FINALIZING THE GEOLOGIC MAP OF THE BOREALIS QUADRANGLE (H-1) ON MERCURY.

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Introduction: We are nearing completion of a new geologic map of the northern polar region of Mercury (H-1 Borealis Quadrangle) using MESSENGER orbital observations at the 1:5M map scale. Our mapping leverages current and ongoing USGS-supported geologic mapping efforts including the 1:15M-scale Mercury global geologic map [1–4] and the 1:5M-scale H-10 Derain Quadrangle [5] to establish basic standards and practices for quadrangle mapping of Mercury using MESSENGER data. Importantly, these maps will be among the first USGS Scientific Investigations Map (SIM) series prepared with MESSENGER data.

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

Mapping Data: The MESSENGER Mercury Dual Imaging System (MDIS) monochrome mosaic serves as our base map and comprises Narrow Angle Camera (NAC) and Wide Angle Camera (WAC) images at ~166 meters per pixel (m/px). This mosaic includes images with low emission angles and moderate- to high-incidence angles favorable for emphasizing morphology and topography, which are beneficial for mapping.

We use both the MESSENGER Mercury Laser Altimeter (MLA) digital elevation model (DEM) (covering 55°N–90°N at 500 m/px), and the MDIS DEM [7] (with global coverage at 665 m/px) as needed, to aid in identification and mapping of physiographic landforms, geologic units, and crater identification.

Mapping Progress: We are in the process of finalizing age determinations, crater degradation states, and required map components in advance of map submission. This process includes reviewing crater measurements and degradation assessments, finalizing the Description of Map Units (DOMU) and Correlation of Map Units (COMU), along with the text for the map pamphlet, and finalizing the GIS package for map submission. We are diligently working to submit the map prior to the end of FY20, as progress was hindered in FY19 due to the partial government shutdown. The working map and draft unit definitions for plains materials are displayed in **Fig. 1**.

We continue to make progress toward completion of the impact crater classification and degradation state assessment. Impact structures ≥20 km in diameter and their related materials are classified according to degradational state using the methodology applied in the global geologic mapping effort [e.g., 4,6]. At the Annual Planetary Geologic Mappers Meeting in 2019, we discussed strategies for mapping crater materials on Mercury so as to be as consistent as practical with the active USGS-supported global map and H-10 quadrangle. We continue to work closely with the leaders of those mapping efforts (M.J. Kinczyk and J.L. Whitten, respectively) to develop and refine the definitions for crater materials during mapping.

Consistently mapping the intercrater plains, the most areally extensive geologic unit on Mercury [e.g., 7], remains a challenge in H-1 as it does for other USGS-supported mapping investigations [4, 5]. The intercrater plains unit consists of gently rolling plains materials in between large craters and basins, with a high areal density of small, superposed craters ~5–15 km in diameter that is indicative of a complex resurfacing history [5, 7]. In H-1 we have mapped two intercrater plains units primarily distinguished by textural differences. However, both the ongoing global map and H-10 quadrangle efforts are employing multiple techniques in an attempt to consistently and confidently subdivide the intercrater plains and, as such, we may revise our unit definitions and mapping based on collaborative work with those mapping teams.

