SHORTENING LANDFORMS IN MERCURY'S H-11 DISCOVERY QUADRANGLE - NOVEL, HIGH-RESOLUTION TOPOGRAPHY DATA REVEALS STRUCTURAL CONTROL BY ANCIENT BASINS. J. D. Clark[1], H. Bernhardt[1], F. Preusker, C. Klimczak, M. E. Banks, D. A. Williams[1], D. Nelson[1], T. R. Watters, [1]School of Earth and Space Exploration, Arizona State University, Tempe, USA (h.bernhardt@asu.edu).

Introduction: The global distribution of shortening structures on Mercury as well as geographic and temporal trends of any of their morphometric and structural parameters are key to learn more about the planets' history of contraction, tidal despinning, and lithologic/rheologic variations in its current crust [1–4]. Previous mapping efforts by [4] were based on lower-resolution ~250 m/pixel (m/px) data by MESSENGER's Mercury Dual Imaging System (MDIS) as well as 665 m/pixel digital terrain models (DTMs) [5] and did not include comprehensive morphometric analyses other than displacement-length (D/L) assessments. Furthermore, as recently elaborated on by [6], the association of shortening structures with larger tectonic complexes needs to be assessed to derive a more realistic inventory of actually implied faults. We are producing a new global map and parameter catalog of shortening structures on Mercury using the latest MDIS mosaics (166 m/px) in combination with a novel stereo-imaging-derived DTM (222 m/px) that we completed for the entire globe based on preliminary earlier work [7–9]. Here, we present initial observations from the H-11 "Discovery" quadrangle (Fig. 1), the first quadrangle we completed as part of our global investigation. Another part of our investigation are absolute model age constraints for certain scarps based on crater size-frequency distribution measurements, which are detailed in our companion abstract (#1461).

Data & methodology: We established a thorough step-by-step procedure [10] to map and parametrize each identified shortening structure including, amongst others, measurements of relief, the shape of throw, length, lobateness, width and an assessment of whether a scarp is part of a complex (including compound scarps of wrinkle ridges).

Observations: About a third of the lobate scarps in the H-11 quadrangle are concentric to ancient basin outlines as mapped by [11]. This pattern did not become apparent in previous maps [4,12] as differently illuminated hillshade models based on our 222 m/px DTM allowed us to identify several new scarps without a bias from the illumination conditions of the MDIS mosaics. Comparable to scarps concentric to the Hellas basin on Mars [13,14], such scarps in the H-11 quadrangle that are concentric to the Andal-Coleridge basin can either face towards or away from the basin center. The relief of inward-facing scarps, e.g., parts of the Astrolabe Rupes, might be the result of original ring structures corresponding to the Montes Cordillera around the lunar Orientale impact basin, i.e., normal faults due to basinward movement during the collapse of the transient impact cavity [15,16]. Including such structures in an assessment of global shortening should therefore be revisited. Outward-facing scarps such as the Discovery Rupes might correspond to the Dorsa Brevia south of the Hellas basin, which could represent an Orientale-Cordillera-type scarp that was (re-)activated by compressive stresses unrelated to initial basin-formation such as mascon subsidence and/or global contraction [14]. Material strength is expected to be drastically reduced in such pre-existing zones of weakness, which might, in turn, affect the D/L of such scarps.

Based on these observations it becomes clear that global and regional assessments of contraction, tidal despinning, thermal weakening, mascon subsidence, as well as lithologic/rheologic variations [1,4,6,17–23] based on the orientation, location, and the relief of lobate scarps on Mercury must consider their structural control and possibly even origin by ancient impact basins. Regional or hemispheric trends of scarp orientations as well as other parameters and derived hypotheses about tidal stresses, lithospheric heterogeneities, and global contraction [4,12,23] seem to be affected by basin-concentric arrangements observed on data that is compromised by illumination-biases. As demonstrated in the H-11 quadrangle, we will use our novel DTM to reduce any such biases and significantly expand the catalog of shortening structures on Mercury. Further work will see our map cover the entire planet. We will then be able to assess scarp parameters such as D/L or their shape of throw (topography along the scarp crest) as a function of their association with an ancient basin, its approximate diameter, and estimated age. Based on this as well as assessments of each scarp's potential association with a larger scarp complex (and a resulting new estimate on the total number of faults and absolute displacement), we will be able to offer new constraints on Mercury's global contraction, potential regional stress fields, tidal interactions, and material-related controls.

