PREPARING THE FIRST GLOBAL GEOLOGICAL MAP OF MERCURY. Mallory J. Kinczyk[1], Louise. M. Prockter[1], Paul K. Byrne[2], Brett W. Denevi[1], Lillian R. Ostrach[3], James W. Head III[4], Caleb I. Fassett[5], Jennifer L. Whitten[6], Rebecca J. Thomas[7], Debra L. Buczkowski[1], Brian M. Hynek[8], David T. Blewett[1], Carolyn M. Ernst[1], and the MESSENGER Mapping Group. [1]The Johns Hopkins University Applied Physics Laboratory, Laurel, MD 20723, USA. [2]North Carolina State University, Raleigh, NC 27695, USA. [3]NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA. [4]Brown University, Providence, RI 02912, USA. [5]Mount Holyoke College, South Hadley, MA 01075, USA. [6]National Air and Space Museum, Smithsonian Institution, Washington, DC 20560, USA. [7]The Open University, Milton Keynes, MK7 6AA, UK. [8]University of Colorado, Boulder, CO 80303, USA.

Introduction: The first reconnaissance of Mercury was carried out by the Mariner 10 spacecraft in the 1970s. Three flybys of the planet yielded images of just under half of the globe that were used as the basis for a U.S. Geological Survey (USGS) series of Mercury quadrangle maps [1]. However, the map authors did not follow a uniform set of mapping conventions or units, resulting in inconsistencies across map boundaries and making it difficult to compare geologic units across multiple regions of the mapped hemisphere.

The MErcury Surface, Space ENvironment, GEochemistry, and Ranging (MESSENGER) spacecraft orbited Mercury from 2011 to 2015 and imaged the planet in its entirety. A global monochrome image mosaic was released to the Planetary Data System (PDS) in May 2016 at largely uniform viewing geometry and a resolution of ~250 m/pixel [2], providing a comprehensive dataset for geomorphological mapping. This vastly improved data product forms the basis for the first global geological map of Mercury (**Fig. 1**) [3]. The geological map will facilitate the comparison of units distributed discontinuously across Mercury's surface, thereby enabling the development of the first global stratigraphic column, and provides a guiding basis for future mappers.

Data: The map has been prepared at 1:15M scale and will be submitted to a peer-reviewed planetary journal for publication. It has been created using standard USGS mapping guidelines within a geographical information system (GIS). In addition to the monochrome basemap and other image products with alternate viewing geometries, ancilliary topography and color data were used where necessary to aid in the identification of units. Datasets from other published and ongoing local and regional mapping efforts have also been incorporated, including: a global map of crater and basin rims [4], ghost craters [5], smooth plains [6], and tectonic structures [7]. The locations of features not resolvable at our map scale, such as pyroclastic vents [8] and hollows [9], will be indicated as point features on the map to assist future analyses.

Mapped Units: Geomorphological units were mapped on the basis of texture, color, and topographical relief. Due to the highly eccentric elliptical orbit of the MESSENGER spacecraft, the resolution of geochemical data obtained varies greatly between the northern and southern hemispheres of the planet. For this reason, geochemical data was not considered in the mapping of units.

Impact Craters: All impact craters >40 km in diameter were classified during the mapping process using a revised version of the earlier five-class scheme [10-12] and based on the new MESSENGER image dataset. Rims, ejecta, and classifications for craters ≥90 km in diameter were included on the map.

Intercrater Plains: Mercury's surface consists of two major plains units, smooth and intercrater plains. Intercrater plains lie between large craters and basins and contain a high spatial density of small superposed craters 5–15 km in diameter [13]. They are generally of lower reflectance and shallower spectral slope than smooth plains [14].

Smooth Plains: In contrast, smooth plains are sparsely cratered and postdate the intercrater plains. The spatial density of relatively small superposed craters on this unit is approximately uniform, indicating that it is nearly coeval, globally [6].

One unit included by the Mariner 10 mappers [1] that does not appear on our map is *Intermediate Plains*. A recent analysis [13] showed that areas previously mapped as intermediate plains are indistinguishable from either intercrater or smooth plains. We follow the recommendation [13] that the intermediate plains unit is not a sufficiently distinct map unit, especially at the global scale used in our map.

Basin Units: In addition to the globally distributed plains units, we have also included prominent units associated with larger basins. One such example is the Odin Formation, consisting of discontinuous patches of hummocky plains that extend up to 800 km beyond the rim of the Caloris basin. A second prominent unit is the Caloris interior plains, which closely resembles smooth plains material but has undergone at least two phases of intense tectonic deformation [15]. Additional basin-related units have been also been incorporated into the map including Rembrandt [16], Raditladi [18], and Rachmaninoff basin units.

