INTERCRATER PLAINS ON MERCURY: TOPOGRAPHIC ASSESSMENT WITH MESSENGER DATA.

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Introduction: Following receipt of the first Mariner 10 images of Mercury in the mid-1970s, a wide range of regional plains types were identified and mapped [e.g., 1-5], and debate centered on their origin: extrusive volcanic [1-7] or impact ejecta-related [8, 9]. Three main types of plains deposits were identified by early workers: intercrater plains, intermediate plains and smooth plains [e.g., 1-3]. Both intercrater and intermediate plains were interpreted to result from a combination of volcanic [1-7] and impact processes [8, 9]. Most mappers favored a volcanic origin for the smooth plains [e.g., 3, 4, 7] but their origin was also debated [9], with some suggesting that these deposits were produced from basin-sized impact events, similar to the formation of the lunar Cayley plains [1, 10]. Later workers [11] used Mariner 10 data to classify different ages of intercrater plains on the basis of states of degradation of superposed and embayed craters and found that these plains were temporally extensive prior to emplacement of smooth plains. Taken together, these three plains units form ~60% of the surface of Mercury that was mapped from Mariner 10 data [2]; this great extent, and its difference from that of maria on the Moon [7], were among the reasons that many workers favored a volcanic origin for plains, despite their lack of albedo differences from the more heavily cratered terrain and distinctive morphologic indicators of volcanism [e.g., 7].

MESSENGER flyby and orbital data have established that many of the areas mapped as smooth plains in Mariner 10 data are indeed of volcanic origin [e.g., 12, 13], that smooth plains cover at least 40% of the surface [14], that many examples of intercrater plains also show evidence for a volcanic origin [14], and that the lack of recognizable volcanic edifices and related features may be due to a dominant flood-volcanism style [15,16]. How much of the intercrater and intermediate plains mapped from Mariner 10 data are of volcanic origin? Addressing this question is essential to deciphering the crustal stratigraphy, early history, and thermal evolution of Mercury. We begin this analysis by revisiting areas mapped from Mariner 10 data as intercrater/intermediate plains [3, 4].

Current Study: We use two MESSENGER [17] data sets: (1) Mercury Laser Altimeter (MLA) topography (Fig. 1) to analyze the hypsometry of several study regions (Fig. 3) and for flooding experiments [18]; (2) Mercury Dual Imaging System (MDIS) image data [19] to assess morphology and to collect crater statistics (Figs. 1-2). Our approach is threefold: (1) Analyze the topography and hypsometry of plains units to assess their origin, (2) Perform artificial flooding experiments [20, 21] with MLA data [18] (test region is flooded in 0.5 km intervals; the crater size-frequency distribution (SFD) of exposed craters is recorded at each flooding interval and patterns and calculated SFDs are compared with those completed for the mapped intercrater plains in order to evaluate the two formation hypotheses and aid in identifying the volcanically sourced regions). (3) Plains crater SFDs are tabulated to build a record of area, origin, and age of units of volcanic origin. Here we report on the initial stages of this analysis for two areas mapped with varying amounts of smooth and intercrater plains [3, 4] (Fig. 1, 2) to assess Mariner 10 formation hypotheses and to better understand the process of volcanic resurfacing.

Region 1 (Fig. 1a, 2a) (centered at 69.0º N, 234.7ºE, ~130,000 km^2, spans ~5 km of elevation) has an abundance of older crater materials [3] and shows only a few patches of intercrater plains. Region 2 (centered at 52.4ºN, 261.4ºE) is similar in area and total relief (Fig. 1b, 2b) but has fewer impact craters and is mapped largely as intercrater plains [4]. Assessment of topography and hypsometry for region 1 shows that the intercrater plains are indeed regionally smooth and occupy generally contiguous areas (intermediate in elevation between the deeper floors of large embayed and superposed impact craters, and the higher rims and rim crests of these larger craters). These patterns are very similar to those shown in flooding experiments of cratered terrain [20, 21]. Intercrater plains mapped in region 2, on the other hand, show a very different pattern, spanning over 3 km of elevation. Of particular interest is the large area in the north comprised of a rough-textured plateau consisting of the combined rims of two large craters, rather than potential plains of volcanic origin. This initial analysis suggests that global reexamination of plains units mapped in Mariner 10 with MESSENGER data will help to distinguish plains of volcanic origin and may revise downward the global estimate of those of volcanic origin. We are proceeding with hypsometry/flooding/chronology analyses of other Mariner 10 mapped and new areas.

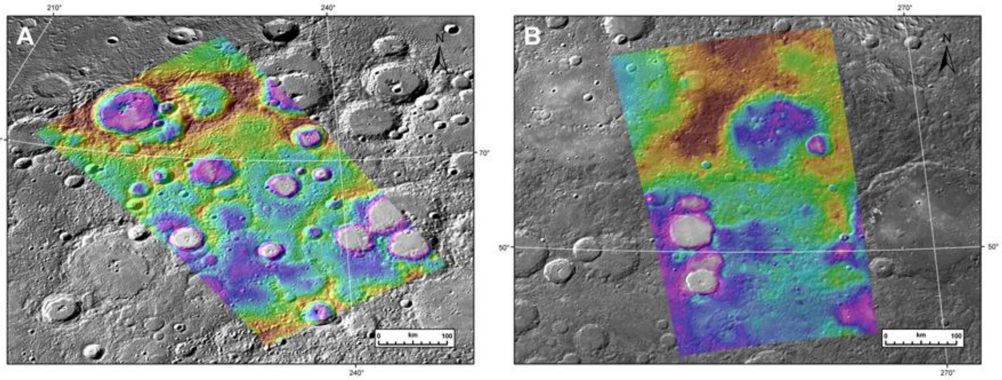

Figure 1. MLA gridded topography data overlaid on MDIS 250 m/pixel mosaic. (A) region 1 (-2.7 to 1.9 km). (B) region 2 (-3.5 to 1.2 km).

