**GEOLOGIC MAP OF THE BOREALIS QUADRANGLE (H-1) ON MERCURY: 2017 STATUS REPORT.**

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**Introduction:** With MESSENGER observations of the Borealis Quadrangle [H-1], we are drafting a new geologic map at 1:5M map scale. Mapping at this scale allows for direct comparisons with the original USGS geologic maps for Mercury [1], enabling assessment of similarities and differences between the mapped geologic unit boundaries, unit descriptions and observations, and the derived regional chronostratigraphy. Furthermore, our mapping is leveraging the 1:15M-scale global geologic map [2-4; selected for PDART16 funding]. The global map provides context for mapping in the H-1 quadrangle as well as serves as one of several bases for geologic unit and feature definition. Importantly, the new H-1 map will be the first USGS Scientific Investigations Map (SIM) published for a geologic quadrangle map prepared with MESSENGER data, providing an opportunity to establish basic standards and practices for quadrangle mapping of Mercury in conjunction with the global map now being prepared for USGS publication.

**Mapping Effort:** Three general tasks were defined, informed by past experience producing and publishing geologic maps with the USGS and mapping other regions of Mercury's surface and conducting crater analyses. *Map production (Task 1; Year 1)* will result in a geologic map of the H-1 quadrangle from MESSENGER datasets compiled in a GIS database. *Age determination (Task 2; Year 2)* will assign relative ages to mapped units from observed stratigraphic relationships and measures of areal crater density to place the mapped units in the new chronostratigraphic system for Mercury [5, 6] and develop a geologic history for H-1. When possible, absolute model ages will be derived from those crater measurements. *Map publication (Task 3; Year 3)* encompasses map submission, revision, and publication.

**Mapping Data:** Several MESSENGER datasets are used during our mapping investigation.

*Image base:* The Mercury Dual Imaging System (MDIS) monochrome mosaic is comprised of Narrow Angle Camera (NAC) and Wide Angle Camera (WAC) images at 250 meters per pixel. This mosaic includes images with low emission angles and moderate- to high-incidence angles favorable for emphasizing morphology and topography, which are beneficial for cartographic purposes. Global monochrome high-incidence angle illumination mosaics are assembled from images acquired at high solar incidence angles (average >70°) with an illumination direction from the east or the west. High-incidence angle mosaics will be used for reference as needed during mapping to enhance morphological details of surface features [Fig. 1]. "Smooth plains" have a distinct color from the surrounding terrain [Fig. 2], making the MDIS color mosaic useful as a reference tool for drawing and refining smooth plains boundaries during geologic mapping.

*Topography:* The Mercury Laser Altimeter (MLA) Digital Elevation Model (DEM) is a gridded data product extending from 55°N to the pole at 500 meters per pixel [Fig. 3]. The MDIS DEM [7] is a global product derived from MDIS images and sampled to 665 meters per pixel. Both products will be used as needed to aid in identification and mapping of physiographic landforms and geologic units.

*Compositional data:* Traditionally, geologic maps do not incorporate geochemical data; however, unique compositional observations within H-1 indicate that geochemical terranes and geomorphological units are not consistently correlated [e.g., 8]. Measurements from the Mercury Atmospheric and Surface Composition Spectrometer (MASCS), X-Ray Spectrometer (XRS), and Gamma Ray Spectrometer (GRS) will therefore be used for reference rather than for the bulk of our mapping effort, and key differences between identified geochemical terranes and our geologic units will be noted.

**Mapping Strategy:** This year (Year 1), we are focused on creating a draft of the geologic map including units and features. Our mapping strategy thus far has started with identifying and mapping prominent physiographic landforms, including impact craters, ridges, scarps, and other lineations, etc. We are also identifying the contacts and boundaries between markedly different geologic units (e.g., crater ejecta, those units initially described as "heavily cratered terrain" and "smooth plains" [Fig. 3], etc.), although we are in the process of developing geologic unit definitions. We have compiled and begun to consider geologic unit definitions from previous and ongoing mapping efforts, including those from the original H-1 quadrangle map [9], the current global map [2-4], and other quadrangles mapped as part of BepiColombo planning activities [e.g., 10, 11]. Although the geologic units we define and use will be ultimately based on our mapping and interpretations of H-1, we currently place particular emphasis on those defined (and being revised) for the global geologic map

[2-4]; the global mapping effort is the most comprehensive to date in considering geologic units from a perspective larger than that of a single quadrangle.

**Summary:** The new H-1 map will be the first published USGS SIM geologic quadrangle map produced with MESSENGER data. Creation of the H-1 quadrangle map at 1:5M scale will provide a comprehensive, detailed view of the north polar region of Mercury, a key portion of Mercury's surface. This map, in conjunction with the 1:15M-scale global map, will provide critical context for planet-scale investigations such as the global distribution of smooth plains and their ages [e.g., 12] and the history of tectonic activity on Mercury [e.g., 13]. The H-1 quad map will also facilitate more region-specific investigations, including tectonic deformation in the northern smooth plains [e.g., 14], emplacement and resurfacing history of the northern smooth plains [15], and the geological context of radar-reflective deposits [e.g., 16, 17]). Importantly, this map will also mark the first quadrangle mapping effort on Mercury that conforms to USGS geologic mapping standards.

