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Geo-structural mapping and age determinations of Rembrandt Basin region

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Abstract

During its second and third flybys, MESSENGER imaged a new large and well-preserved basin called Rembrandt Basin [1] in Mercury's southern hemisphere. In attempt to reveal the basin evolution, we used MESSENGER MDIS mosaics to map its geological units and infer - where possible - their stratigraphic relationships. Thus, we fixed the contractional and extensional local patterns and the global tectonic features. In addition, we performed crater counts on several of these units and derived age estimates by applying the Model Production Function (MPF) [2].

1. Introduction

Rembrandt basin is a 715-km-diameter impact feature which displays a distinct, hummocky rim, broken up by the presence of several large impact craters. Its interior is partially filled by volcanic materials, that extend up to the southern, eastern and part of the western rims [1], and is crossed by a marked lobate scarp. In this work we have performed a geological mapping and age determination of several units of the basin as well as a structural and kinematic analysis mainly focused on the mayor Rembrandt scarp.

2. Geo-structural mapping

Rembrandt Basin displays evidence of both global-scale and basin-localized deformations, in some cases possibly controlled by the rheological layering within the crust. Extensional features are essentially radial and confined to the *Inner Plains*, displaying one or more uplifts episodes of the inner basin. The more widespread wrinkle ridges form a polygonal pattern of radial and concentric features on the whole floor, probably due to one or more near-surface compressional stages [1]. Thus, through their cross-cutting relationships, we attempted to distinguish the cascade of events. About global landforms, we focused on the 1000-km long Rembrandt scarp. The structures can be subdivided into three branches: the southern one with clear evidences of a right-lateral strike slip movement acting together with an inverse kinematics, the northern one with some evidences of a left-lateral component, well-recorded in the displacement of a younger 60-km diameter crater, (fig. 1) and the central sector without any evidence of strike slip movements.

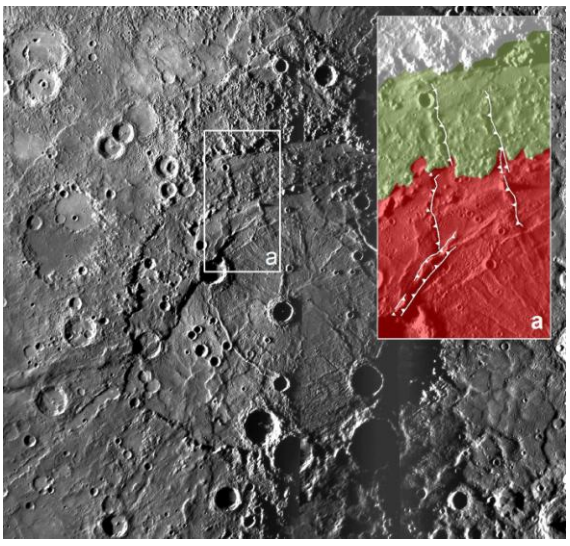

Figure 1: Rembrandt Basin from MESSENGER MDIS-NAC image and (a) geological sketch of the northern-branch of Rembrandt scarp.

The resulting bow shape geometry could be compared with the Beagle Rupes feature despite Rembrandt structure does not show a clear frontal ramp but two lateral ramps converging in a narrow cusp. Similarly, it may imply special conditions of

weakness inside the crust [4]. The main phase responsible of the Rembrandt scarp build-up was followed by minor compressional structures detected within younger craters and possibly associated to a slowing down phase of the global contraction.

3. Age determinations

We subdivided the basin into two main systems for age determination purposes: the volcanic *Inner Plains*, that flooded the crater floor after the impact, and the *Hummocky-Rim Area*, that includes both rim materials and fallout proximal ejecta. The age assessment was obtained by adopting Marchi et al.' (2009) chronological model [2], because it takes into account both (1) the Main Belt Asteroids (MBAs) and the Near Earth Objects (NEOs) projectile populations and (2) the uppermost layering of the target [5]. More in detail, we adopted a lunar-like crustal structure and set fractured silicates of variable thickness on top of a bulk anorthositic crust in turn laying above a peridotitic mantle. In the case of the Rembrandt basin systems, the adopted layering for MPF age determination was well constrained by the good statistics and crater-diameter range of the data set. Indeed, the Crater Size-Frequency Distribution (CSFD) of the hummocky *Rim Area* shows a typical kink, which likely reflects a layer of fractured material with a thickness of about 8 km on the other hand the *Inner Plains* do not show any kink despite the wide crater diameter range that characterize its population. Considering these constraints on the crustal layering and an MBA population, MPF ages of Rim Area and Inner Plain are about 3.7 and 3.6 Ga, respectively [6].

4. Conclusions

The derived MPF ages of Rembrandt Basin inner units imply a short stage of volcanism straight after the basin formation at around 3.6 Ga [6], while our structural analysis shows a long lasting activity of global contraction well-expressed along the Rembrandt scarp. In addition, as well as the Beagle Rupes case, the Rembrandt scarp displays geometries and kinematic indicators suggesting the presence of a basal detachment.

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