THE SUBSURFACE STRUCTURE OF LARGE WRINKLE RIDGES, VALLES MARINERIS, MARS.

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Introduction: Wrinkle ridges within the Martian surface are linear topographic expressions which change direction along their lengths, generally mimicking the outline of the Tharsis Province [1,2]. They are thought to be the result of compressional tectonism and produced by underlying thrusts [2-5]. Most of the wrinkle ridges that surround Valles Marineris appear sub-perpendicular to the main trend of the chasmata [2, 10, 11].

Previous studies have determined that the cross-sectional morphology of wrinkle ridges is typically composed of two landforms, a narrow ridge ~2-5 km wide superimposed onto a broad low relief arch ~10-20 km wide [2,4,6,7]. The superposition of the two landforms creates an asymmetric topographic expression, a key morphologic element of wrinkle ridges. The steep side of the ridge points in the direction of the underlying thrust and thus faces away from the center of the Tharsis Province. Elastic dislocation models using the USGS deformation and stress-change software (COULOMB) [8,9] simulated the possible underlying structure of wrinkle ridges. By iteratively adjusting the fault parameters associated with the structure, they replicate the current topography from digital elevation datasets.

Ophir Planum (OP) has three high relief features (i.e. OP1, OP2, and OP3) that trend ~45° (Fig. 1A). We examine their morphology and show their resemblance to wrinkle ridges. We model their formation using COULOMB and subsurface geometry inferred from the planes exposed on the walls.

Topographic Analysis: The morphology of the large formations was analyzed using HRSC DEMs of resolution ~50-150 m/px [10] and detailed analysis of the walls of Valles Marineris using a DEM made from Context Imager (CTX) datasets [11]. The wall below the OP formations was analyzed using the AVA tool [12], which shows the attitude of each surface pixel using a schematic color-wheel (Fig 1A).

The large ridges resemble wrinkle ridges in morphology, but have the opposite sense of asymmetry, with the steeper side facing the center of the Tharsis Province. With a relief of ~200-900 m, a width of ~30-35 km and a length of ~90-150 km, they are also an order of magnitude larger than other wrinkle ridges near Valles Marineris. To distinguish them from regular wrinkle ridges, we refer to them as large wrinkle ridges (LWR). Their proximity to the walls of Coprates suggests that the walls might expose the underlying structure of these LWRs. Close inspection of the wall subjacent to the LWRs shows planes with anomalous attitudes dipping into the wall (Fig. 1A, yellow planes). We hypothesized that these Anomalous Planes (AP) are associated with underlying faults and that they are complex thrust faults. We examine their possible connection to LWRs using COULOMB.

Elastic Modelling: In order to test the hypothesis, elastic dislocation models were made for the two APs subjacent to the LWRs OP1 and OP3 (Fig. 1A) using geometrical measurements from the walls to describe the underlying structures (Fig. 1B-D). They were modelled as segments of faults where each segment has a different characteristic fault length L, dip angle θ, fault depth T, and displacement D. The attitude of the fault segments is defined by the trend of their respective LWR and their respective dip value was obtained from the geometrical measurements on the wall. The values for the displacement of each fault segment are values similar to those used on previous studies [4].

Preliminary Results: The results from the models show that the asymmetry of the LWRs was replicated (Fig. 1E-F) using the same stress conditions of regular wrinkle ridges. Similarly, comparison of the models with the actual topography of the LWRs shows a strong resemblance (Fig. 1E-F).

As result, these comparisons suggest that the defined geometries can describe the underlying structures of the LWRs, suggesting that the APs do represent the underlying structure of the LWRs indicating that LWRs are indeed a type of wrinkle ridge.

