RE-EVALUATING THE STRUCTURE OF THERMUTHIS CORONA THROUGH DETAILED GEOLOGICAL MAPPING: THE SECOND LARGEST CORONA ON VENUS?

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Introduction: A comprehensive 1:2,500,000 scale geological mapping study of the Alpha Regio (V-32) quadrangle is currently in progress. We have mapped the structural elements in a subset of this quadrangle, extending from 23°-40° E longitude, 0°-17° S latitude, that also includes a portion of the adjacent Scarpellini (V-33) quadrangle. The selected area covers the feature named Thermuthis Corona (centred at 33° E, 8° S), which was listed in the global corona catalogue of [1] as a concentric corona of category 2 (moderate associated volcanic features), with a maximum diameter of 330 km and a maximum annulus width of 60 km. The topographic signature of Thermuthis Corona has been described as an interior rim approximately 260 by 330 km in diameter that surrounds an interior depression. Our mapping aims to provide a detailed characterization of Thermuthis Corona for comparison with potential terrestrial analogues [2].

Methods: Geological mapping was conducted using full resolution (~75 m/pixel) left-looking Magellan synthetic aperture radar (SAR) images, and altimetry and gravity data in ArcGIS 10.5. Stereo left-looking SAR images and stereo-derived topography data [3] are also available for a portion of the selected area and were used to supplement interpretations. Two classes of structures were mapped: 1) extensional structures, including graben, fissures, fractures, and normal faults, and 2) wrinkle ridges, defined as compressional structures thought to represent anticlines and thrust faults (Figure 1). Structures were also characterized based on their geometry, which could belong to three categories: 1) linear, 2) radiating, or 3) circumferential. Structures sharing similar trends that were interpreted to have formed during the same event have been grouped into systems.

Topography and Geoid: As with many coronae, the topographic signature associated with Thermuthis Corona is complex (Figure 2). There is an interior rim that defines the outer boundary according to [1]. The interior contains several regions of high and low elevation. In addition, we recognize a much larger, exterior rim with a maximum diameter of ~970 km. With the consideration of this newly recognized exterior rim, Thermuthis Corona best fits within group 6 (outer rise, trough, rim, inner low – comprising 1% of coronae) in the topographic classification scheme for coronae defined by [4].

A positive geoid anomaly with a maximum height of over 20 m is observed in the region surrounding Thermuthis Corona, particularly within the inner topographic high recognized by [1]. The shape of the geoid anomaly matches nearly perfectly with the shape of the inner topographic high as observed in the altimetry data and SAR images.

Structural Trends: Five significant structural trends were identified in our mapping. Four of these trends have been interpreted to be related to Thermuthis Corona.

Extensional Structural Trends: A circumferential (CE) and a radiating (RE) extensional system were identified and interpreted to be associated with Thermuthis Corona. Extensional structures in CE extend for ~270° around the centre of the corona, and are mostly concentrated on the western and eastern edges. They generally coincide with relatively high regions along the exterior and interior rims. Structures associated with RE are also mostly preserved close to the central region, and especially within the exterior rim. However, a portion of RE extends >1300 km away from the centre. Both RE and CE have been flooded by a later volcanic plains event. Cross-cutting relationships between these two extensional systems are ambiguous, thus their relative ages are uncertain.

Compressional Structural Trends: Three main compressional structural trends, expressed as wrinkle ridges, were identified: 1) a regional linear ENE-WSW trending system (LW), 2) a circumferential system (CW), and 3) a radiating system (RW). The focus of both CW and RW appears to be approximately centred on Thermuthis Corona, whereas LW extends across the entire northern half of the Alpha Regio quadrangle and is likely related to a regional compressional event. CW is concentrated along the exterior rim of the corona; some structures in CW extend ~800 km from the centre. CW clearly cross-cuts the ridges in LW and RW. Wrinkle ridges in RW extend ~1200 km from the centre. RW does not clearly cross-cut LW. However, the structures in RW often transition into the trend observed in LW away from the centre of Thermuthis Corona. RW is also often observed to follow the trends of graben in RE. RW may therefore represent the same generation of structures as LW, that: 1) changed trend locally around Thermuthis Corona, reflecting potential changes in the stress field and/or 2) represent reactivated pre-existing faults in RE. LW is part of a larger system, named the circum-Sappho Patera trend, that extends north of the mapped area (into the Sappho Patera (V-20) quadrangle) and circumscribes geoid highs in Eistla Regio [5].

Evidence for an Increased Maximum Diameter for Thermuthis Corona: Corona size can be estimated using either: 1) the maximum width of the topographic signature, or 2) the maximum width of structures associated with the corona. The former approach is typically used and yields the estimate of 330 km cited by [1], which is the maximum diameter of the interior rim. However, our detailed structural mapping identifies a secondary exterior rim located approximately 200 km outside of the interior rim. We have also identified the structural system CE, which has a maximum diameter of 1250 km.

