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► To cite this version:

Ben Man, David A Rothery, Matthew R Balme, Susan J. Conway, Jack Wright. Newly discovered widespread extensional grabens on Mercury's compressional structures. Mercury 2022, Jul 2022, Orléans, France. ⟨hal-03851221⟩

HAL Id: hal-03851221

<https://hal.science/hal-03851221v1>

Submitted on 14 Nov 2022

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Newly discovered widespread extensional grabens on Mercury's compressional structures

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Mercury is a shrinking planet with a surface dominated by compressional tectonic landforms as first identified by Mariner 10 and then confirmed by MESSENGER. Extensional structures are present but are much rarer, with almost all reported examples found exclusively in smooth plains material within craters [1]. The only two reported examples of extensional structures outside of the aforementioned setting are extensional grabens associated with lobate scarps; pristine back-scarp grabens associated with small lobate scarps (10s of kms in length and 10s of metres in relief) [2], and crestal grabens found on Calypso Rupes (381km in length and ~ 1 km in relief) [3,4]. These grabens form when thrusting produces a hanging wall anticline resulting in local tensional stresses along the anticlinal axis parallel or sub-parallel to the hinge zone. Here, tensional stresses cause antithetic faults to form, which results in a narrow down-dropped fault block.

We find that extensional grabens on compressional structures are much more common than previously recognised. These small-scale landforms (often less than 1km in width, 10s of km in length and likely 10s to 100s metres in depth) are not expected to survive 100s of millions of years due to continual regolith formation and impact gardening masking their signature [1,2]. Our discovery and documentation of potentially young extensional grabens may indicate that many of Mercury's compressional structures have continued to move until geologically recent times. This work therefore may call into question the old absolute age estimates of tectonic features' last movements calculated using crater counting [5-9].

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