CREATION OF A NEW GEOLOGIC MAP OF THE BOREALIS QUADRANGLE (H-1) ON MERCURY.

L.R. Ostrach1,2, S.C. Mest3, L.M. Prockter4, N.E. Petro1, and P.K. Byrne5, 1NASA Goddard Space Flight Center, Greenbelt, MD, 2USGS Astrogeology Science Center, Flagstaff, AZ (as of Aug. 2016), 3Planetary Science Institute, Tucson, AZ, 4Johns Hopkins University Applied Physics Laboratory, Laurel, MD, 5North Carolina State University, Raleigh, NC. (email contact: lillian.r.ostrach@nasa.gov)

**Introduction:** Until the MErcury Surface, Space ENvironment, GEochemistry, and Ranging (MESSENGER) spacecraft [1] inserted into orbit around Mercury in 2011, almost 60% of the north polar region, Borealis Quadrangle [H-1; Fig. 1], remained imaged at illumination and viewing geometries poorly suited for morphological observations, or unimaged at all. For nearly forty years, the geology of H-1 was poorly understood due to incomplete Mariner 10 [M10] image coverage. The M10-based H-1 geologic map helped to determine that smooth plains observed there were one of the largest such units on Mercury [2; Fig. 2]. The map, however, could not help answer critical outstanding questions such as the spatial extent and origin of the extensive smooth plains in the north polar region. Answering this question would provide information on the timing of emplacement (i.e., rapid versus prolonged) of these plains, as well as how Mercury’s lithosphere, and by extension those of other terrestrial worlds, were built.

**New H-1 Map:** MESSENGER orbital observations have provided full image coverage of the Borealis Quadrangle [H-1; Fig.1], enabling investigation of key questions and hypotheses and the ability to create new geologic maps. Our 2015 PDART proposal was recently selected to create a new geologic map for H-1 at a 1:5M map scale, following the USGS mapping standards and incorporating multiple MESSENGER datasets to determine the geologic history of this region. Mapping at the 1:5M scale will allow for direct comparisons with the original USGS geologic maps for Mercury, enabling assessment of similarities and differences between the mapped geologic unit boundaries, unit descriptions and observations, and the derived regional chronostratigraphy. Moreover, a global mapping effort conducted by the MESSENGER project at 1:15M map scale is nearing completion [3], with the intention of providing context for upcoming quadrangle and re-

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**Fig. 1.** MESSENGER orbital data provided the first full coverage of the north polar region. This new view conclusively revealed the extent of the northern smooth plains, providing indisputable evidence for a volcanic origin. Stieglitz crater is 100 km in diameter. Mercury Laser Altimeter Digital Elevation Model (500 mpp) over Mercury Dual Imaging System monochrome mosaic (250 mpp).

**Fig. 2.** The original H-1 map [2], where ~60% of the region was not mapped. Three plains units were mapped, along with five units of crater materials, tectonic landforms, and areas of bright or low albedo. 0°E at bottom.
rional mapping. Leveraging the geologic units derived from the global map will be advantageous for quadrangle mapping efforts, particularly since the geologic units mapped as part of the M10 quadrangle effort [4] were inconsistent. Importantly, the new H-1 quadrangle map would provide an opportunity to establish, with the USGS, basic standards and practices for quadrangle mapping using MESSENGER data in conjunction with the global map of Mercury.

**Mapping Effort:** Three general tasks were selected based on 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)* will result in a geologic map of the H-1 quadrangle using MESSENGER datasets compiled in a GIS database.

*Age determination (Task 2)* will assign relative ages to mapped units from observed stratigraphic relationships (e.g., i.e., superposition, cross-cutting, crater degradation; [Fig. 3]) and measures of crater density to place the mapped units in a chronostratigraphic system for Mercury [5] and develop a geologic history for H-1. Absolute model ages will be derived from crater measurements using three published chronologies [6–9].

*Map publication (Task 3)* will encompass map submission and publication.

**Conclusions:** This new H-1 map will be the first USGS-published geologic map covering the entirety of the north polar region of Mercury and will vastly improve upon the original USGS geologic map [2], in part by filling in the unmapped region in the M10 data. Creation of the H-1 geologic map will provide an updated and detailed view of the north polar region of Mercury, allowing comprehensive understanding of a key portion of Mercury’s surface for the first time. This map will provide critical context for global-scale investigations (e.g., the global distribution of smooth plains and their ages [10,11]; the history of planet-wide tectonic activity [12,13]) and region-specific investigations (e.g., tectonic deformation in the northern smooth plains [14,15]; emplacement and resurfacing history of the northern smooth plains [16]; characteristics of radar-reflective deposits [17,18]), in addition to providing a valuable resource for future mission planning for the BepiColombo mission.


**Fig. 3.** Crater degradation is interpreted to reflect relative age; C4 craters are the least degraded (sharp rim/features) and young (Mansurian), and C1 craters are the most degraded (indistinct crater form) and the oldest (possibly Tolstojan or pre-Tolstojan). No C5 craters (visible ejecta, youngest Kuiperian-aged) ≥4 km in diameter are in the northern smooth plains.