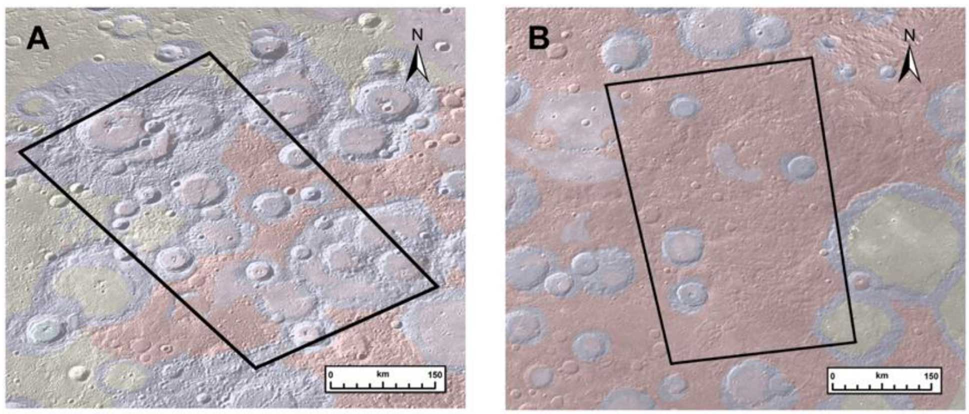

Figure 2. Geologic map showing the different units/features mapped from Mariner 10 data [3,4]. A: region 1 [3]. B: region 2 [4]. Red: intercrater plains; blue and yellow: different types of crater deposits.

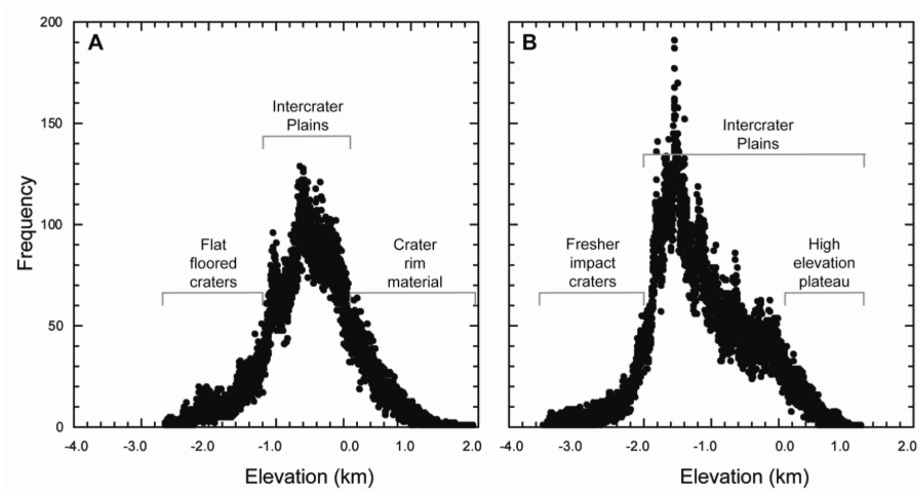

Figure 3. Hypsometry from MLA topography for (A) region 1 and (B) region 2.

References: [1] Strom R. G. (1977) *Phys. Earth Planet. Inter.*, *15*, 156-172. [2] Kiefer W. S. and Murray B. C. (1987) *Icarus*, *72*, 477-491. [3] Grolier M. J. and Boyce J. M. (1984) USGS map I-1660. [4] McGill G. E. and King E. E. (1983) USGS map I-1409. [5] Murray B.C. et al. (1974) *Science, 185,* 169-179. [6] Murray B. C. et al. (1975) *JGR, 80,* 2508-2514. [7] Spudis P. D. and Guest J. E. (1988) *Mercury*, 118-164. [8] Trask N. J. and Guest J. E. (1975) *JGR, 80,* 2461-2477. [9] Wilhelms D. E. (1976) *Icarus, 28,* 551-558. [10] Oberbeck V. R. et al. (1975) *Earth Moon Planets*, *12*, 19-54. [11] Leake M.A. (1982) *NASA TM, 84894*, 3-535. [12] Murchie S. L. et al. (2008) *Science*, *321*, 73-76. [13] Head J.W. et al. (2008) *Science*, *321*, 69- 72. [14] Denevi et al. (2009) *Science*, *324*, 613-618. [15] Head et al. (2011) *Science*, *333*, 1853-1856. [16] Head J. W. et al. (2012) *LPS 43*, Abstract# 1451. [17] Gold R. E. et al. (2001) *Planet. Space Sci.*, *49*, 1467-1479. [18] Zuber M.T. et al. (2012) submitted to *Science*. [19] Hawkins S.E. et al. (2007), *Space Sci. Rev.*, *131*, 247-338. [20] Whitten J.L. et al. (2011) *Lunar Sci. Forum*, Abstract #360. [21] Whitten J.L. et al. (2012) *LPS 43*, Abstract# 1470.