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The First Global Geological Map of Mercury

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Abstract

The global geological map of Mercury is derived from the final data products produced by the MErcury Surface, Space ENvironment, GEo-chemistry, and Ranging (MESSENGER) mission conducted from 2011 to 2015. While previous quadrangle maps have been produced from Mariner 10 and MESSENGER data, a global geological map provides a consistent, planet-wide framework for understanding Mercury's geological history.

1. Introduction

In the 1970s the Mariner 10 spacecraft conducted three flybys of Mercury. Due to the flyby geometry, the spacecraft imaged approximately 45% of the surface, leaving an incomplete picture of Mercury's geological history and evolution. In 2011, the MESSENGER spacecraft was inserted into orbit about Mercury, beginning the first global reconnaissance of the innermost planet. We present here the geological interpretation of data collected from the MESSENGER mission, aggregated into the first global geological map of Mercury.

2. Datasets

The MESSENGER spacecraft orbited Mercury for four years, ending its mission on April 30th, 2015. From these data, global products of color, reflectance, composition, and topography were developed and released to the Planetary Data System [1]. These data products are the primary tools used to create the 1:15 million-scale geological map.

3. Geological Units

Geological units were distinguished on the basis of morphology (i.e., texture and topographic relief), color, and reflectance. The major geological units include intercrater plains, smooth plains, and impact crater facies [2,3]. Additional surface features such as hollows, tectonic landforms, and pyroclastic vents, are indicated as point and linear features [3 and references therein]. The following is a discussion of the two dominant geological units on Mercury.

3.1 Intercrater Plains

The intercrater plains is the largest mapped unit on Mercury's surface. This unit consists of the material between large impact craters and contains a high spatial density of small craters ~5–15 km in diameter [4]. The nature and origin of the intercrater plains is still a topic of discussion [2]. Proposed mechanisms of the formation of the intercrater plains include: 1) an impact origin where the emplacement of large impact basins efficiently mixed and distributed material across Mercury's surface, and 2) a volcanic origin due to the anomalous lack of craters ≤ 65 km in diameter compared to the Moon, suggesting partial resurfacing [2].

Due to the complexity of intercrater plains formation and modification, identifying sub-units within this region is challenging. Surface properties such as reflectance and texture vary widely within the intercrater plains, and do not display consistent characteristics when compared with other plains units [2]. In order to address this issue, the intercrater plains unit (*light blue* in Figure 1) will be subdivided primarily on the basis of morphology, and supplemented with color and crater degradation datasets [5]. These separations distinguish self-consistent morphological regions as potentially discreet iterations of intercrater plains emplacement.

3.2 Smooth Plains

Smooth plains have been identified across the entirety of Mercury's surface with the largest contiguous portion found in the northern hemisphere. This unit is defined as deposits that are relatively sparsely cratered and maintain a sharp contact with surrounding terrain [6]. While these deposits are morphologically distinct from the intercrater plains, it is not clear that this unit is of different origin from all intercrater plains material.

4. Summary & Conclusions

Early mapping efforts [6] revealed that most contacts between the smooth plains and intercrater plains have strong color and compositional differences [7], but there are several contacts that do not show these same differences. This observation suggests that there are regions within the intercrater plains that may have previously been smooth plains deposits with similar composition, but emplaced in the more distant past. Therefore identifying and mapping these different facies of intercrater plains is an important contribution to our understanding of Mercury's geological history and evolution.

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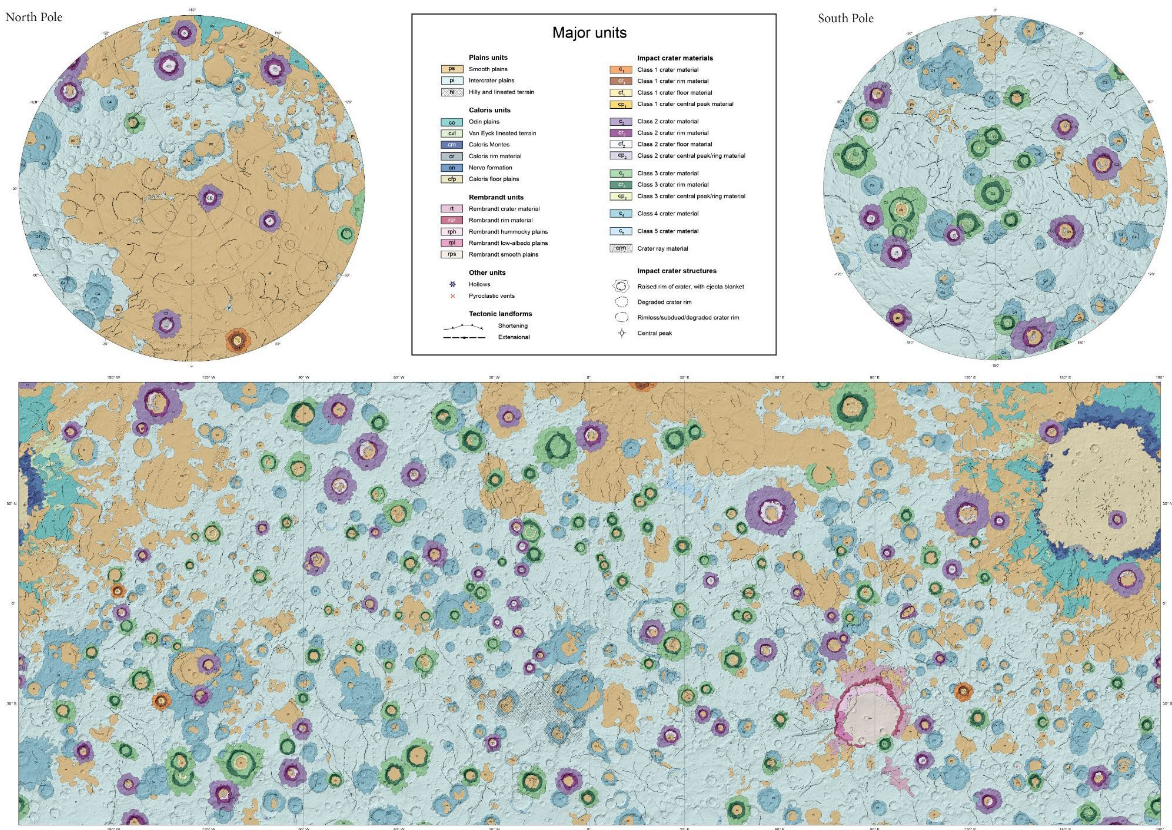

Figure 1. Draft of Mercury global geological map. (*light blue*) intercrater plains, (*tan*) smooth plains deposits.