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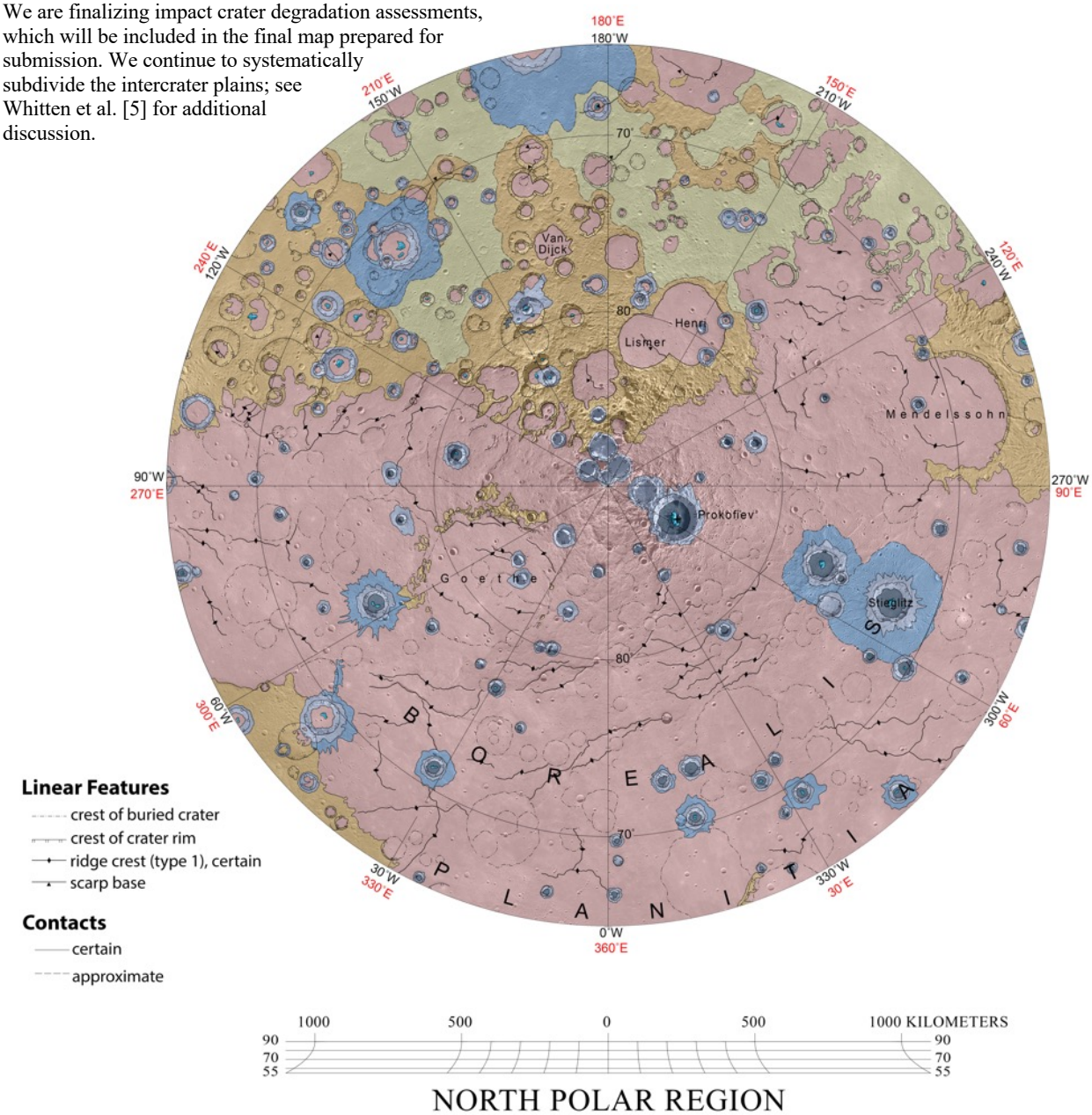
References: [1] Prockter, L.M. et al. (2016) LPS 47, Abst. 1245. [2] Kinczyk, M.J. et al. (2016) PGMM, Abst. 7027. [3] Kinczyk, M.J. et al. (2017) 3rd Planetary Data Workshop, Abst. 7116. [4] Kinczyk, M.J. et al. (2018) PGMM, Abst. 7031. [5] Whitten, J.L. et al. (2018) PGMM, Abst. 7027. [6] Kinczyk, M.J. et al. (2017) LPS 48. Abst. 2717. [7] Trask, N.J. & Guest, J.E. (1975) JGR, 80, 2461-2477.

Fig. 1: Working draft of the H-1 Borealis Quadrangle map. We are finalizing impact crater degradation assessments, which will be included in the final map prepared for submission. We continue to systematically subdivide the intercrater plains; see Whitten et al. [5] for additional discussion.



Plains Materials

ps — Smooth Plains Material – Flat to gently rolling plains, sparsely cratered, occurring in topographically low areas (Borealis Planitia) and within some basins. Stratigraphically younger than other plains materials. Contacts with older units are observed to be sharp with distinct boundaries in some locations or exhibiting a gradational contact (where older terrain was embayed). *Interpretation: Volcanic plains emplaced by effusively erupted lavas; no volcanic vents observed. Hosts abundant tectonic deformation, primarily in the form of narrow to broad wrinkle ridges. Pervasive arcuate tectonic deformation forming wrinkle ridge rings interpreted to reflect the rim crests of buried craters.*

pi1 — Intercrater plains (Younger) – Lie between large craters and basins, contains fewer superposed craters (~5–15 km diameter) than pi1 and more than ps, appear to have lower albedo than ps and pi2. Texturally intermediate between ps and pi2: rougher than ps and smoother than pi2. Embayment relations with ps gradual without a distinct contact. Boundaries with pi2 uncertain; approximate contact. *Interpretation: Mixture of volcanic deposits and impact materials, including both basin and crater ejecta. Evidence of emplacement by lava or fluidized ejecta abundant.*

pi2 — Intercrater plains (Older) – Lie between large craters and basins, contains highest density of superposed craters (~5–15 km diameter) of the plains units, hummocky texture. Contacts with pi1 indistinct and uncertain. Some contacts with ps distinct, whereas others gradational. *Interpretation: Mixture of basin and crater ejecta and associated materials and volcanic plains emplaced nearing the end of the Late Heavy Bombardment.*