INVESTIGATING THE ARCHITECTURE AND EVOLUTION OF THE VICTORIA RUPES – ANTONIADI DORSUM ARRAY, MERCURY.

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Introduction: Since Mercury was first imaged by Mariner 10, its tectonic evolution has been investigated and several tectonic models were proposed, e.g. [1] [2] [3]. Data coming from the MESSENGER spacecraft extended our knowledge of the planet at a global scale, and despite the global contraction due to core solidification [1] is still the main model that can explain Mercury's ubiquitous contractional structures [4] [5], there are still localized structure alignments that might suggest a more complicated architecture of Mercury's crust and mantle as already hinted by the past Mariner 10 observations, e.g. [6]. One of the most prominent fault alignements on Mercury is represented by the Victoria Rupes – Endeavour Rupes – Antoniadi Dorsum array (Victoria – Antoniadi array), interpreted as a fold-and-thrust belt by [5]. The recent completion of the geologic map of the Victoria quadrangle (H02) [7] has led to significant insights on the structural framework of this area of Mercury, revealing the presence of at least two main non-parallel fault systems [8]. A recent study of contractional features on another portion of Mercury [9] also revealed the possibility that two stages of deformation might have occurred in that area. These findings seem to hint that localized structural analyses of Mercury structures could help defining more complete tectonic models of the planet in the future. To this end, here we describe the methods followed to analyse the Victoria – Antoniadi system (and its surroundings), the preliminary results and open questions for the future.

Structural analysis: Inside the H02 area three main systems were identified and their orientation was statistically defined through rose-diagram analysis: the N–S "Victoria system", the NW–SE Carnegie Rupes system and a less prominent NE–SW system found in the area of Larrocha crater ("Larrocha system"). A detailed study based on a hierarchical segment subdivision lead to assess that the Victoria – Antoniadi array defines a central longitudinal tectonic fault-free bulge limited to the west by Carnegie Rupes and other Carnegie system east-dipping faults, which are inferred to be kinematically related and antithetical to the Victoria system faults. A geometric analysis done using faulted craters as kinematic indicators [10] revealed that Carnegie system dips 30° ± 3° E (i.e. fault crossing Duccio crater), the Victoria Rupes sector dips 20° ± 3° W (i.e. fault crossing Enheduanna crater), a segment pertaining to the Endeavour Rupes sector dips 21° ± 7° W (i.e. fault crossing a small crater at 331.8°E, 39.9°N) and the Antoniadi Dorsum sector dips 14° ± 3° W (i.e. fault crossing Geddes crater). Repeated measures in these areas were used for a finite strain inversion analysis of the entire fault system resulting in a shortening axis trending 71°E. To the west of the bulge, the "Larrocha system" faults are more degraded, thus no craters permitted to assess their geometry. Along the west limit of the bulge, some "Larrocha system" segments seem to accommodate the transition between some minor "Victoria system" segments in a manner similar to the relay ramps observed in terrestrial fault systems, e.g. [11]. They are interrupted by the H02 central bulge and in an early stage of the analysis were inferred to be older than the Victoria system faults, thus hinting to the existence of two stages of deformation [8].

Dating results: The buffered crater counting method [12] [13] was used to assess the age of the "Victoria system" faults and the "Larrocha system" faults. Preliminary results give an average age of ~3.77 Ga for both systems. This result may suggest that the "Larrocha system" encompasses second order NE-SW fault segments linked to the same tectonic event that developed the more prominent (i.e. first order) N-S faults pertaining to the "Victoria system".

Future work: It is evident that in this area the faults are systematically aligned and pertaining to different orders of deformation. Are these systematic alignments due to crustal or mantle discontinuities? The Victoria – Antoniadi array is characterised by the presence of pit craters (i.e. volcanic vents) defining three peculiar spots along the array that correspond to systematic changes in fault zone segmentation, implying a strict relationship between volcanic activity and faulting in this area (Figure 1). This occurrence is quite common on Earth, where relevant upwelling processes (e.g. volcanoes, geothermal fluids and vents) usually happen in correspondence of fault intersections where an effective percolating system might develop, e.g. [14]. A deeper knowledge of Mercury crustal or mantle discontinuities is required to further investigate this case. Finally, if these faults formed ~0.8 Ga after the formation of Mercury, these results are inconsistent with the latest thermo-mechanical models [15] that predict the start of global contraction at ~1.5 Ga after the formation of the planet. Further investigation of each sector pertaining to the Victoria – Antoniadi array is required to disentangle the regional history of this portion of Mercury.

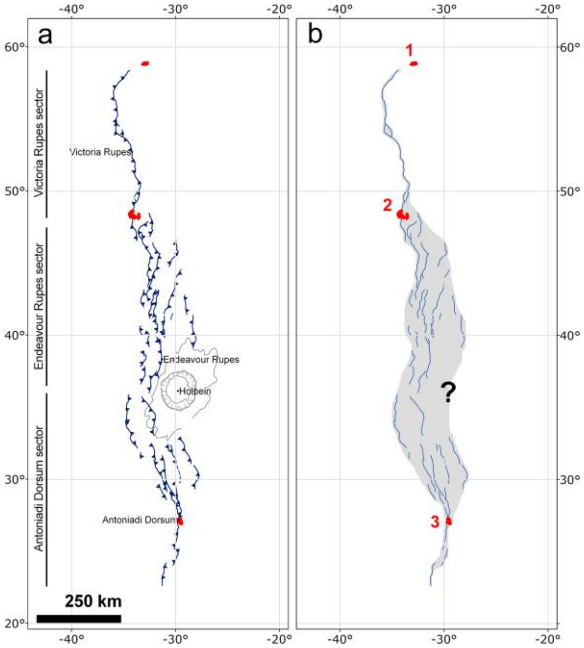

Figure 1. Structural scheme of the Victoria – Antoniadi fault array showing the three pit craters located on three peculiar spots of the fault system. a) Red polygons represent irregular pit locations; blue lines are thrusts with triangle laying on the footwall; grey contacts indicate Holbein crater main boundaries; to the left Victoria – Antoniadi array sectors are indicated. b) Pit craters are indicated by a number: 1) pit crater inside Namatjira crater defines the northern tip of the fault array; 2) pit crater inside Enheduanna crater defines a sudden change in fault segmentation; 3) pit crater inside Geddes crater defines a sudden decrease in fault segmentation. The black question mark indicates an area covered by the sin-tectonic Holbein crater [7].

Acknowledgments: This research was supported by the Italian Space Agency (ASI) within the SIMBIOSYS project (ASI-INAF agreement no. I/022/10/0).

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