FAR GREATER POPULATION OF FLOW DEPOSITS AROUND MERCURIAN IMPACT CRATERS THAN PREVIOUSLY KNOWN.
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Introduction: Flow features emanating from impact craters are found across the solar system. For some flows on rocky planets and icy moons, they are believed to be "impact ejecta flows", specifically the deposits of ground-hugging flows of ejecta during an impact event. These features have a layered morphology with steep margins, and are often lobate in shape, contrasting with ballistically emplaced ejecta that thins exponentially away from crater rims. For Mars, the Earth, and some icy satellites, volatiles have been suggested as a possible fluidising agent for ejecta flows [1,2,3]. Other flow features emanating from craters have more contentious origins. Flow features on dry bodies like the Moon (e.g. at Tsiolkovskiy crater [4]) are unlikely to have been fluidised by volatiles, and dry granular flows of ejecta have been proposed instead [5,6]. Alternatively, flow features emanating from craters could be mass movement events [7]. These may occur during or immediately after crater formation, or may be later events triggered by some other process.

On Mercury, seven flow deposits around impact craters were reported by Xiao and Komatsu [8]. They are described as impact ejecta flows: single layer deposits, extending downslope into adjacent, older craters. Despite this description, they suggest it is unclear whether these features formed during the impact process, or afterwards via mass-wasting. Hokusai crater also has an apparent ejecta flow [9], but by contrast it occurs on relatively flat ground and does not extend into an adjacent crater, indicating this is a "true" ejecta flow rather than a later mass movement.

Method: We undertook a global search of Mercury for flow features around craters, using grid-squares to systematically survey each Mercury quadrangle in turn. We then investigated the morphology, topographic profile, host crater attributes and geologic setting of features found. Examples are shown in Fig 1.

Results: 39 craters with flow features were identified, with a further 32 probable examples. This is at least a fourfold increase on the number of flows previously reported, showing the abundance of these features on Mercury. The flows mainly occur around craters 30-80km in diameter, and are widespread: they are found in 14 of the 15 Mercury quadrangles (Fig 2). All but two of the flows extend into adjacent craters or nearby topographic lows (Fig 1a,b). The northern smooth plains and circum-Caloris plains have an apparent dearth of flow features, likely due to their lower crater density causing fewer intersecting craters to occur in these locations. In addition to Hokusai, one other crater was identified as the source of a flow on flat ground (<2° slope), that does not extend into an adjacent crater (Fig 1c). These two flat ground examples look distinct from other examples on Mercury, in that they resemble single-layer ejecta craters on Mars, with distal ramparts and a ropey texture.

Fig 1 *Examples of ejecta flows found in this survey. Flow margins indicated with red arrows.*

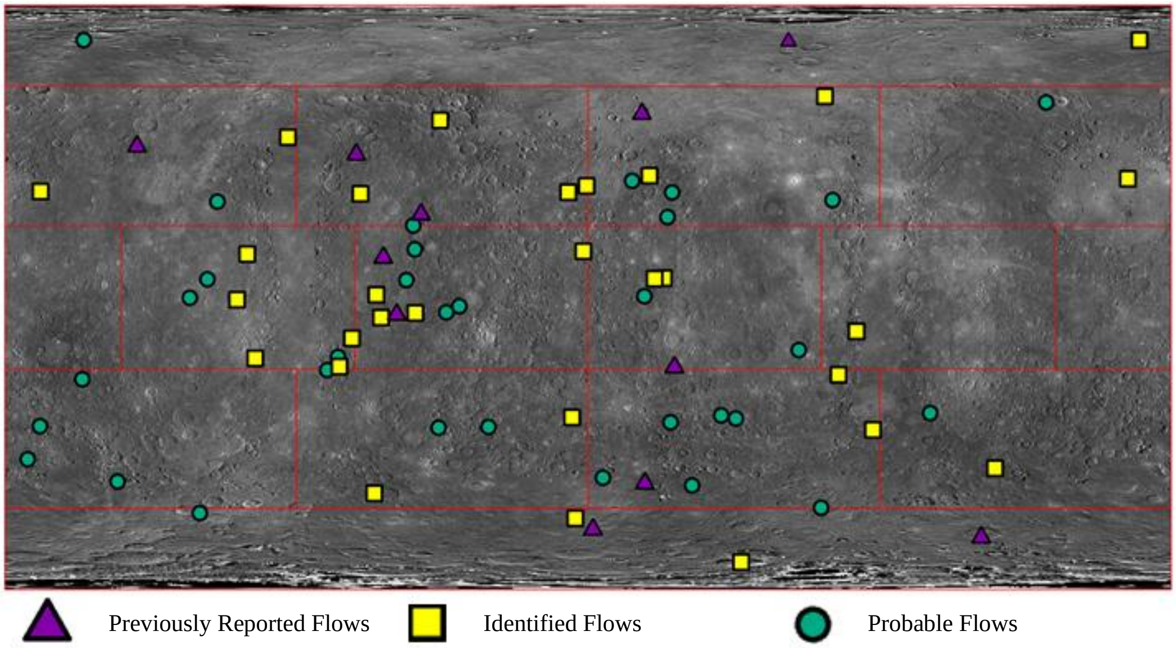

Fig 2 *Global survey of Mercury for ejecta flows. Monochromatic basemap of Mercury in a simple cylindrical projection. Middle of the image at 0 degrees longitude, with red Mercury quadrangle outlines.*

Discussion: Local topography is clearly a major factor in influencing the development of crater related flow features on Mercury, since almost all examples extend downslope into adjacent craters. This may suggest these features are in fact mass movements rather than ejecta flows. Lennox et al. [10], however, recognised impact melt stratigraphically on top of one flow, and within this survey we find 2 more possible examples of this. These observations, along with the marked absence of recognisable failure scarps for flow features, indicate that mass movements long after crater formation are an unlikely origin for these particular features. Mass movements occurring during or soon after crater formation are harder to rule out however, and may be difficult to distinguish from ejecta flows. Due to the variety of crater related flow features on Mercury, it is likely that more than one formation process is occurring.

As Mercury has volatile-bearing materials at the surface [11,12], these could potentially facilitate ejecta fluidisation. However, we find no clear evidence for volatile involvement in flow feature development, in that features indicative of local volatile concentration (e.g. hollows) don't occur preferentially near to flows.

Of the flows on flat ground, Hokusai crater exhibits evidence of excess impact melt: a possible fluidising agent [9]. However, the other crater with a flow on flat ground has no identifiable impact melt outside the crater rim (Fig 1c). The crater is also considerably smaller than Hokusai (37 km vs 95 km diameter), and smaller craters tend to have proportionally less impact melt [13].

Future Work: For testing a mass movement origin for flow features, estimates of flow volume using shadow height measurements will be compared with estimates of potential crater rim volume loss. If the flow features are the result of rim collapse and subsequent mass movement, you may expect these volumes to be similar, discounting any increase in flow volume from entrainment. The rim profiles of intersecting craters with and without flow features will be compared, to assess the influence of uneven topography and potential mass movements in altering crater rim shape. Surveying other planetary bodies is also a potential research direction, particularly the Moon, where similar features have been identified.

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