Geophysical Research Abstracts
Vol. 12, EGU2010-1969, 2010
EGU General Assembly 2010
© Author(s) 2010

Wrinkle ridges on Mars: Absence of décollement tectonics

Richard Schultz (1), Amanda Nahm (1), and Laurent Montési (2)

(1) Geomechanics-Rock Fracture Group, Department of Geological Sciences, University of Nevada, Reno NV 89577 USA,
(2) Geodynamics Group, Department of Geology, University of Maryland, College Park MD 20742 USA

Wrinkle ridges, anticlines formed above blind thrust faults, are common structures on the terrestrial planets. Domains of wrinkle ridges on Mars and Venus are characterized by approximately regular spacings to form distributed arrays of low-strain folds across large areas. Precision topographic data for Mars demonstrate both very low regional slopes across wrinkle-ridged terranes such as Solis and Hesperia Plana (<0.5°) and vergence directions for the subjacent blind thrust faults equally up- and down-slope, implying that gravity-induced sliding was not a significant factor in wrinkle ridge deformation.

We test the long-standing assumption that wrinkle ridges are associated with slip along a common basal décollement. Critical taper wedge mechanics, used in this analysis, relates décollement strength to the strength and cross-sectional geometry of the deforming stratigraphic section; slip along the décollement occurs once the section has deformed into a critical wedge-shaped taper. By using measured topography across Solis Planum (regional slope of 0.2°) with plausible values of stratigraphic properties (strength, density, pore fluid pressures) we show that décollement dip angles as low as 1–2° may be possible, but only for restricted conditions including nearly frictionless stratigraphic contacts.

The lowest décollement slopes require a near-zero coefficient of friction on the décollement, implying either near-lithostatic pore fluid pressure or a horizon of intrinsically weak material. The weakest material that can be justified at the inferred décollement depth is water-saturated talc, with a coefficient of friction of 0.15. High pore fluid pressure requires a steady supply of water, typically provided on Earth by sediment compaction and clay dewatering, to replenish the fluids lost though the wedge. Its presence at Solis Planum would imply that a sediment layer lies buried underneath the near-surface basaltic unit; rapid emplacement of massive flood basalts might then have triggered compaction and dewatering of the underlying sediments. Although high pore fluid pressures and weak horizons may be conceptually possible for Solis Planum, they are not sufficient in themselves to promote translation of the overlying stratigraphic section.

Even if the décollement was nearly frictionless, and sloped by only 2°, its depth would change by more than 50 km over the width of Solis Planum. This cannot be reconciled with ridge morphology unless Solis Planum is organized as a series of independent wedges, each less than $\sim$115 km wide in the direction of shortening, containing only two or three wrinkle ridges each. In this case the growth of wrinkle ridges and any associated décollements would have progressively swept across Solis Planum. We conclude that wrinkle ridges more likely formed in association with unstable compression of the lithosphere with slipping basal décollements requiring special conditions, with the compressive stress supplied on Mars by Tharsis and/or global contraction and on Venus by global climate change.