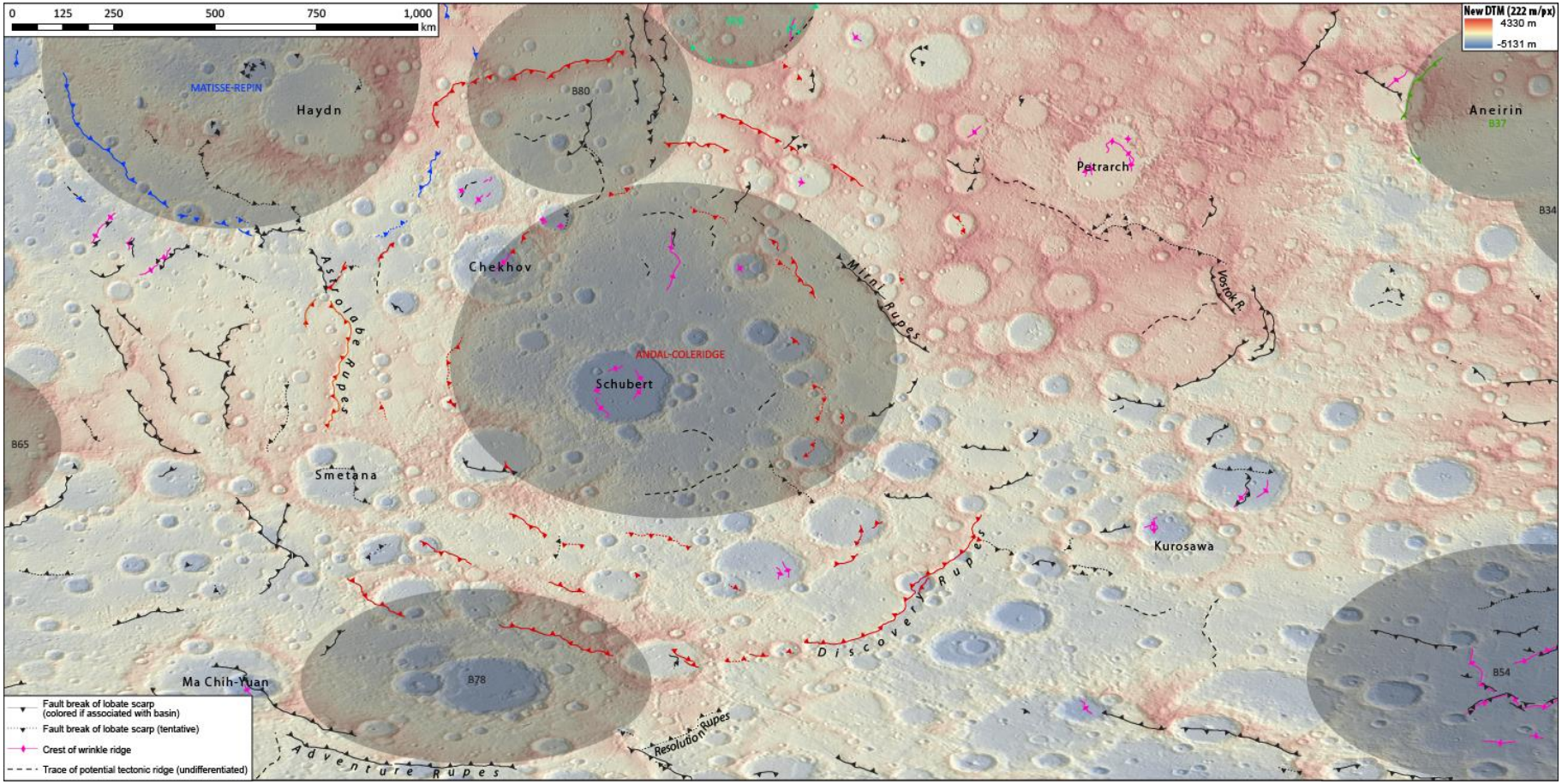

Figure 1: Simple cylindrical view of the H-11 "Discovery" quadrangle of Mercury showing color-coded topography over a hillshade model of our novel, global, high-resolution DTM (222 m/px). Linework shows our map of shortening landforms based on the DTM as well as 166 m/px MDIS mosaics. Dark-shaded areas are ancient basins as mapped by [11] including their respective labels. Mapped scarps, whose orientation and location we tentatively associate with a structural control by one of the basins are colored accordingly: Matisse-Repin basin (blue), Andal-Coleridge basin (red), B98 basin (blue-green), Aneirin/B37 basin (dark green). The apparent structural control by the Andal-Coleridge basin extends beyond its previously mapped extent by approximately one radius, including the Discovery Rupes and parts of the Astrolabe Rupes.

References:

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