TRANSTENSION IN THAUMASIA PLANUM: EVIDENCES FOR A COPRATES RISE OBLIQUE TRANSFER ZONE.

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Introduction: A new automatic method for normal fault strain assessment [1] was applied to an East-West rift located between Melas Dorsa and Lassel crater. As previously pointed, en-echellon graben arrays in the western part of the rift indicate a left-lateral transtensive regime for this region [2; 3].

The strain analysis presented in this work gives a better perspective of the geometry and kinematics of this Thaumasia Planum rift.

Automatic strain estimation: The semi-automatic scarp mapping procedure introduced in [1; 4] was used to map all the tectonic scarps in the analyzed region. A DTM with ~231 m/pixel resolution, derived from MOLA data, was used for this purpose. The extracted lineaments were then classified manually using THEMIS infrared, HRSC and CTX imagery as context (fig. 1).

The strains associated with normal faults on Mars have been traditionally evaluated through the interpretation of topographic profiles [ex. 5; 6]. This methodology has been recently automated and extended [1], allowing a fast 2D analysis of the strain spatial distribution.

Fault scarps were modeled as being pure dip-slip faults with a constant dip of 60º. Figures 2c and 2d show the extension vectors computed, respectively, for the South and North dipping scarps.

Discussion: The tectonic phase responsible for the rift formation postdates the wrinkle ridge formation, since normal faults dissect all the compressive structures. In the rift central region, an ancient right-lateral E-W shear zone seems to have contributed to the offset and warping of some of the N-S wrinkle ridges, suggesting a basement-controlled wrinkle ridge formation.

The obtained lineament map shows that normal faults appear in alternating sets of faults with different azimuths (fig. 2a). Note that the boundaries between the sets of faults are located near larger wrinkle ridges, which reinforces the importance of the inherited structures for the formation of the rift.

The faults in the western part of the rift, where en-echelon grabens are more evident, accommodate less extension and denote a transtensive sinistral regime. Between 67-69ºW and 64-65ºW two large rhombohedric depressions resembling pull-apart basins are present. In those areas extension is spread over several small faults while in the central region of the rift (65-67ºW) the deformation is concentrated in two main faults.

The rift central sector accommodates the higher extensions but the extension is not evenly distributed. The presented strain analysis shows that the strain distribution is not symmetric. For the North-dipping faults, the region where extension is maximum is located 40 km eastward of the location where extension of South dipping faults peak (fig. 2b and 2c), denoting a change in the rift polarity. This polarity shift is characteristic of negative flower structures [7; 8], in this case associated with a regional sinistral strike-slip shear component. In what concerns the fault model used, this strike-slip component was not modeled since only a pure dip-slip scenario was considered. Soft linkage cannot be dismissed but a strike-slip component can be present in some of the faults.

Previous mapping efforts inferred that the analyzed rift acted as a transfer zone between two distinct lithospheric blocks [3; 9] in a transtensive regime.

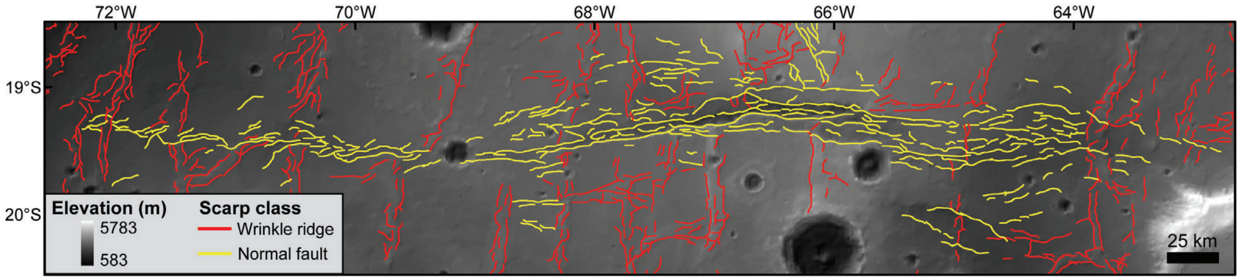

Figure 1 – Extracted lineaments that mark tectonic scarps. Lineaments were automatically derived from MOLA data and manually classified using the available imagery for context (THEMIS infrared, HRSC and CTX imagery was used) [1].

