Explosive Vents on Mercury: Commonplace Multiple Eruptions and Their Implications

Conference or Workshop Item

EXPLOSIVE VENTS ON MERCURY: COMMONPLACE MULTIPLE ERUPTIONS AND THEIR IMPLICATIONS.

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Introduction: The MESSENGER mission imaged high albedo red spots (now referred to as faculae) on the surface of Mercury [1-3]. Faculae show little relief apart from central rimless, non-circular depressions. They are interpreted to be explosive volcanic vents surrounded by explosive volcanic deposits [1,2, 4].

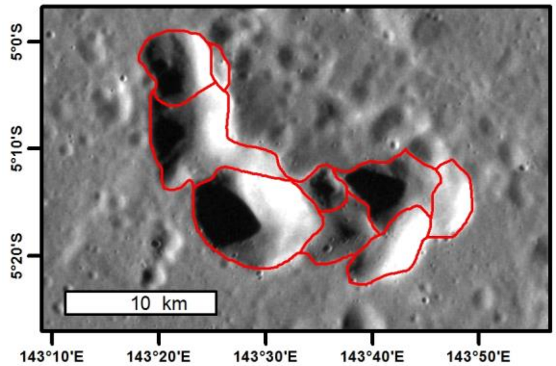

Fig 1: Example of a compound vent system on Mercury. Sinusoidal projection centered on the vent.

Their global distribution, setting and overall shape have been studied [4-8], but little work has been undertaken on their internal structure: only the vent within Agwo Facula has been described in detail [9], where several vents inside a common rim were identified, making it a compound volcanic vent [10].

We present here a larger study of all compound vent sites on Mercury, in which their internal structures are described and analyzed.

Methods: We used the high resolution MDIS images [11] of faculae within the database of [6] to study vents contained within them. Where a vent structure was clearly resolved and had two or more immediately adjacent or overlapping vents, we classified it as compound(eg. Fig 1) (unless the vents were clearly separated within the same structure, such as on different parts of a peak-ring)).

We identified compound vents based on internal structures, predominantly septae (narrow ridges between vents). Distinct volcanic craters (non-circular with defined, but not raised, rims) were also identified.

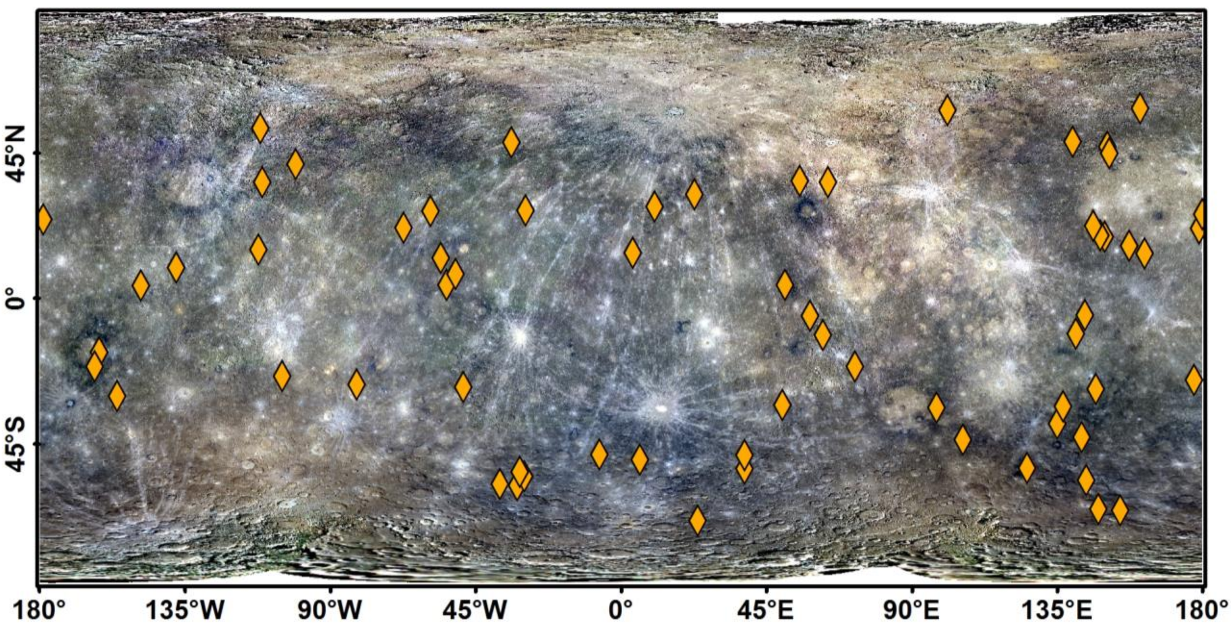

Fig 2: Global distribution of compound volcanic vents identified on Mercury, using the Mercury global color basemap [12].