We have chosen to define the maximum diameter as the outermost extent of CE (i.e. the annulus). A revised maximum diameter of 1250 km would make Thermuthis Corona the second largest currently recognized corona on Venus, preceded by Heng-O Corona (1060 km) and superceded by Artemis Corona (2600 km). The structural approach to estimating size used here facilitates comparison of Venusian coronae with terrestrial analogues, for which topography may not be preserved due to erosion [2]. If applied to other coronae on Venus, it may also lead to larger size estimates than have previously been described. For instance, this methodology has yielded a 280% and 140% increase in the size of Fatua and Cybele Coronae, respectively [6].

References: [1] Stofan, E.R., *et al.* (1992). *JGR* 97(E8), 13347-13378. [2] Buchan, K.L., and Ernst, R.E. (2019). In: *Dyke Swarms of the World, A Modern Perspective*, 1-44. [3] Herrick, R.R., *et al*. (2012). *Eos* 93(12), 125-126. [4] Smrekar, S.E., and Stofan, E.R. (1997). *Science* 277, 1289-1294. [5] Bilotti, F., and Suppe, J. (1999). *Icarus* 139, 137-157. [6] Bethell, E.M., *et al*. (2017). *LPSC XLVIII*, Abstract #2177.

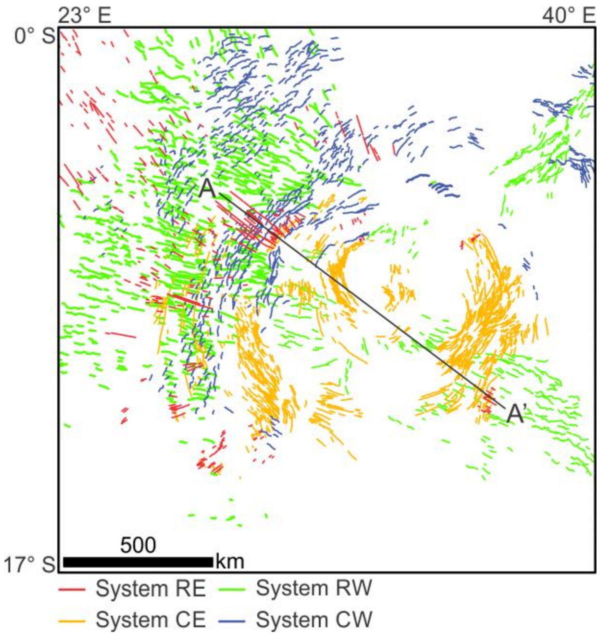

Figure 1: Map of structures interpreted to be associated with Thermuthis Corona. The line extending from A to A' corresponds to the topographic profile shown in Figure 2. System LW, and other structures which have been mapped but not associated with any of the systems defined above, have been omitted from the map.

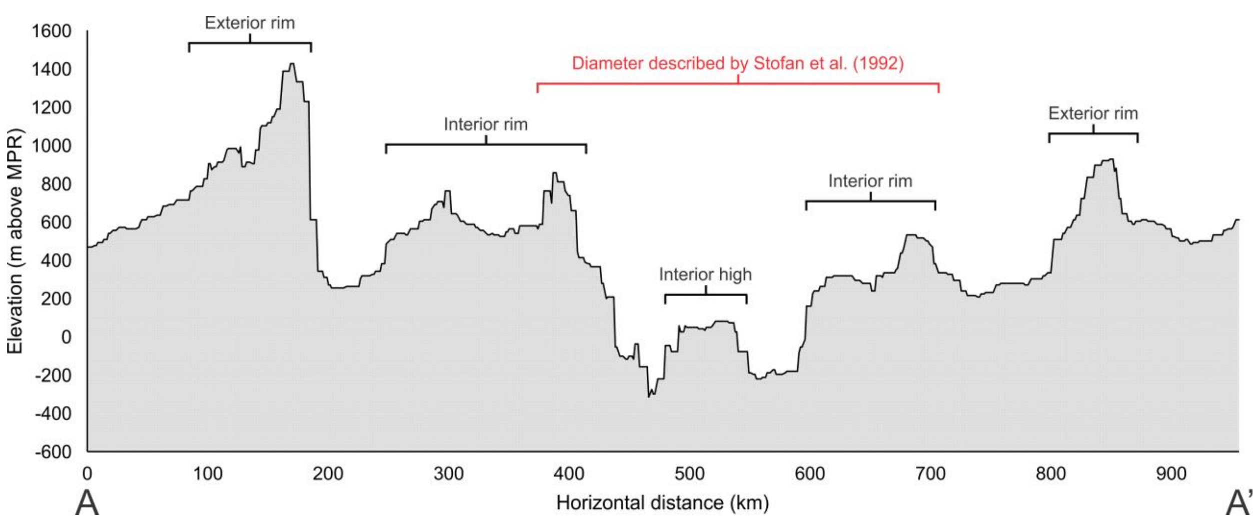

Figure 2: Topographic profile of Thermuthis Corona along the A to A' line shown in Figure 1. Elevations on the vertical axis are relative to Mean Planetary Radius (MPR), which is ~6051 km.