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Slope stability analysis of Valles Marineris, Mars

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Valles Marineris (VM) in the equatorial area of Mars exhibits several gravitational failures which resulted in a series of large landslides up to several hundred cubic kilometers in volume. Questions arise as to forces at play and rock strength in the stability of the walls of VM. In this work we address the stability analysis of the walls of VM by considering the strength of the materials of the chasma walls and the causes of landslides.
Using finite element calculations and the limit analysis upper bound method, we explore the range of cohesion and friction angle values associated to realistic failure geometries, and compare predictions with the classical Culmann's wedge model. Our analysis is based both on synthetic, simplified slope profiles and also on the real shape of the walls of VM taken from the MOLA topographic data. Validation of the calibrated cohesion and friction angle values is performed by comparing the computed unstable cross sectional areas with the observed pre- and post-failure profiles and estimated failure surface geometry. This offers a link between rock mass properties, slope geometry and volume of the observed failure. Pseudo-static seismic analyses generated another set of dimensionless charts. Our pseudo-static analyses show that low seismicity events induced by meteoroids impacts compatible with the size of craters could be a cause for some of the observed landslides if poor rock properties for VM is assumed.