CHRONOLOGY OF VOLCANISM IN SOUTHERN THARSIS, MARS: CONSTRAINTS FROM LAVA FLOWS IN DAEDALIA PLANUM. Daniel C. Berman and David A. Crown, Planetary Science Institute, 1700 E. Ft. Lowell Rd., Suite 106, Tucson, Arizona 85719 (bermandc@psi.edu).

Introduction: Extensive lava flow fields extending from the southwest rift apron of Arsia Mons characterize the southern part of the Tharsis Volcanic Province and form Daedalia Planum. In conjunction with geologic mapping of Daedalia Planum and associated morphologic and thermophysical analyses [1-4], we have derived new constraints on the chronology of volcanism. Here we report on age constraints from MTM quadrangles -25127 and -25122 determined from both examination of cross-cutting relationships between lava flows and analyses of crater size-frequency distributions (CSFDs).

Geologic Mapping: Digital geologic mapping of MTM quadrangles -25127 and -25122 [22.5-27.5°S, 120-130°W] using CTX and THEMIS IR images has resulted in the identification of six geologic units (Figure 1). *Highland material* occurs as small, degraded remnants of once rugged cratered terrain. *Crater material* includes the ejecta, rim, and floor deposits of impact craters scattered across the map area. Some exposures are well-preserved with continuous ejecta deposits superposed on lava flow surfaces; in other cases, relatively fresh-appearing craters have been embayed by younger flows. Four volcanic units dominate the map area. *Daedalia Planum flow material, unit 1 (DPf1)* includes undivided flows that appear to embay *highland material* and are embayed by the other volcanic units. *DPf1* has a relatively smooth, featureless surface that exhibits some scarps and troughs, lava flow margins, and some large impact craters. *Daedalia Planum flow material, unit 2 (DPf2)* is characterized by lava flows with broad, sheet-like forms, that, in the western part of the map area, coalesce to form a vast flow field. More elongate forms and embayed remnants of *DPf2* are found to the east, surrounded by younger flow units. Surface morphologies range from smooth to rough, with platy and ridged textures indicating local deformation of the surface crust. The margins of these broad flows are lobate and in places highly digitate, suggesting differential advance of a broad flow front. *Daedalia Planum flow material, units 3 and 4 (DPf3 and DPf4)* extend from the north into the map area and embay the other mapped geologic units. Detailed characteristics of these flow types, including their surface morphologies, flow behavior, and emplacement styles, are described in [1]. Elongate rough flows (*DPf3*) have knobby, ridged and/or platy surfaces and commonly have medial channel/levee systems. Elongate smooth flows (*DPf4*) extend from distributary systems that may include lava channels, lava tubes, and sinuous ridges and plateaus. CTX images reveal local interfingering and overlapping relationships and indicate that, while smooth flows are generally younger than rough flows, diverse and complex temporal relationships exist.

Volcanic Chronology: Geologic mapping suggests three main sequences of volcanism in Daedalia Planum represented by (from oldest to youngest): *DPf1* (undivided flows), *DPf2* (broad flows), and interspersed smooth (*DPf4*) and rough (*DPf3*) elongate flow units. In order to supplement our mapping-derived stratigraphy, we compiled a database of 3,625 craters ≥ 250 m in diameter for the map area. In order to improve statistical characterizations, we extended our crater counts to smaller diameters (≥ ~100 m) for some units (e.g., *DPf3*), which allowed comparisons to be made between individual flow lobes. Results are shown in Figure 1 and Table 1. CSFDs were analyzed with Craterstats 2 software in differential format using established production [**5**] and chronology functions **[5, 6].**

