AGE DISCREPANCIES WITHIN THE CERBERUS PLAINS CHANNELIZED LAVAS, MARS: OBSCURED ERUPTION SOURCES? K. B. Golder[1], D. M. Burr[1], [1]University of Tennessee Knoxville, Department of Earth and Planetary Sciences, 1412 Circle Drive, Knoxville, TN, 37996 (kgolder@vols.utk.edu).

Introduction: The lava flows located within the Cerberus plains are the youngest regional scale flows on Mars [e.g., 1-4]. Examples of areally extensive lava flows are found within three circum-Cerberus outflow channels, Athabasca (AV), Grjota (GV), and Marte Valles (MV) [Fig. 1]. The lava flows within AV and GV clearly originate from the regional Cerberus Fossae fissure network [e.g., 5-7], whereas the source of the lava infilling MV is obscured, but may have initiated from a now-buried segment of the Cerberus Fossae [6,7], or within the Cerberus plains [9]. The latest lava flows in each channel are interpreted as having been emplaced during a single eruptive event, and generally have been mapped as possessing consistent morphologies along their entire length [9-11]. Based on these findings, we expected the lava ages at disparate locations within each channel to be similar, regardless of distance from the observed source. This work presents an update to earlier, more preliminary, results [12], and discusses an unexpected trend.

Update to Previous Results: Crater counts on the lava surfaces were performed on sites that are proximal, medial, and distal to the lava flow sources [12]. These counts were performed using the CraterTools plug-in [13] in ArcGIS, using a minimum area of 1000 km^2 [14]. All craters were counted, excluding obvious secondary clusters or preexisting lava-embayed craters. In particular, we avoided secondaries from the Zunil impact (~1 Ma) [15,16] which overlap AV, GV and MV, along with secondaries associated with the Corinto impact (~3 Ma) [17] which overlap AV. Crater-count model ages were derived using best-fits to isochrons, excluding craters <40 m in dia., based on crater production functions in Craterstats2 [18,19].

In contrast to expectation, we find that ages of the lava flows in each channel *decrease* with distance from the apparent (previously mapped [8-11]) sources. Specifically, the proximal, medial, and distal AV ages trend from 3.4 ±0.2 Ma → 3.2 ±0.2 Ma → 2.9 ±0.1 Ma, for GV from 58 ±1 Ma → 33 ±1 Ma → 31 ±1 Ma, and for MV from 79 ±1 Ma → 26 ±0.6 Ma → 8.2 ±0.4 Ma (Fig. 2). Though some ages (for AV and GV) overlap within the error bars, a significant gap exists within the boundaries of the flows within GV and MV.

Hypotheses: To explain this trend, observed in all three outflow channels, of decreasing lava ages with distance from the observed source, we propose three working hypotheses: **(1)** Sub-carapace flow of lava beneath the lava crust promoted an extended timeframe for multiple lava emplacement events; **(2)** Preferential weathering of craters in the distal portions of the lava flows skews the derived ages younger; and **(3)** (An) additional but unmapped lava source(s) fed the more distal, younger portions of the lava flows.

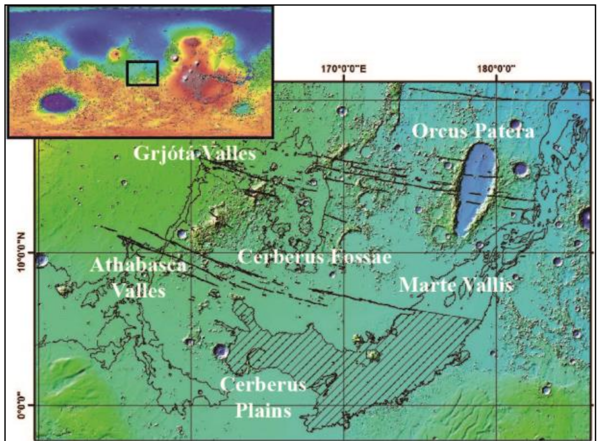

Figure 1: Regional context image of the Cerberus plains, centered at 170° E, 10° N, with the mapped extent of the three main channels, Athabasca, Grjótá, and Marte Valles overlain on a MOLA shaded-relief basemap. The hatchered section corresponds to the lava not contained within the main channel body of MV, which was traced back into the Cerberus plains. Inset: Global context image, including the study area within the bounding box.

Methodology: To test hypothesis 1, we visually inspected high-resolution images to determine whether textural changes were present along the course of the lava flow, and whether previously unidentified flow fronts were present. Changes in texture (development/changes of a platy-ridged texture) or additional flow fronts would suggest multiple lava emplacement events occurred in the channel, as additional lava was added to the system after the surface crust developed. Hypothesis 2 was tested by counting any ghost craters that were present in the intial count regions, along with the identification of any small channel structures which could be indicative of erosive processes. We tested hypothesis 3 by inspecting for any previously unidentified source vents or unidentified/muted fissure segments, which may be indicative of new locations which could have contributed lava to the channels.

Results: The platy-ridged texture is present along nearly the entire length of both AV and MV, though discontinuous/muted in GV. Several small flow fronts were identified within GV, but, based on their small size, were not interpreted as evidence of significant flows separate from the primary flow. No additional distinct flow fronts were identified in AV or MV.

