A SPECTRUM OF TECTONISED BASIN EDGES ON MERCURY.

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Introduction: Lobate scarps on Mercury are generally accepted as being surface expressions of thrust faulting. This is taken as evidence of lithospheric contraction on a global scale, reflecting either global cooling, leading to thermal contraction and internal phase changes [1], [2], [3], [4]; or tidal despinning, leading to collapse of an equatorial bulge [5], [6]; or a combination of both [7], [8]. It has been further suggested that the orientations of lobate scarps could reflect a pattern of mantle convection [9].

Here we describe compressional tectonics localized along the interface between basin-fill and the inner walls of >200 km diameter impact basins. These are considerably larger than the ghost craters with deformed rims that have been the focus of other studies [10], [11], [12]. We draw attention to several examples of outward-directed thrust faults following the inside of basin rims, mostly un-remarked in a global survey of >300 km basins by Fassett et al. [13].

Methods: Having noted some basins with tectonized edges, we examined cylindrically-projected MDIS mosaics in ArcGIS systematically at 1:10k scale to locate further examples. We checked all basins identified in [13] and found no further candidates except Goethe, which shows adequately only on a polar projection. Traceable edges of all basins with an apparent thrust are shown on Fig. 1. We include three basins in the 230-300 km diameter range as examples of a continuum of types.

Examples: We show examples to illustrate the range of styles, suggesting a general model of progressive deformation.

Basin b37, 430 km, 27º S 80º E. The N and S rims of this basin are unremarkable. The E rim is obscured by later lava plains, but there is a lobate scarp just inside the W rim (Fig. 2). The relatively late age of this scarp is demonstrated by cross-cutting and superposition relationships. Some time after formation, the basin was flooded by lavas. Afterwards a 140 km crater was formed, overprinting part of the W rim. The floor of this basin became flooded by lavas, before a 30 km crater was formed within it.

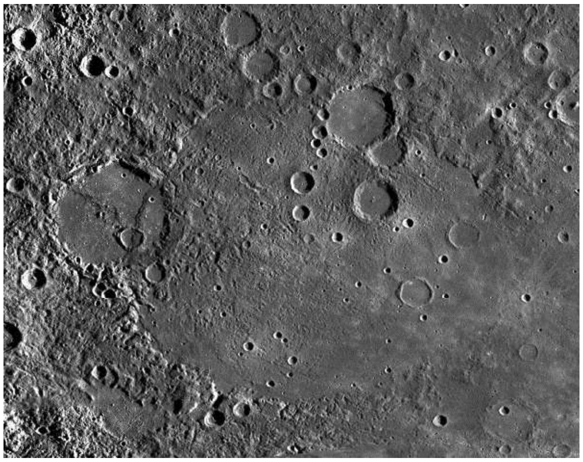

Fig. 2. Basin b37. 430 km diameter.

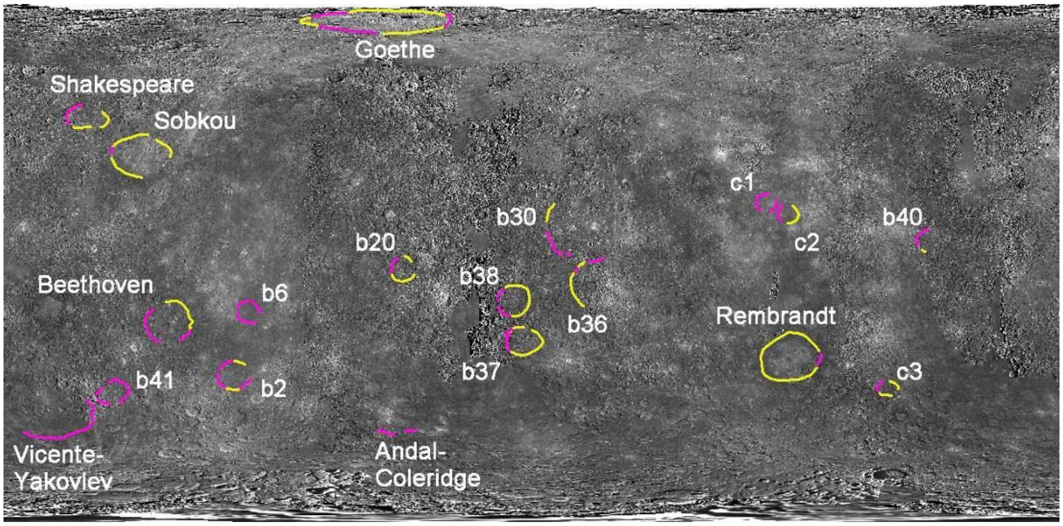

Fig 1 MDIS8 mosaic (cylindrical projection) showing basins with tectonised edges. Pink = tectonised edge. Yellow = non-tectonised edge. Names and 'b' designations are from [13], c1, c2 & c3 (280, 300 and 230 km) are new here.

This 30 kim crater is shallow, with a smooth floor and no central peak, suggesting that it too was flooded by a plains unit. The youngest relevant event is the formation of the lobate scarp, which cross-cuts all those units. These relationships were noted in [13], but without drawing attention to the implied long duration between formation of the basin and the tectonic activation of the junction between basin-fill and its rim.

Shakespeare, 49º N -152º E. This (Fig. 3) resembles b37 in having a lobate scarp inside its W rim, cutting a younger crater. The rim is scarcely discernable between NE and SE, where it appears to have been buried by plains lava. In the SW it is obscured by ejecta from a younger overlapping basin, suggesting that the last tectonic episode is older than for b37.

