were typically 100-250 km long, with some flows reaching almost 400 km in length. Systematic mapping of lava flows [10] in the summit region and on parts of Alba Mons' flanks defined five flow types, with tabular and crested being the dominant morphologies.

CTX images are currently being used to identify, map, and characterize lava flows on the western flanks of Alba Mons at high resolution. Geologic and feature mapping are being used to assess the types, distribution, and ages of lava flows. Spatial and temporal patterns revealed by mapping may indicate progressions in volcanic development, eruptive style, and/or lava composition.

Ages Constraints: We have compiled crater size-frequency distributions (CFSDs) to provide preliminary age estimates for parts of the Alba Mons summit area. Three regions have been examined: 1) the upper flanks surrounding the caldera complex and extending to ~5000 m elevation, 2) the entire caldera complex as defined by scarps and structural deformation at the summit, and 3) the SE collapse depression, which is interpreted to be the youngest part of the caldera (Fig. 1b). Craters were identified using CTX images. CraterStats software was used for plotting and analysis of crater statistics. Total numbers of craters counted were 2492 for the upper flanks, 1676 for the caldera complex, and 438 for the SE collapse depression. Fits to the differential CSFDs show ages of ~2.1 Ga for the upper flanks (for craters 1 km and larger), ~3.4 Ga for the caldera (for craters 3 km and larger), and ~3.4 Ga for the SE collapse depression (for craters 1 km and larger). In addition, both caldera regions show a resurfacing age of ~1.6 Ga. These preliminary results show good consistency for both eruptive and subsequent activity. They also provide evidence for younger volcanic activity on the surrounding flanks; the ~2.1 Ga age is presumably a composite representing lava flow sequences of different ages. Age estimates will be examined further upon definition and mapping of geologic units across the summit region and western flanks.

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] Crown DA et al. (2016) *LPSC XLVII,* Abstract #2383. [15] Crown DA et al. (2016) *AGU,* Abstract #191193. [16] Crown DA et al. (2016) *PGM,* Abstract #7031. [17] Mouginis-Mark PJ (1981) *Proc. LPSC 12th*, 1431-1447. [18] Lopes RMC and CRJ Kilburn (1990) *JGR 95*, 14,383-14,397. [19] Peitersen MN and DA Crown (1999) *JGR 104*, 8473-8488.

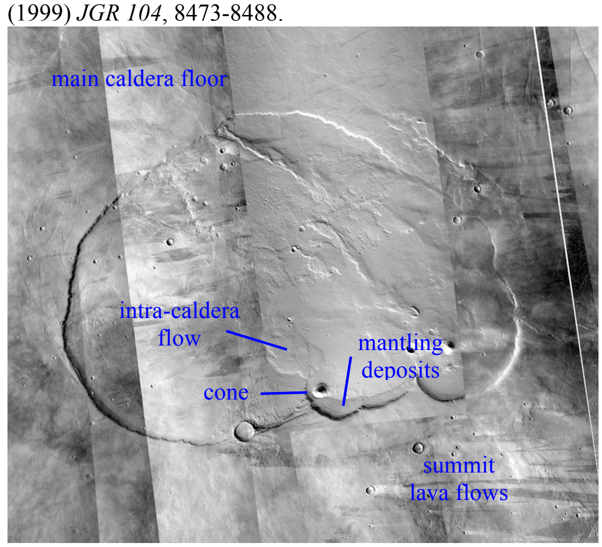

Figure 1. a) CTX image mosaic showing youngest collapse depression (~65 km across) within Alba Mons' caldera region. b) Crater size-frequency distribution plot for collapse depression.