Tectonics: Two primary tectonic landforms are observed at global map scales: (1) extensional landforms, which consist of negative-relief, steep-sided depressions that are usually linear in plan view, and (2) shortening landforms, positive-relief features that are linear to arcuate in plan view. Shortening landforms are distributed across the planet and are the dominant form of tectonic deformation on Mercury, resulting from widespread global contraction [5 and references therein].

Future Work: A proposal is being submitted through the PDART program to submit the map as a USGS Scientific Investigations Map (SIM) series product. Though the current version of the map will be submitted to a peer-reviewed planetary journal around the time the PDART Step-2 proposals are due, the standards for maps published through the USGS afford more detailed community feedback and result in a product that will provide a robust basis for future mappers and missions.

Several mapping objectives that have not been addressed thus far will be investigated including: 1) whether there is cause to subdivide the major surface unit, *Intercrater Plains*, into additional subunits [17]; 2) subdivision of additional basin units; and 3) revise boundaries of the *Smooth Plains* unit, all on the basis of crater density and the new PDS-available global color dataset [2].

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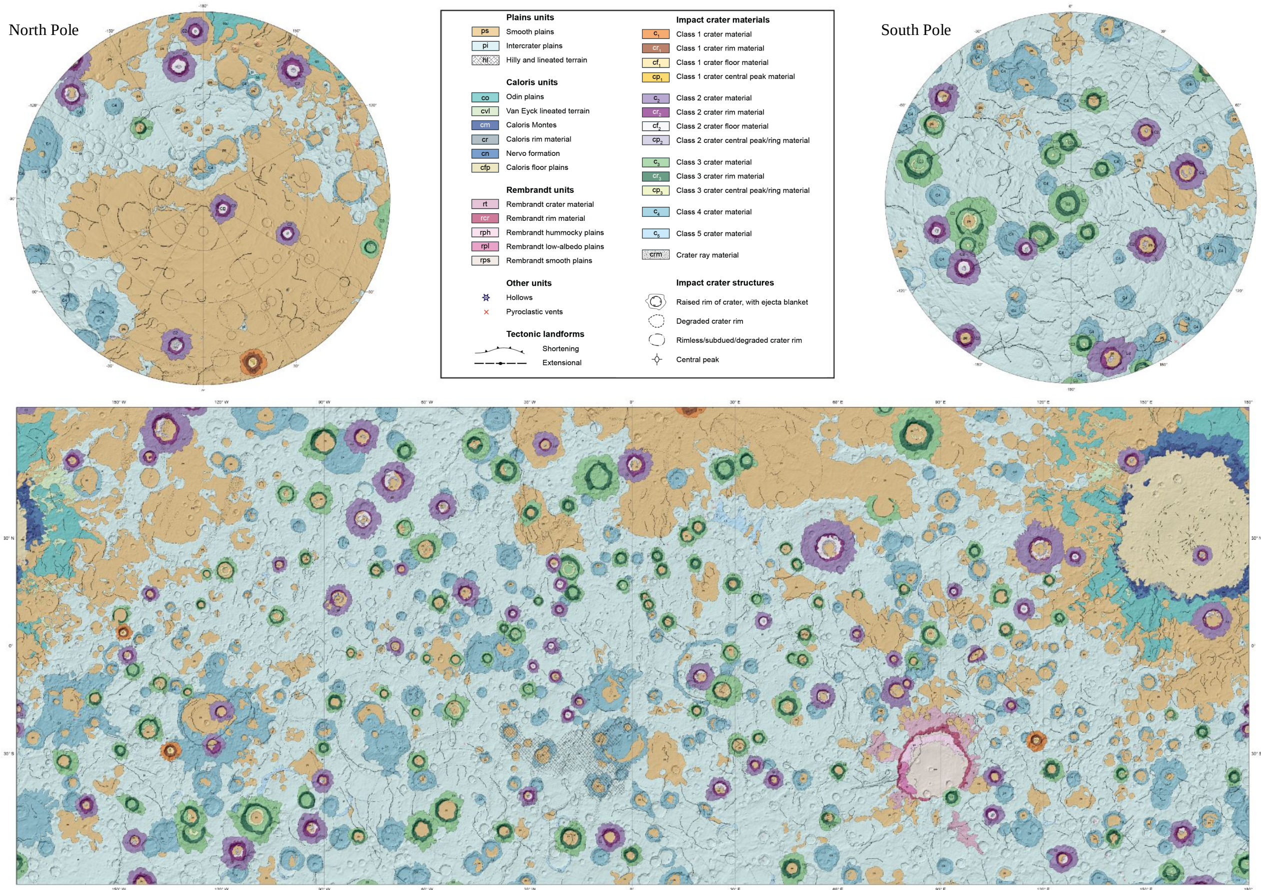

Figure 1. Draft version of the global geological map of Mercury at 1:15M scale, showing major plains units and classified craters ≥90 km in diameter.