Analysis of enigmatic structures on Mars and Venus and implications for crustal history

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Abstract

The crustal history of two structurally complex areas on two different planetary bodies is explored, using a combination of image and topographic analysis, kinematic mapping and numerical modeling. Throughout the polygonal terrain of Utopia Planitia, Mars are found circular grabens that are inferred to overlie the rims of buried impact craters. The correspondence of circular grabens and polygonal terrain suggests that their formation may be intrinsically linked. A topographic analysis of circular grabens shows that they bound topographic depressions whose surface relief scales directly with diameter, consistent with a model of polygon formation dependent upon a “wet” cover material. A model is presented for why the circular grabens are sometimes comprised of two nested ring fractures. The model results imply that cover material in the southwestern polygonal area of Utopia may range from 1–2 km thick and strongly favors a wet sedimentary origin for the cover material. A systematic study of the topography of quasi-circular depressions (QCDs) around the Utopia Basin is presented. The results of this study support the assumption that QCDs are the surface representations of buried impact craters. There are ridges radial to Irnini Mons, Venus, revealed by high resolution mapping at 75 m/pixel. Unlike the unit of arcuate ridges directly south, these ridges are on top of the Irini flows and cannot be an older feature. Analytical modeling of the perturbation of regional stresses around a pressurized magma chamber conduit shows that in the presence of the regional north-south compression, responsible for the regional set of east-west trending wrinkle ridges, circumferential stresses can be compressive. Directional models of Venus' tectonic history argue that all wrinkle ridge formation occurred prior to the formation of large volcanoes. Thus, continuing the regional compression that formed the wrinkle ridges through the volcano building event contradicts directionalism and supports non-directional

tectonic models. ^

Subject Area

Geology

Recommended Citation