**References:** [1] Holt, H.E. (1977) BAAS 9, 456. [2] Prockter, L.M. et al. (2016) LPS 47, Abst. 1245. [3] Kinczyk, M.J. et al. (2016) PGMM, Abst. 7027. [4] Kinczyk, M.J. et al. (2017), this volume. [5] Banks, M.E. et al. (2016) LPS 47, Abst. 2943. [6] Ernst, C.M. et al. (2017) LPS 48, Abst. 2934. [7] Becker K.J. et al. (2016) LPS 47, Abst. 2959.[8] Peplowski, P.N., Gleyzer, S.V. (2017) LPS 48, Abst. 1592. [9] Grolier, M.J., Boyce, J.M. (1984) Map I-1660, Misc. Investigations Ser., USGS. [10] Galluzzi, V. et al. (2016) J. Maps 12, 227-238. [11] Rothery, D.A. et al. (2017) LPS 48, Abst. 1406. [12] Byrne, P.K. et al. (2016) GRL 43, 7408-7416. [13] Byrne, P.K. et al. (2014) Nat. Geosci., 7, 301–307. [14] Klimczak, C. et al. (2012) JGR 117, E00L03. [15] Ostrach, L.R. et al. (2015) Icarus 250, 602–622. [16] Chabot, N.L. et al. (2013) JGR Planets 118, 26–36. [17] Chabot, N.L. et al. (2014) Geology 42, 1051–1054.

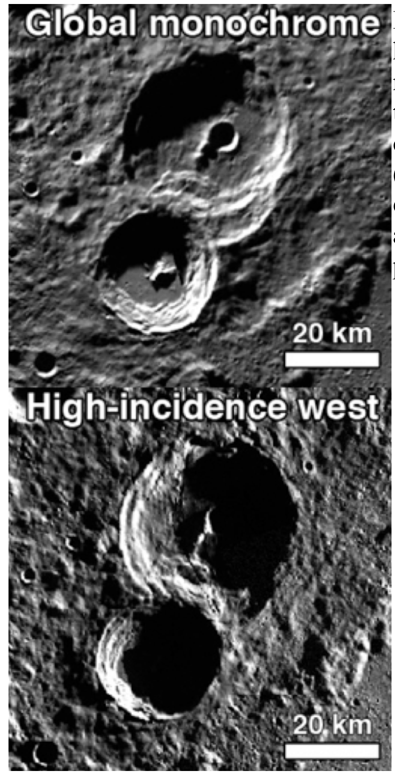


**Fig. 1.** Here, the high-incidence angle mosaic reveals portions of shadowed crater interiors (78.8°N, 169.8°E), enabling complete and detailed mapping.

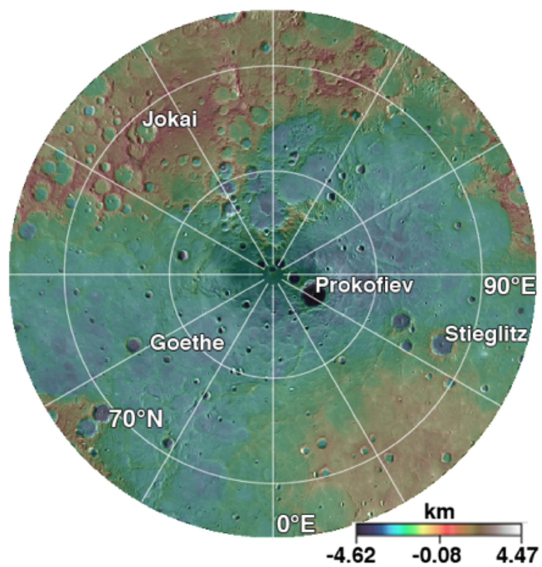


**Fig. 3.** MLA DEM over MDIS monochrome mosaic. Stieglitz crater is 100 km in diameter.

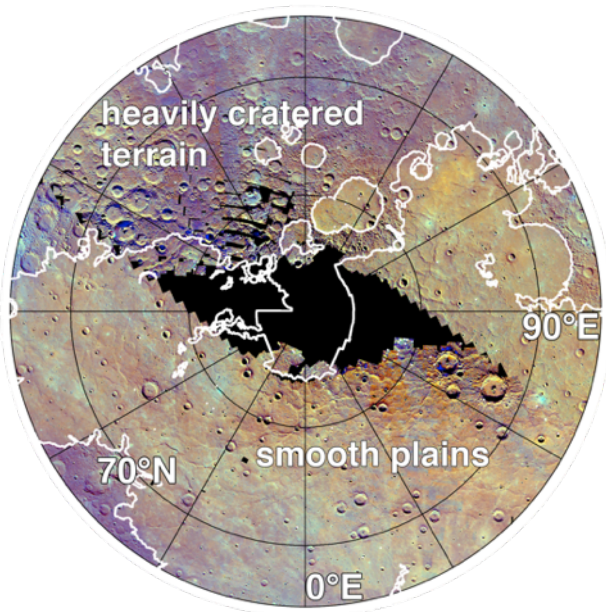


**Fig. 2.** The boundary between "heavily craterd terrain" and "smooth plains" (white lines) is revealed in the WAC principal component (PC) and ratio composite (PC2 in red, PC1 in green, and the 430/1000 nm in blue). "Smooth plains" have a reddish-orange color; the color boundary will serve as a reference during mapping. Black regions are gores in coverage. Figure from [15].