We used cross-cutting relationships to infer relative timing where possible. In a few cases, where image resolution was sufficient, we used the relative internal roughness of each vent to aid inference of relative timing: smoother surfaces being assumed to be older (blanketed by a thin layer of younger volcanic ejecta, or muted by thicker regolith).

Results: There are 64 compound vents within the 184 faculae on Mercury (Fig 2), so at least a third of all faculae have compound vents at their source. This is likely to be an underestimate, due to illumination constraints and the limited availability of high resolution images. We noted a wide variety of individual vent sizes, and that vents within a single compound vent system can have different depths.

There is no clear pattern to the global distribution of compound vents. Globally the proposed link between faculae and tectonic structures cannot be seen

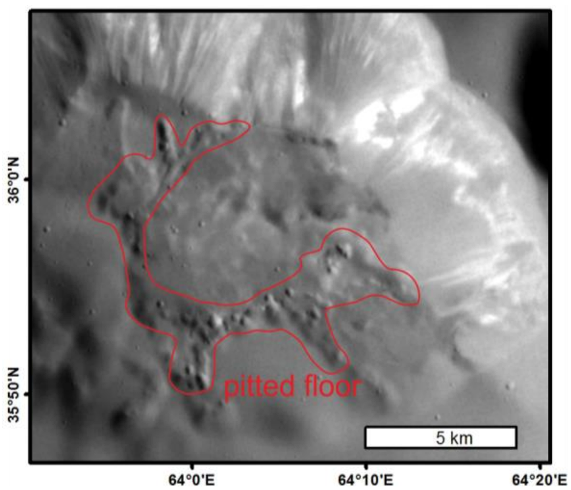

Fig 3: Vent floor within Nathair Facula highlighting small pits around the texturally roughest (youngest?) part of vent.

[13], but the morphologies of individual vents are often controlled by structural features.

Internal features: Within most vent sites there is little evidence of the constructive edifices previously identified at some pits [8], suggesting that the dominant style of volcanism is explosive excavation. This includes newly-recognized features from our study: small-scale pits on the edges of the larger vents within a compound structure (e.g., Fig 3). These pits do not have the spectral characteristics of hollows seen on Mercury [2,4,5,14] and in some cases appear to follow existing structures within the pit.

Discussion: Previous work has shown that explosive vents on Mercury formed over a long period (and possibly as recently as the Kuiperian) [6,8]. It is not possible to make estimates of the length of time individual vent sites were active, both due to their small size and their rough appearance, which makes impact crater statistics unreliable. The large proportion of faculae with compound vents suggests that at least a third of the vents were not made simply by single eruptive events. The different scales of vents observed, including the much smaller end-stage textures and overlapping vents, suggests that many vents on Mercury were active for prolonged periods of time. This prolonged activity suggests that the dyke systems that presumably fed these vents must have been recharged with volatiles. Possible mechanisms for this include magmatic recharge tapping a volatile rich mantle [15], or assimilation from volatile rich crust [16].

Given the small size of many of these features it seems likely that some have not yet been located due to the low resolution of images available. This is also true for single vents.

Conclusion: A large proportion of explosive volcanic vents on Mercury are compound structures indicative of multiple eruption events at that site. This suggests that magma sources were long-lived and recurrent. Volatiles were replenished over time, either through magma recharge or assimilation. This has wide implications for the internal plumbing of these sites, suggesting that, once established, they can be long-lived. Multiple eruption centers associated with each facula must be accounted for in models of eruption velocities, which often assume a single central vent. Further study by BepiColombo will provide more information on these structures and their implications for Mercury's volatile rich volcanism.

Acknowledgements: STFC for funding my studentship (grant number ST/R504993/1).

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