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Dating tectonic structures on Mercury

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Abstract

Mercury surface appears to be interested by several tectonic structures, the most interesting ones being numerous lobate scarps formed mainly thanks to planet cooling and contraction. The Messenger cameras (MDIS WAC and NAC) allowed us to map several structures not previously detected. Among these a 250 km-long thrust has been detected crossing a peak ring basin. The region encircled within the inner ring of the basin is covered by a smooth plain with evidence of a sin-deformational emplacement. Dating this smooth plain with crater counting technique allowed us to give an age constrain of the tectonic structure.

1. Introduction

Mercury is a planet classically dominated by contractional features at a global scale formed during the cooling of its core. The dating of these features will permit to estimate the rate of global contraction and whether limits could be placed on when the contraction occurred. This will give us new clues to better understanding the thermal evolution of the planet.

2. Lobate scarps on Mercury

The hermean deformations are represented mainly by lobate scarps. These structures are the expression of surface-breaking thrust faults and are linear or arcuate features widely distributed on Mercury. Since they display a broad distribution of orientations their origin is hypothesized to be related to a global contraction [1]. The Messenger cameras (MDIS WAC and NAC), validated the prediction that the contractional deformation has dominated the tectonic history of the planet acquiring images of new regions of the Mercury surface that allowed us to detect several lobate scarps not previously visible, especially in correspondence of the terminator, where the illumination geometry is more favorable for the structural analysis [2,3].

3. Dating the structures

The age of the lobate scarps can be constrained by the age of the material they deform. The oldest material deformed emplaced near the end of the Late Heavy Bombardment (>3.8 Ga ago) [1,4]. Younger smooth plains units are also cut by lobate scarps suggesting that the thrust faulting activity continued even after the emplacement of the youngest smooth plains. New lobate scarps detected with MESSENGER images would allow us to gain new information on the timing of their formation. Among the new structures a 250 km-long thrust has been detected crossing a peak ring basin (about 186 km of diameter), located at 3° 87’ N and 87°17’E (Fig.1).

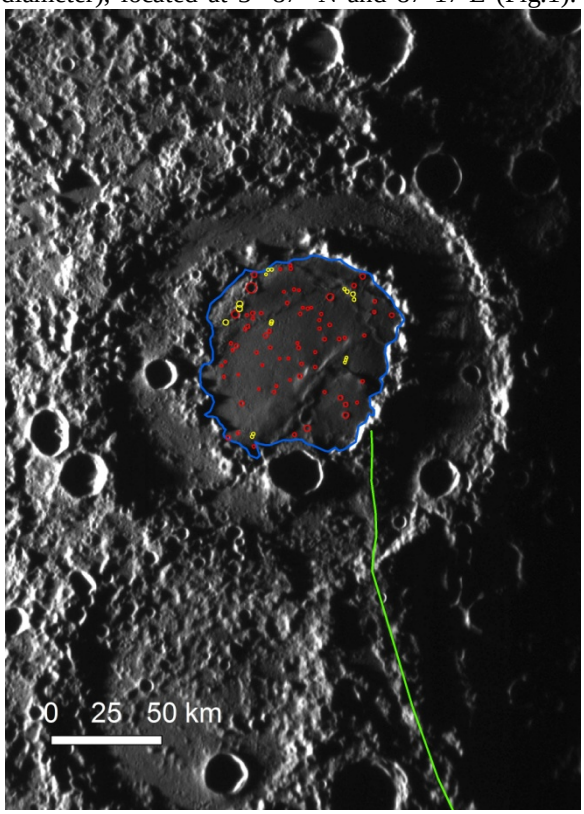

Figure 1. Peak ring basin with an interior smooth plain (outlined in blue) showing a sin-deformational emplacement. The smooth plain was dated by crater counting (red circles: bonafide craters, yellow circles: secondary craters).

The region encircled within the inner ring of the basin is covered by a smooth plain with evidence of a sin-deformational emplacement. Dating this smooth plain allowed us to give an age constrain of the tectonic structure. Crater count method was applied to calculate the age the inner plain. The counts of the craters will be performed with CraterTools[5], within ArcGIS.

6. Conclusions and future works

Our preliminary crater count dates the smooth plain at 3.7 Ga (Fig.2), using the Neukum Production Function (NPF) model [6]. A similar age has been obtained by MPF, although it is partly affected by the assumed subsurface layering. This fixes a straight upper limit to the contractional deformation in this sector of the planet.

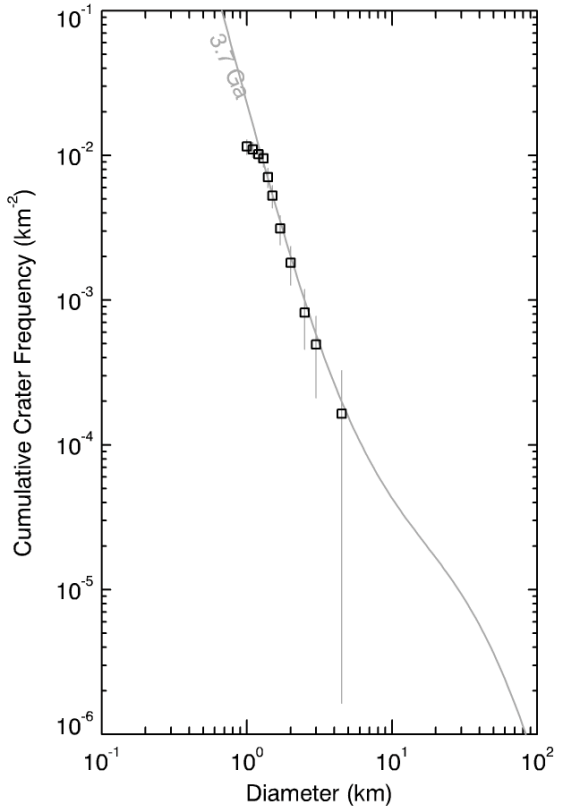

Figure 2: NPF best fit of the bonafide crater SFDs for the inner smooth plain showed on Fig.1.

Future works will be devoted to obtain the absolute age of the hermean tectonic structures through the buffered crater counting technique [7]. This method is based on the observation that a linear feature of limited or insignificant area has a density of superimposed impact craters that depends on the area defined by the crater diameters. This methodology derives an age for tectonic structures using only the relationship of the tectonic system with impact craters, rather than relying on stratigraphic relationships between units. This method has not been applied on the hermean structures yet then the results will give significant improvements on the age constrain of these features and therefore on the knowledge of the hermean thermal evolution. For this activity NPF and the Model Production Function [8] will be used.

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