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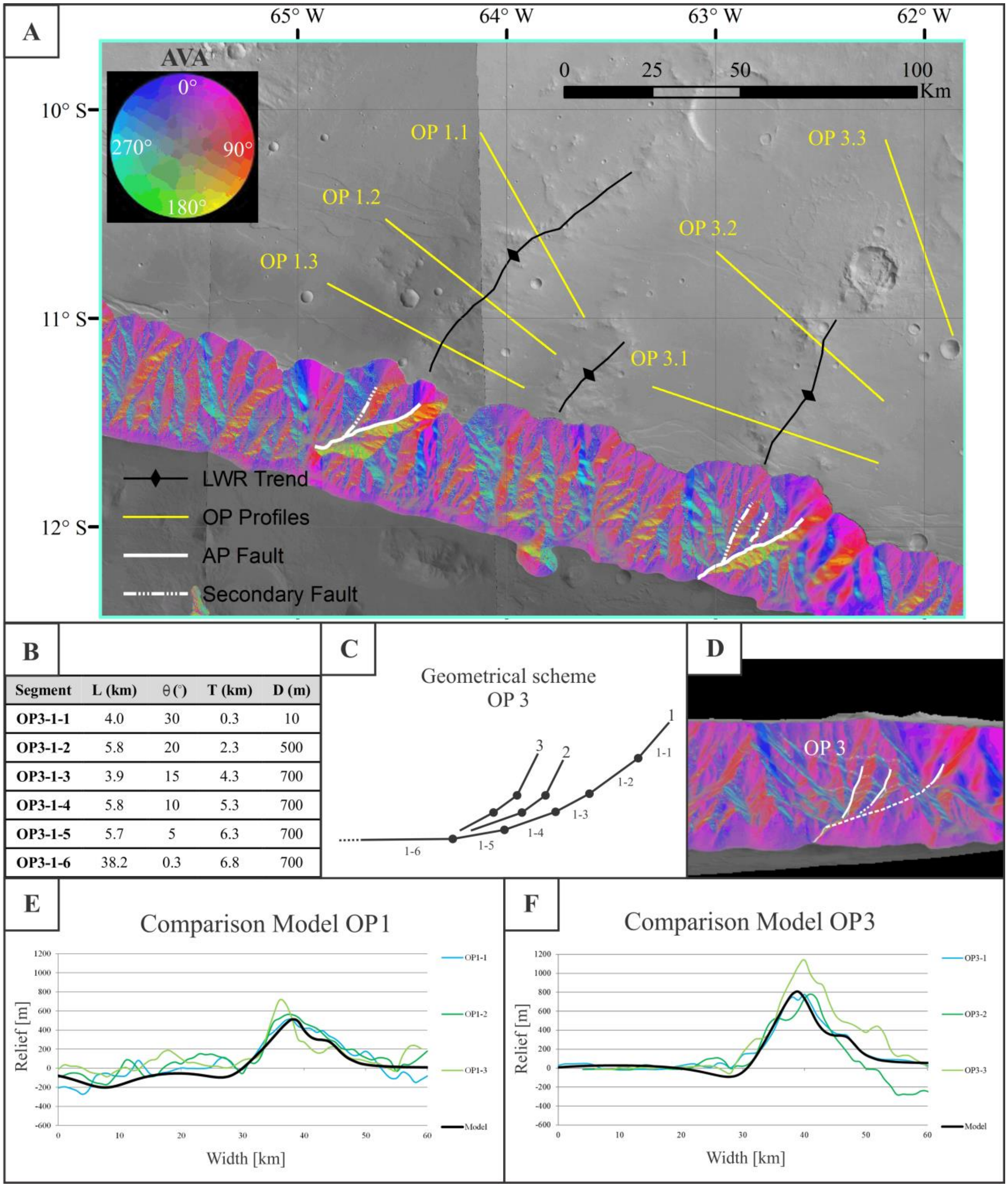

Segment	L (km)	θ (°)	T (km)	D (m)
OP3-1-1	4.0	30	0.3	10
OP3-1-2	5.8	20	2.3	500
OP3-1-3	3.9	15	4.3	700
OP3-1-4	5.8	10	5.3	700
OP3-1-5	5.7	5	6.3	700
OP3-1-6	38.2	0.3	6.8	700

Figure 1: (A) Inferred faults within the walls and selected topographic profiles of the LWRs OP1 and OP3. Mosaic of HRSC Imagery for the plateau and floor (~12.5 m/px), and CTX AVA for the walls (~18 m/px). (B) Characteristic geometry of the underlying structure of the LWR OP3 (C) Geometrical scheme of the inferred faults used to model the LWR OP3 (D) 3D view of the inferred faults outlined on the walls. Dotted portion of faults are obscured by wall ridge in front of it in this view. Both with 2x V.E. (E, F) Comparison of topographic profiles over the LWRs OP1 (E) and OP3 (F), and the resultant topography from the model. 33x V.E.