The Devolatilized Landscapes of Mercury: New Insights and Major Uncertainties

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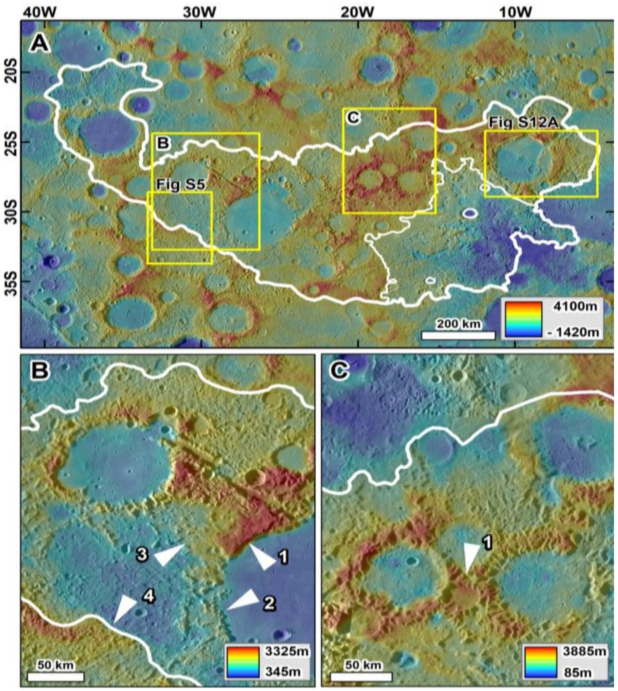
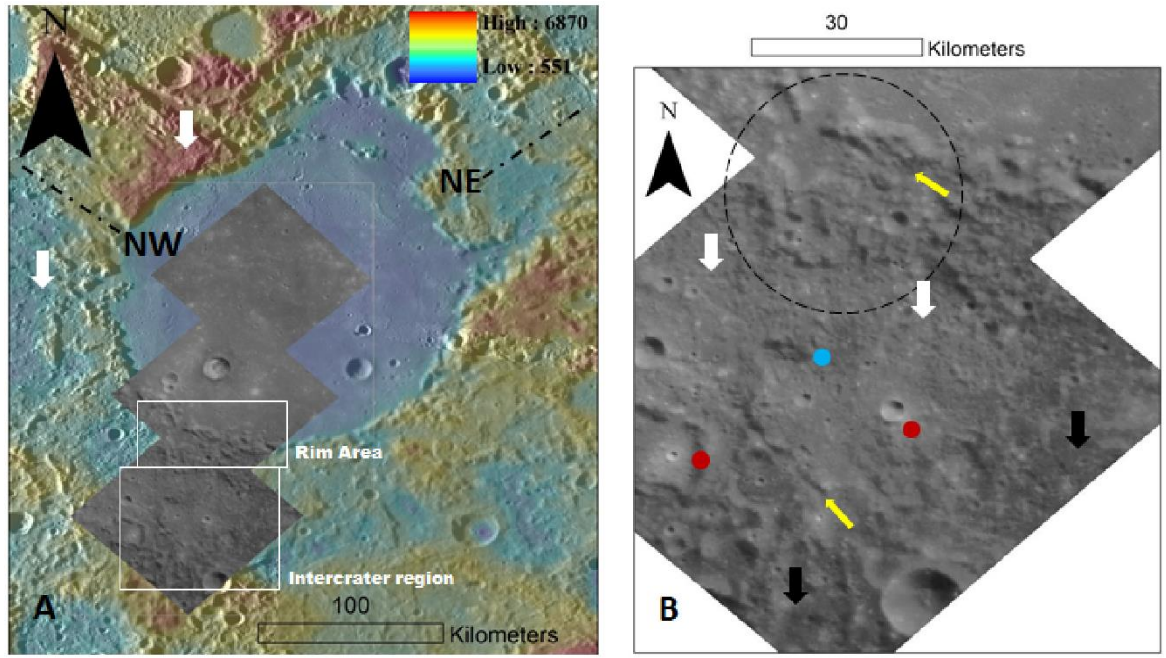
There is emerging evidence of a current-day volatile-rich surface and subsurface materials on Mercury. We show evidence for Mercury's chaotic terrain as the residue due to a devolatilized crust. We show that volatile removal leading to hollows formation did not occur within the plains that they modify. Instead, the devolatilization likely occurred from within an extremely ancient, buried volatile-rich stratigraphy. We present evidence that the north circum-polar plains and adjoining cratered regions formed in a crustal layer originally composed of volatile-rich materials. Our scenarios explain the origin of a primordial volatile-rich layer, its connection to widespread chaotic terrain formation, the clustering of the north polar craters, and the formation of widespread younger volatile-rich plains, regionally modified by hollows.



(A) *Extent of a vast chaotic terrain (CBACT, white outline) at the antipode of the Caloris basin.* ***(B)*** *Zoom in showing evidence of variable collapse. Arrow 1: a rim section that is smoothed but not broken into knobs. This area adjoins another part of the rim that has been almost entirely removed (arrow 2). The nearby intercrater regions exhibit deep and abrupt relief losses, too (arrows 3 & 4).* ***(C)*** *Zoom in showing a cluster of three impact craters with diameters ranging from ~ 25 km to ~75 km. Notice that while the rims exhibit abrupt variations in their collapse magnitudes (arrow 1), the knobby materials' distribution retains the craters' circularity. Panels are parts of a MESSENGER Mercury global DEM (~665m/px) draped over the MESSENGER Mercury Dual Imaging System (MDIS) global base map (~166m/px).*



(A) *Context and location for the RTM N01_002948_0697899 (76 m/px, gray areas), which we plan to investigate during this task. Thin dashed lines are tagged with the regional structural trends to the NW and NE.* ***(B)*** *Close up on the southern part of the RTM, which includes part of a crater's rim and adjoining plains, which have undergone significant surface elevation losses. The black arrows are within a low albedo region consisting of smooth plains, which occupy the SE part of the view. The white arrows are situated within an adjoining higher albedo and rougher surface. These higher albedo materials appear to be exposed in the ejecta of some small craters that occur within the low albedo region, indicating that they form a lower stratigraphic zone (red dots). The high albedo area includes clusters of sub-kilometer-scale hills (e.g., black circle's interior area). The yellow arrows identify narrow (some also sub-kilometer in width) grooves that align with the regional NW structural trends. Our interpretation is that the low albedo surface underwent collapse to produce the high albedo surface and that the collapse involved structurally controlled surface elevation losses. The magnitude of the collapse was variable, and locally there appear to be low albedo inliers within the collapsed terrains (blue dot).*