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Beagle Rupes and Rembrandt scarp: a comparison on Mercury surface.

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Abstract

Areas of crustal convergence and shortening on Earth, Mars and Venus are often characterized by structural domains where thrust faults are associated with strike-slip systems [1]. In the case of Mercury most structures maintain a wide elongated frontal scarp and only few of them show kinematic indicators of lateral slip. The comparison between two Mercurian linked fault systems like Beagle Rupes [2] [3] and Rembrandt scarp [4] could aid understanding of whether diverse hermean strike-slip structures are influenced by geological context such as surface heterogeneity and crustal layering or have different deformational history.

1. Introduction

During these last decades several contractional forms had been recognized and mapped on Mercury, firstly using Mariner10 and then MESSENGER data [5]. In cross section, the structures consist of a steeply sloping scarp and a gently sloping back scarp [6] forming an arched planar shape, so they are usually called lobate scarps. Usually regarded as caused by gradual cooling of the planet, these features are the clearest evidence of crustal deformation present on Mercury, being the surface expression of thrust faulting initiated after the period of Heavy Bombardment (3.8 Gyr ago) [8]. However, other origins such as despinning and mantle convection have been suggested to explain common orientations and regional vergences of some structures [9]. Despite the plethora of studies dealing with lobate scarps on Mercury and other planetary surfaces (Mars and Moon), very few structures have been recognized as linked fault systems. Among them Beagle Rupes seems to be the most prominent one, although also the Rembrandt scarp may show some evidence of linkages between fault segments (fig. 1).

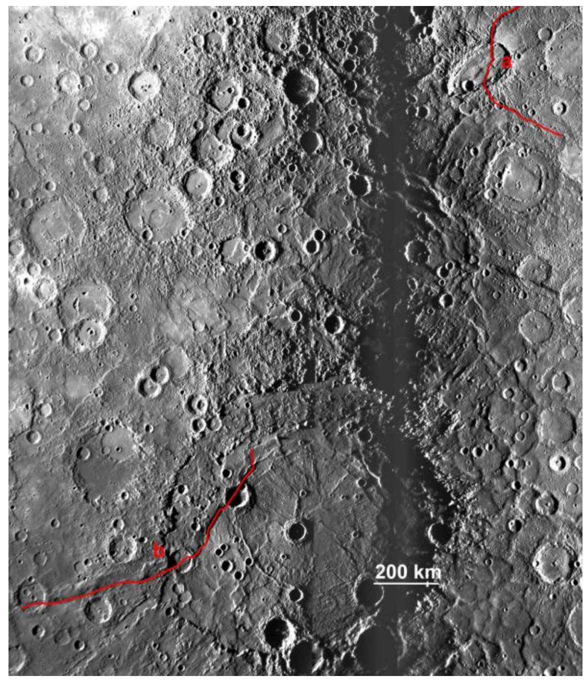

Figure 1: MESSENGER MDIS-NAC image showing both (a) Beagle Rupes at the equatorial area (upper right) and (b) Rembrandt scarp (lower left), which partially cross-cuts the 715-km-diameter Rembrandt impact basin centered at 33.2 S - 88.2 E. The image is courtesy of USGS Astrogeology Science Center http://astrogeology.usgs.gov and http://messenger.jhuapl.edu

2. Beagle Rupes and Rembrandt scarp linked fault systems

In the context of the development of giant tectonic structures like lobate scarps, the equatorial Beagle Rupes can be considered a special case, because it has been interpreted as a component of a linked fault system by Rothery and Massironi [3]. They suggest that Beagle Rupes displays a frontal scarp terminated by transpressive lateral ramps. Indeed, the structure consists of two linked north–south trending arcs that turn at the ends to become straight scarps trending northeast and southeast. These straight scarps have been interpreted to be lateral oblique ramps bounding a thrust sheet [10][11], which transfer motion to a series of younger fault scarps by out-of-sequence thrusting [3]. The inferred dip angle of the main thrust seems to decrease with depth and to be as low as to imply an along-dip displacement. A low angle and the presence of other diagnostic features are coherent with a basal decollement that occurs within or at the base of Mercury’s lithosphere. Candidates for the decollement must imply a change in mechanical properties and therefore could be the base of the elastic lithosphere, the base of the crust, or a regional low-angle discontinuity within the crust. The single example of Beagle Rupes provides no clear basis for deciding among the global chances and the structure seems not to be affected by any visible regional discontinuity like buried basins [5] [6].

Another wide structure recently discovered on the south hemisphere of Mercury and named Rembrandt scarp [4] appears to be a linked fault system, but shows important differences from Beagle Rupes. In particular the scarp partially cuts the large Rembrandt Basin and has two distinct branches with opposite strike-slip component converging towards a narrow cusp. This unusual geometry could be the result of multiple episodes of deformation which may have reworked some inherited structures now representing parts of the final scarp. Alternatively, the Rembrandt Basin may have severely affected the shape and development of the scarp constraining its geometry. Indeed, the structures inside and outside Rembrandt basin display different behavior. The crustal layering, which can be hypothesized is likely to be inhomogeneous in the region of the Rembrandt scarp where it cuts through the huge Rembrandt basin.

The timing of formation of the lobate scarp thrust faults can be constrained by the age of the materials they deform - 3.6 Ga for the Rembrandt Basin inner plains [12]. However we have observed minor compressional structures within younger craters cutting the main scarp, so the contractional activity in this area seems to be prolonged.

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