Introduction:

We present the results of a detailed study of the walls of Valles Marineris, which also examines structural features (e.g., grabens) visible on the plateau. We suggested that features in the plateau can be linked to spurs and gullies (SG) in the walls. The expression of SG varies in different tectonic settings.

The results are presented as four cases in which a structural influence is suggested for the development of the wall geometry: (I) Wall development which is influenced by the presence of a graben intersecting a wall at a high angle; (II) V-shaped channels with planar walls; (III) The structural influence of grabens on the formation of headwalls, and (IV) Identification of multiple anomalous planes within the walls of Valles Marineris.

The documented cases indicate that wall development is influenced by different structural settings. Further work will explore the geometrical properties and geomorphology of the identified features in order to characterize them and to understand their formation.

Case (I): Wall development and Graben intersection

Grabens at Ophir planum [12,13] intersect the walls of Valles Marineris at different angles (Fig. 8). In this case a graben crosses at a relative high angle the wall of East Candor (Fig. 10). It is suggested that the graben extends through in the wall as the flanks of the spurs. Attitude measurements [1] of the walls of the graben and the flanks of the spurs provide insights into a possible connection (Fig. 2).

The extension of the graben forms the flanks of the spurs, and later erosional processes and wall retreat [8,9] widen the graben in the Chasma wall.

Figure 1: 3D Model of East Candor wall showing a graben crossing the Chasma wall and aligns with the flanks of the spur. A planar color scheme is projected over a CTX-D19586npy.

The dip of the graben walls differ (Fig. 2) resulting in asymmetry. The graben floor is tilted as the result of the asymmetry [14,15,16].

Figure 2: Stereonet of attitude measurements. The cluster at midlatitudes for each side of the wall of the graben and flanks of the spurs.

This agrees with a new model for planetary grabens [14,15,16] which proposed an hourglass shape (Fig. 3).

Figure 3: Hourglass model for surface breaking planetary grabens [14,15,16].

Measured graben walls are shallower than depicted in the schematic Fig 3 due to erosion.

Case (II): V-shaped channel

Three planes were identified within East Candor walls (Fig. C) using the AIL color tool [1]. They extend over the east wall of East Candor Chasma. P1 crosses the north wall and dips towards the north wall (Fig. 8), which is one of the characteristics of observed anomalous planes throughout the walls of Valles Marineris (Case IV). P2 and P3 are planes with ridges that extend from the east wall of East Candor Chasma.

It appears that P1 crosses with a plane (P4) that stands out at the north wall of East Candor (Fig. 4) and they form a V-shaped structure sub-parallel to the equator.

Figure 4: Dip color scheme over CTX-D19586npy [10,11,12], and planar models of P1 and P4 from Orion measurements on HRSC-DTM 50 mpy. Stereonet shows the attitude from each planar feature and determines the trend and plunge of the intersection between them.

Interpretation measurements proved that P1 and P4 possess stable walls (Fig. 5). Results for dip values are within the range of 30-40 (Fig. 4). Dip results suggest consistency of the planar extension of P1 and P4. We determined that strike ranges for P1 and P4 of 240-270 and 280-110 (Fig. 5C) respectively.

Note that dips are constant for most of the planar faces. Measurements using Orion yielded attitudes of 095/37 and 241/37 for P1 and P4 respectively (Fig. 4), which is an approximately 10° steeper that general walls within Valles Marineris.

Figure 5: (A) Valles Marineris Chasma (e.g., Ius, Candor and Ophir) AIL image [1] at 17.5% transparency over HRSC-DOTS workshops 12.5 mpy (B) Parallel tributary canyons at East Ius Chasma with a strike color scheme showing the undulating planes (C) V-shaped structure in East Candor Chasma with a Strike color scheme showing the consistency in planarity.

The V-shaped structure is compared to tributary canyons which have similar smooth surfaces due to tectons in filling (Fig. 5B). The walls of tributary canyons and those of the V-shaped structure have similar dip values. There are however differences in the consistency of strike values (Fig. 5B-SC).

Walls of the V-shaped structure are more planar with less variation in strike values than the more undulating tributary canyons (Fig. 5B-SC). Other differences include the presence of coarse ribs at the upper part of the V-shaped planes.

Case (IV): Anomalous planes crossing Spurs and Gullies

Anomalous planes (AP) were found at different locations of Valles Marineris. They share similarities such as: dip towards the wall (Fig. 8), a constant stable wall slope [2], and the presence of occasional small spurs and gullies (SG) (Fig. 8) on their surface. The origin of these AP structures is unknown.

Location (E) shows an AP that possesses these features (Fig. E, and 8). An elevation profile (green line) (Fig. 8B) indicates that the elevation of the SG above and below the AP differ. The study of these AP is still under development and considers the involvement of possible tectonic [4] and erosional processes [3,6].

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Figure 8: (A) HRSC-DTM (100 mpy) of West Coprates wall showing a set of SG with different trends and an anomalous plane (AP) that dips towards the wall (yellow plane). (B) The green line represents the elevation profile (A4).

CONCLUSIONS

The documented cases indicate structural control of the geometry of Valles Marineris walls.

Martian grabens have the characteristics of the hourglass model for Planetary grabens (Fig. 3) [16]. In some cases these grabens can be linked to spur and gully formations.

Spurs and gullies cover a large part of the walls of Valles Marineris. We considered that they are not simply erosional features but can provide more information about the processes involved in the formation of Valles Marineris.

Anomalous planes are found throughout Valles Marineris. Further work will explore the geometrical properties and geomorphology of these planes with the aim to characterize them and explain their origin.