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The Beagle Rupes area – evidence for a basal decollement of regional extent in Mercury's lithosphere

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The Beagle Rupes lobate scarp was particularly clearly imaged during the outbound leg of MESSENGER's first flyby, thanks to its location at low latitude and proximity to the terminator. Previous interpretations of mercurian lobate scarps regard them as surface expressions of thrusts whose fault planes dip uniformly and die out at depth, and that lack lateral ramps or any extensive detachment horizon. However, we interpret Beagle Rupes as a component of a linked fault system, consisting of a frontal scarp terminated by transpressive lateral ramps. The terrain bounded by these features is the hanging-wall block of a thrust sheet and must be underlain by a basal decollement (a detachment horizon) constituting the fault zone at depth.

Displacement at the Beagle Rupes frontal scarp is no more than about 3 km. However, the decollement must extend a minimum of 150 km eastwards from the frontal scarp, and at least 400 km if displacement is transferred to features interpreted as out-of sequence thrusts and offset lateral ramps that appear to continue the linked fault system to the east. The depth of the basal decollement could be controlled by crustal stratigraphy or by rheological change within, or at the base of, the lithosphere. One such candidate horizon could be the brittle-ductile transition in quartz-bearing lower crust as predicted by some models of Mercury's early differentiation history (Brown and Elkins-Tanton, 2009).

Further analysis of the terrain north and south of Beagle Rupes reveals ridges (10s of km wide and 100s of km long) that we interpret as pop-up structures probably associated with blind thrusts and very likely providing additional evidence of a decollement of regional extent.

Brown, S. M., Elkins-Tanton, L. T., 2009, Compositions of Mercury's earliest crust from magma ocean models. Earth Planet. Sci. Lett. 286, 446-455.