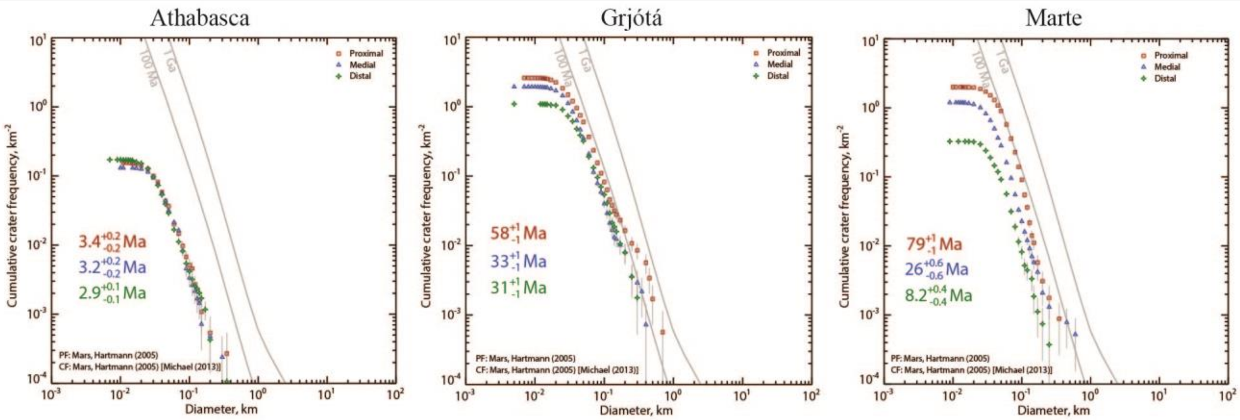

Figure 2: Crater-count derived ages for the channelized lavas. All ages exhibit a decreasing trend downstream from the apparent lava sources.

Including ghost craters in the count regions yielded minimal variations in the previously determined crater counts ages, with shifts of only a few Ma at most. These shifts did not significantly change the relative ages of the proximal, medial, and distal regions.

Several potential new source vents and muted fossae segments were identified in GV, in close proximity to both the medial and distal count locations. In MV, small fossae segments circumferential and radial to an ~10 km dia. impact crater were identified immediately south of the medial count location (Fig. 3). Potential source vents and further muted fossae segments were also identified further north along the course of MV, near to the distal count location.

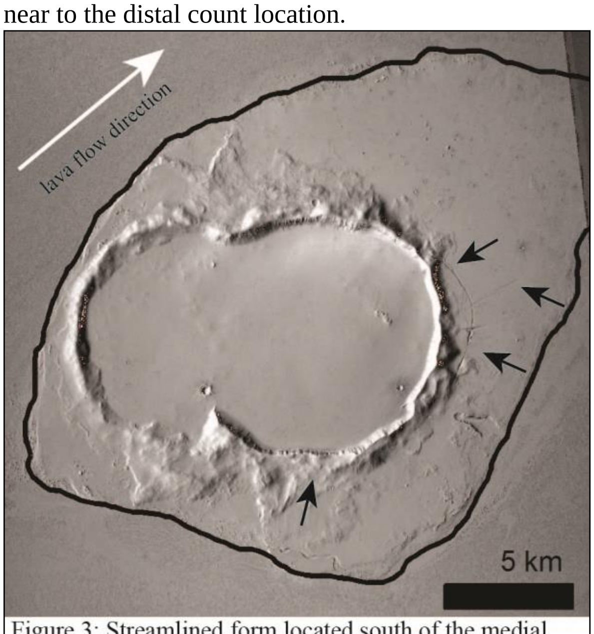

Figure 3: Streamlined form located south of the medial crater count location in MV. Several previously unidentified radial and circumferential fossa segments are present (black arrows).

Implications: These results do not support Hypothesis 2, but do lend support to Hypotheses 1 and 3. The consistent presence of the platy-ridged texture, particularly in AV and MV, supports sub-carapace flow along nearly their entire length. At the same time, the presence of several potential new source vents and previously unidentified fossae segments in GV and MV suggest additional sources of lava may have fed younger lavas at a downstream distance from the previously identified (proximal) source regions for those channelized lavas. The lack of distinct flow fronts associated with these features implies no direct contribution to lava flow on the surface, but contributions may have occurred beneath the crust of the lava flows.

The possibility of hidden lava sources related to GV and MV suggest a complex system exists in the subsurface of the Cerberus plains, feeding multiple generations of eruptions not only in the plains, but within the channels. This result further suggests that multiple magma sources were likely present and intermittently active over an extended period of time (~250 Ma [8]) in the Cerberus region.

References: [1] Plescia, J.B. (1990) *Icarus, 88*, 465-490. [2] Berman, D.C. and Hartmann, W.K. (2002) *Icarus*, *159*, 1-17. [3] Plescia, J.B. (2003), *Icarus*, *164*, 79-95. [4] Burr, D.M. et al. (2009) *Megaflooding on Earth and Mars*, pp. 194-208. [5] Burr, D.M. et al. (2002a) *GRL*, *33*(22). [6] Burr, D.M. et al. (2002b) *Icarus*, *159*, 53-73. [7] Morgan, G.A. et al. (2013) *Science*, *340*, 607-610.[8] Keszthelyi, L. et al. (2004) *GGG*, *11*. [9] Vaucher, J. et al. (2009) *Icarus*, *204*, 418-442. [10] Jaeger, W.L. et al. (2010) *Icarus*, *205*, 230-243. [11] Hamilton, C.W. (2013) *LPSC 44*, Abstract #3070. [12] Golder, K.B., and Burr, D.M. (2016) *LPSC*, *47*, Abstract #1543. [13] Kneissl, T. (2011) *PSS*, *59*, 1243-1254. [14] Warner, N.H. et al. (2015) *Icarus*, *245*, 198-240. [15] McEwen, A.S. et al. (2005) *Icarus*, *176*, 351-381. [16] Williams, J.P. et al. (2014) *Icarus*, *235*, 23-36. [17] Golombek, M. et al. (2014) *LPSC 45*, Abstract #1470. [18] Hartmann, W.K. (2005) *Icarus*, *174*, 294-320. [19] Michael, G. (2013) *Icarus*, *226*, 885-890.