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Large crustal extension across Ceraunius Fossae, Mars

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The “Highly Deformed Terrain Materials” (Nf) of Noachian age outcrop, in the Ceraunius Fossae area, is one of the most strained areas of the Tharsis Volcanic Region. Ceraunius Fossae is characterised by the presence of hundreds quasi-parallel, N-S oriented, grabens with dimensions ranging from 250 m to more than 15 km in width, and from 10 m to 1 km in depth. We used Mars Orbiter Laser Altimeter (MOLA) data, corroborated by Mars Orbiter Camera (MOC) images, to recognise tectonic structures and to quantify the tectonic extension occurred in the Ceraunius Fossae area. Unfortunately, MOLA data are not dense enough along the E-W direction (perpendicular to most of the structures) because the near polar orbit of the satellite; therefore we developed an original method to obtain E-W oriented topographic profiles with a sufficient resolution. We used a simplified structural model to calculate the extension across each graben and along the studied transects. The calculated tectonic extension, that locally reaches 13%, is appreciably higher than previously estimated. The extension due to the bending of the crust is only a negligible fraction of the tectonic calculated extension; this suggest that most of the strain is a consequence of horizontal crustal movements during Late Noachian-Early Hesperian age. According to our interpretation, the deformation affected to a smaller extent, the younger AHcf units (Late Hesperian - Early Amazonian) that are tilted and slightly fractured. This suggests that the tilting lasted at least until Early Amazonian age. The lost-area balancing method, allowed the recognition of a mechanical discontinuity on the western side of the studied topographic profiles at the depth of about 500 m. This discontinuity is interpreted as a weaker layer with ductile-like behavior located at the interface between AHcf units and Nf units. The presence of this mechanical discontinuity is also suggested by the geometry and dimensions of graben in this area.