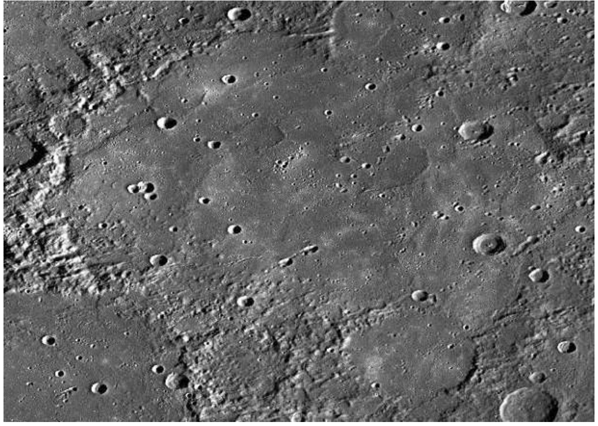

Fig. 3. Shakespeare. 360 km diameter.

Basins c1 & c2, 20º N 80º E &. 16º N 87º E These (Fig. 4) are twin basins near the inbound terminator for flybys 2 and 3. The whole visible inner edge of c1 is a fault scarp, but later craters overprint this in S and NE. c2 has a fault scarp that has over-ridden its W rim

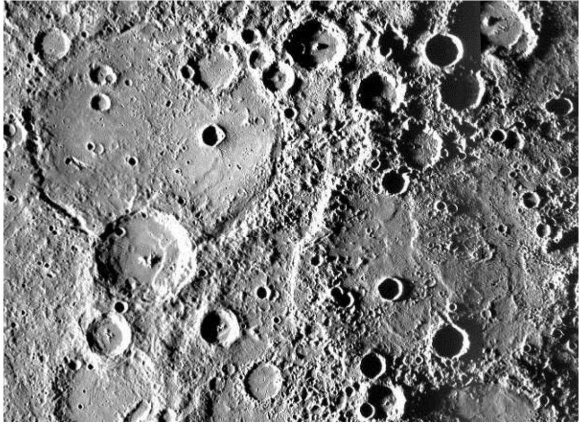

Fig. 4. Basins c1 & c2. 280 and 300 km diameter.

Basin b41 45º S -143º E Listed in [13] as a probable basin with 20% rim completeness, this is in fact a plateau, entirely bounded by scarps (Fig. 5). Much of the S edge has been eaten into by impact craters up to 180 km diameter, and smaller craters overprint the scarp elsewhere. This may not have originated as an impact basin, but if so it is an end-member, with its entire surviving rim over-ridden by thrusting.

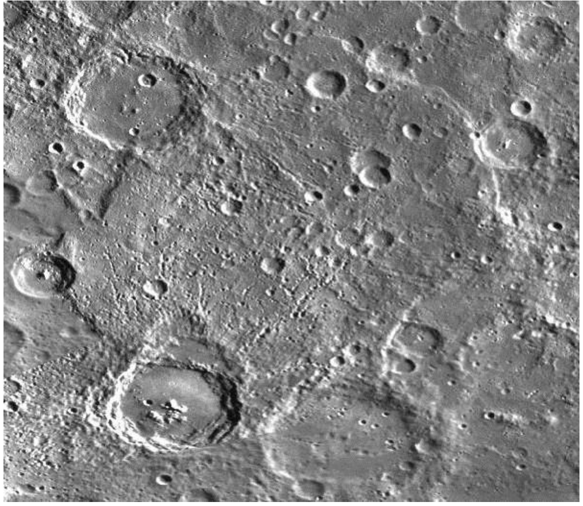

Fig. 5. Basin b41. 340 km diameter.

Model: Irrespective of driving force, the scarps we see are most simply explained by the sketch model in Fig. 6. Thrusting at the edges of low-latitude basins is most strongly developed at eastern and western rims, suggesting (admittedly from a small number of examples) tidal despinning as a driving force. The faulting is demonstrably considerably younger than the plains units filling the basins, and so this observation suggests despinning occurring (or continuing) well after the end of the LHB, contrary to previous expectations [6], [8].

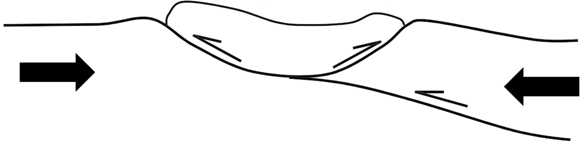

Fig. 6. Sketch cross-section, not to scale, of compressional tectonics acting on a part-filled impact basin.

References: [1] Strom R. G et al. (1975) *JGR*, 80, 2478-2507. [2] Watters T. R. et al. (1998) *Geology*, 26, 991-994. [3] Watters T. R. et al. (2004) *GRL*, 31, L04071. [4] Watters T. R. et al. (2009) *EPSL*, 285, 283-296. [5] Melosh H. J. and Dzurisin D. (1978) *Icarus*, 35, 227-236. [6] Melosh H. J. and McKinnon W. B. (1988) in Vilas F. et al. eds) *Mercury*, UAP, 374-400. [7] Dzurisin D. (1978) *JGR*, 83, 4883-4906. [8] Dombard A. J. and Hauck S. A. (2008) *Icarus*, 198, 274-276. [9] King S. D. (2008) *Nature Geoscience*, 1, 229-232. [10] Klimczak C. (2012) *JGR*, 117, E00L03. [11] Freed A. M. et al. (2012) *JGR*, 117, E00L06. [12] Watters T. R. et al. (2012) *Geology*, 40, 1123-1126. [13] Fassett C. I. (2012) *JGR*, 117.