Volcanic shields on Mercury identified at last?

Conference or Workshop Item

VOLCANIC SHIELDS ON MERCURY IDENTIFIED AT LAST?

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Introduction: Small (<50 km across) shield volcanoes are known on Earth [1], the Moon [2], Mars [3] and Venus [4], but previous identifications of these features on Mercury [5] have been reevaluated [6]. Until now, only low-lying volcanic craters formed by putative explosive eruptions have been positively identified on Mercury [6]. We have found two new candidate small shields at the edges of impact basins using orbital data from NASA's MErcury Surface, Space ENvironment, GEochemistry, and Ranging (MESSENGER) spacecraft. We introduce the better-evidenced candidate here (Fig. 1).

Observations: The candidate shield is a positive relief feature situated within a ~120 km diameter impact basin (Fig. 1A). Smooth plains material covers the basin floor. The positive relief feature appears roughly circular in map view and has a diameter of ~6 km (Fig. 1B). Shadow length calculations return a height of ~600 m and an average slope of ~20°. The bowl-shaped summit depression has a shallower appearance than craters of similar diameter nearby. The northern flank of the feature has a separate depression running from the peak to the base. The superposition relationship between the northern flank depression and the summit depression is equivocal in all available NAC images. The summit has a red spectral anomaly, similar to those of putative pyroclastic deposits elsewhere on Mercury [5] (Fig. 1C). Local impact craters have blue ejecta.

Interpretation: Basins, such as the one shown here, have complex morphologies and should have either central peaks or peak-rings [7]. Our positive relief feature could be an element of this basin's peak-ring (though it is farther from the centre of the basin than would be predicted [7]) with a central superposing impact crater. If this is the case, it is difficult to explain why this element of the peak-ring is present but the remainder is deeply buried with no surface expression. An impact origin for the summit depression is inconsistent with the red spectral anomaly, also. Local impact craters of a similar diameter to the summit depression exhume blue material, requiring a deeper source for the red material. Furthermore, the shape of the summit depression appears shallower than local impact craters. We suggest the smooth plains were emplaced by a volcanic eruption within the basin, burying the peak-ring. The positive relief feature was built as a late-stage volcanic edifice. The depression on the northern flank was formed by subsequent small impacts. Before the extinction of the volcano, at least one deep-sourced [8], explosive eruption occurred, creating the red spot (a pyroclastic deposit, [5]). The relatively undegraded state of the host basin suggests a Mansurian age (~3.5-1.0 Ga) for its formation [9], providing an upper bound on the age of the volcanic edifice.

Conclusions: The apparent paucity of volcanic edifices could be ascribed to the very low molten viscosities of materials matching the surface composition of Mercury [10] or their implied high effusion rates [11]. Our results show that, at least under certain circumstances, eruptions on Mercury could build volcanic edifices. If more candidate shields are found by searching similar settings, then shield building on Mercury may be characteristic of late-stage, post-impact volcanism. Confirmed shields will be important science targets for the upcoming BepiColombo mission to Mercury [12].

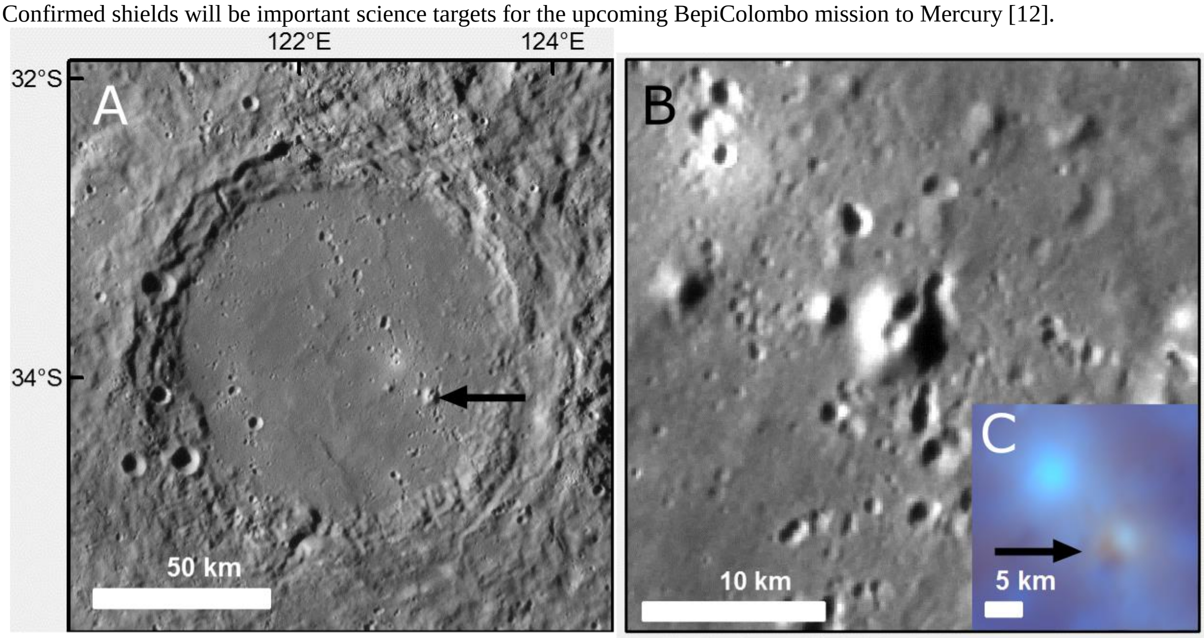

Fig. 1. A – The unnamed impact basin hosting the candidate volcanic edifice (black arrow) (123°02'14" E, 34°07'40" S). **B -** The best view of the edifice (MESSENGER NAC image EN1015774526M, ~136 m/pix). **C -** Enhanced colour mosaic of the host impact basin. The black arrow indicates the red spot associated with the candidate volcanic edifice. Immediately to the north-west of the red spot, bright crater ejecta can be seen from a nearby young impact. This demonstrates that small, local impacts exhume blue material from shallow depths. The red material must have a different, non-impact source.

References: [1] Swanson D. A. 1973. *GSA Bull*. 84:615-626. [2] Head J. W. and Gifford A. 1980. *The moon and planets*. 22:235-258. [3] Hauber E. et al. 2009. *JVGR*. 185:69-95. [4] Ivanov M. A. and Head J. W. 2004. *J. Geophys. Res. Planets*. 109:E10. [5] Head J. W. et al. 2008. *Science*. 321:69-72. [6] Rothery D. A. et al. 2014. *Earth Planet. Sci. Lett.* 385:59-67. [7] Pike R. J. 1988. *Mercury*. 165-273. [8] Thomas R. J. et al. 2015. *Earth Planet. Sci Lett.* 431:164-172. [9] Kinczyk M. J. et al. 2016. Abstract #1573. 47th LPSC. [10] Stockstill-Cahill K. R. et al. 2012. *J. Geophys. Res. Planets*. 117:E12. [11] Byrne P. K. et al. 2013. *JGR: Planets*. 118:1303-1322. [12] Rothery D. A. et al. 2010. *Planet. Space Sci.* 58:21-39.