Absolute model age estimates from analyses of CSFDs are consistent with mapping-derived relative ages and further constrain volcanic history. The degraded surfaces of *highland material* are Late Noachian in age (~3.7 Gy), with the earliest preserved volcanism (*DPf1*) occurring in the Hesperian (~3.4 Gy). The map area is dominated by two large pulses of Amazonian volcanism. *DPf2* formed in the Middle Amazonian (~900 My) and appears to underlie much of the area covered by the younger flow units, as distinctive buried craters identified within *DPf4* show an absolute model age similar to *DPf2*. The absolute model ages for the elongate flow units reflect their interspersed nature as determined from mapping. Crater statistics indicate that *DPf4* (290±20 My) and *DPf3* (260±8 My for individual flows combined together) formed in the Middle to Late Amazonian. Analyses of individual exposures of a given unit, including a series of 17 rough elongate flows (*DPf3*), show natural variability and/or uncertainty introduced by small counting areas, but clearly support the occurrence of at least three main sequences of volcanism in southern Tharsis.

References: [1] Crown DA and MS Ramsey (2017) JVGR 342, 13-28. [2] Simurda CM et al. (2019) JGR, in review. [3] Crown DA et al. (2015) LPSC XLVI, Abstract 1439. [4] Crown DA and Berman (2019) USGS SIM, in prep. [5] Hartmann WK (2005) Icarus 174, 294-320. [6] Michael GG (2013) Icarus 226, 885-890.

