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Evidence for very recent tectonic activity in southern Tharsis

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The formation of Tharsis affected nearly the entire western hemisphere of Mars and had a profound effect on Martian geodynamics. Tharsis-related lithospheric deformation created a variety of tectonic structures that record past stress fields, some of which may still be active today. However, evidence for very recent endogenic activity (<1 Ma) in Tharsis remains limited even after the seismic measurements by the NASA InSight mission. Very few morphologically pristine tectonic structures have been discovered in remote sensing data, limiting our understanding of the current endogenic activity in Tharsis.

Building on our previous research in the southeastern Tharsis region, we focus on the Claritas Fossae region. This area displays several cross-cutting fracture and fault sets, recording a complex history of multiple volcano-tectonic events. Using High Resolution Imaging Science Experiment (HiRISE) images and stereo image-derived Digital Elevation Models (DEMs), we identified uphill-facing scarps on the west-facing Claritas Rupes scarp, which bounds a major N-S-trending extensional structure, informally called the Thaumasia Graben. The two-kilometer-high steep slopes of Claritas Rupes experience intense mass wasting, producing rockfalls (boulders) that accumulate against these uphill-facing scarps. Despite the high boulder fall rates, which over time could fill the accommodation space created by the uphill-facing scarps and mask them, small of these scarps retain a pristine topography. These observations suggest a very young age (<1 Ma) for these scarps. We interpret these scarps as surface expressions of normal faulting linked to Deep-seated Gravitational Slope Deformations (DGSDs), likely caused by seismic activity tied to reactivation of the Claritas Rupes fault associated with Thaumasia Graben subsidence. This indicates neotectonic activity in the region, which is potentially still ongoing.

To better constrain the tectonic processes and the mechanism of the very recent small-scale faulting at the Claritas Rupes scarp, our current structural mapping aims at deciphering the orientations and the spatiotemporal relationships of these scarps. Our approach involves obtaining dip angles through a planar fitting method and quantifying shortening along mapped scarp features. This forms the basis for determining effective stress distribution under isotropic stress conditions with plane strain assumptions, offering insights into the youngest stages of the tectonic evolution of this region. Our satellite image-based morphological investigations focusing

on fresh-looking scarps show great advances in tectonic feature mapping, offering valuable insights into inaccessible subsurface endogenic processes in southeastern Tharsis.