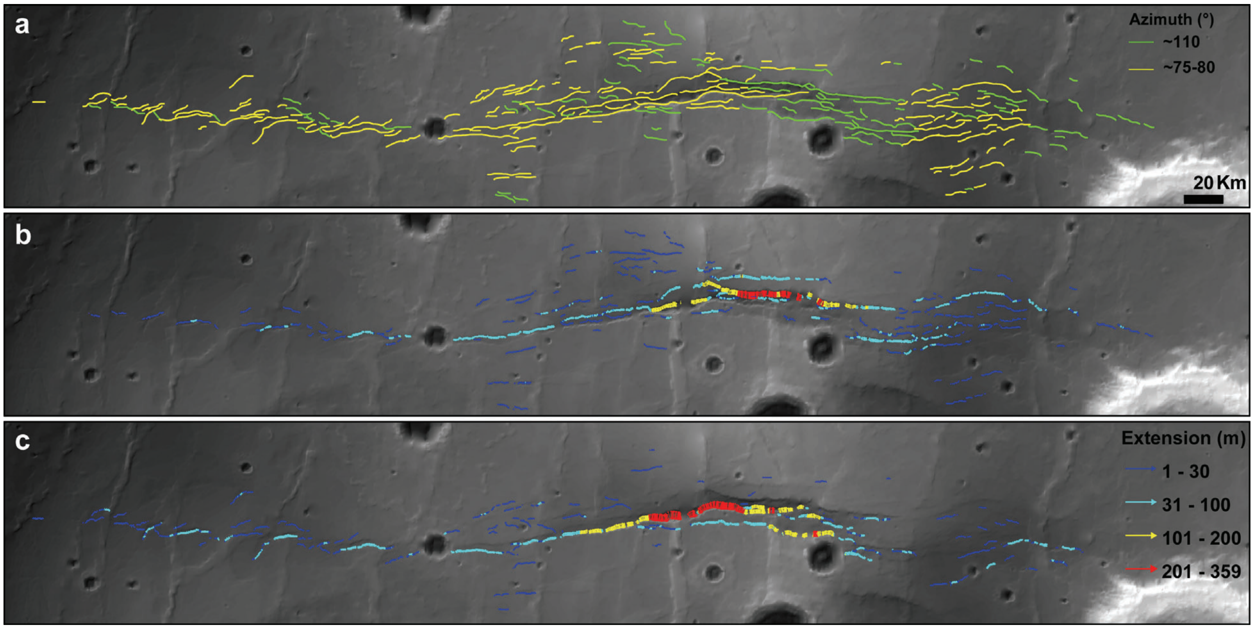

Figure 2 – (a) Rift main sets of normal faults striking N110ºE and N75-80ºE; (b) Extension vectors for the South dipping fault scarps; (c) Extension vectors for the North dipping fault scarps. The vector gaps existent along the scarps correspond to the largest MOLA data gaps, which affect the local quality of the DTM, generating erroneous extension values (see [1] for details).

The presented analysis confirms the role of transtension in the development of the rift, which was formed due to a tectonic inversion (as referred, during the wrinkle ridge formation the shear sense was dextral). The faults arrangement as well as the strain distribution is consistent with a roughly East-West migration of the deformation.

Conclusion: An objective and reproducible strain characterization of the rift located in Thaumasia Planum was given. The complex architecture and strain partition along the rift support the view that the rift acted as a transfer zone between two distinct blocks. Possible Earth analogues are extensional step-overs formed, for instance, along plate limits such as those bordering part of the Anatolia plate [8; 10; 11].

The presented results highlight some of the complexities related with the formation of the Coprates rise and with the possible eastward slide of the Thaumasia Plateau [3; 12; 13]. In the study area, a later phase of tectonic activity lead to the reactivation of inherited basement structures, which acted as transfer zones creating pull-aparts.

The applied automatic strain estimation techniques proved to be a fast and reliable method to give a new insight into the strain distribution. Nevertheless, the simplicity of the fault model used, assuming pure dip-slip faults with a constant dip angle and neglecting any deposition in the base of the scarps, should be considered with caution when the objective is to analyze the strains in absolute terms. A relative analysis, more focused in the comparison of the strains magnitudes on different areas, is perhaps the safest way to look at the obtained results. Future developments should incorporate a scarp degradation model, so that at least a variable dip angle for the faults could be considered.

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