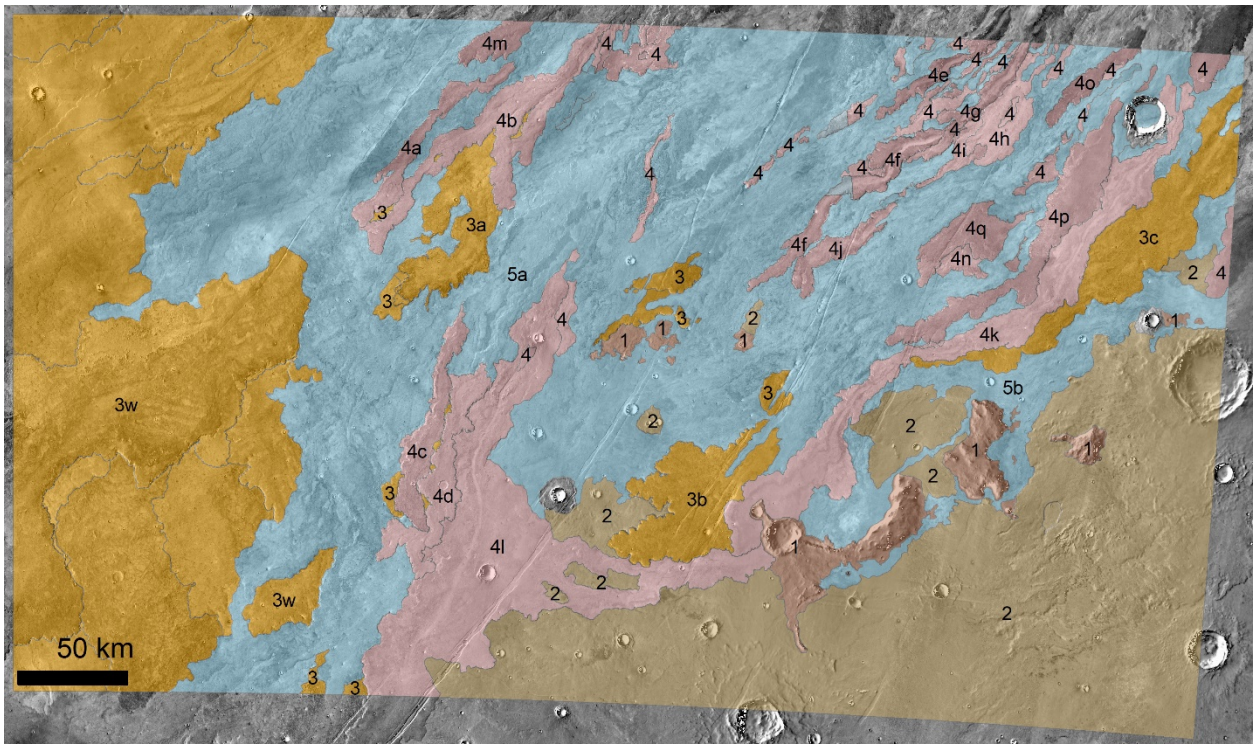

Figure 1: Top) Simplified geologic map of Daedalia Planum [22.5-27.5°S, 120-130°W] showing five geologic units: highland material (brown) and Daedalia Planum flow material, units 1 (tan), 2 (orange), 3 (pink), and 4 (blue). Numbers on the map refer to crater count areas (See Table 1). Bottom) Plot of absolute model ages (± error) from Table 1 for geologic units in the Daedalia Planum map area. Horizontal lines are boundaries of Martian epochs (LN = Late Noachian, EH, LH =Early and Late Hesperian, EA, MA, and LA = Early, Middle, and Late Amazonian). Note buried crater population within *DPf4* (5buried) has age equivalent to *DPf2* (3all).

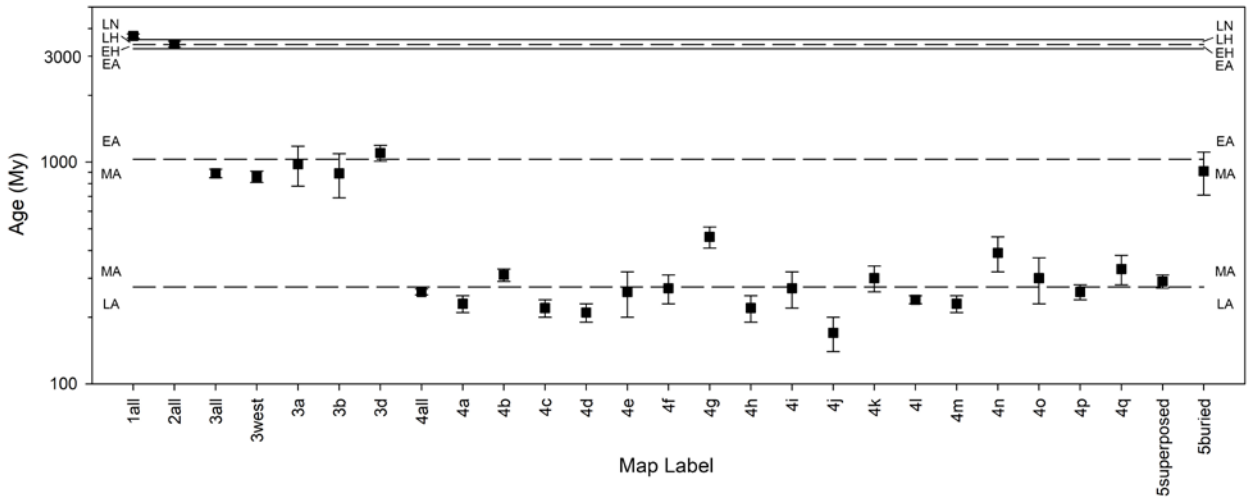

Table 1. Crater Size-Frequency Distribution Parameters for Daedalia Planum Map Area

Unit	Map Label	Area	Age (My)	Error	Total # craters	Min D (km)	Max D (km)	Fit Range	Craters in Fit
Highland	1all	3372.29	3700	+50/-80	55	0.14	15.77	1km-16km	20
DPf1	2all	32134.92	3400	+70/-100	917	0.03	37.17	1km-45km	83
DPf2	3all	42135.26	890	40	4632	0.02	5.44	350m-6.4km	709
DPf3	4all	26543.14	260	8	7910	0.02	15.77	180m-16km	1470
DPf4superposed	5superposed	63904.40	290	20	1749	0.02	3.85	350m-2.8km	347
DPf4buried	5buried	63904.40	910	200	85	0.34	17.72	1km-4km	33