

TOPOGRAPHIC CHANGE OF THE DICHOTOMY BOUNDARY SUGGESTED BY CRUSTAL INVERSION. G. A. Neumann^{1,2}, ¹ *Department of Earth, Atmospheric and Planetary Sciences, Massachusetts Institute of Technology, Building 54, 77 Massachusetts Avenue, Cambridge, MA 02139-4307, (neumann@tharsis.gsfc.nasa.gov),* ² *Laboratory for Terrestrial Physics, Code 926, NASA/Goddard Space Flight Center, Greenbelt, MD 20771.*

Linear negative gravity anomalies in Acidalia Planitia along the eastern edge of Tempe Terra and along the northern edge of Arabia Terra have been noted in Mars Global Surveyor gravity fields [1, 2, 3]. Once proposed to represent buried fluvial channels [4, 5], it is now believed that these gravity troughs mainly arise from partial compensation of the hemispheric dichotomy topographic scarp [6]. A recent inversion for crustal structure [7] finds that mantle compensation of the scarp is offset from the present-day topographic expression of the dichotomy boundary. The offset suggests that erosion or other forms of mass wasting occurred after lithosphere thickened and no longer accommodated topographic change through viscous relaxation.

Introduction Using MOLA topography and the most recent gravity field from MGS and Mars Odyssey tracking, jgm95h01, we invert for the crustal structure required to plausibly match gravity, crustal topography and density variations to degree and order 90, allowing for the effects of power-law constraints applied at degrees 60 and higher to reduce noise primarily in the gravity solution. The effective resolution (minimum resolved pixel size) of this inversion is approximately 125 km (4 degrees of longitude). The inversion does not assume any particular compensation model. If all of the mantle relief were locally compensated by surface topography, a 14.5-km thicker crust in the highlands would have topography elevated by 3 km, while a 14.5-km thinner crust (on average) in the northern lowlands would have 3 km lower topography. This crustal model predicts the known center-of-figure to center-of-mass offset of Mars. Not all of the crustal thickness variation is compensated. The difference between the actual topography (filtered to degree and order 90) and that predicted by the crustal model is shown in Figure 1. This isostatic topography represents the excess (or deficit) relative to locally compensated terrain, much as an isostatic anomaly represents the difference between observed gravity and that of locally compensated terrain.

Results The areas shaded in reddish hues have excess topographic loads, such as Tharsis Montes and Alba Patera. Bluish hues represent uncompensated topographic deficits. We find that the linear gravity troughs coincide with up to 2 km of uncompensated topographic relief (green to blue). Such topography also coincides with the steepest portions of the dichotomy boundary (contour). If these regions were buried channels, they would likely be found north and east of the boundary scarps.

Discussion The model we propose is that such features were formed in early Martian history during a time of elevated mantle temperature, when the lithosphere was too thin to support uncompensated loads. Erosional modification of

the surface expression of the dichotomy occurred after the crust had cooled significantly and was able to support elastic stresses. There are similar but less pronounced gravity troughs along the edges of Hellas and Isidis, as well as the inferred rim of Utopia. Topographic edge effects of partially compensated relief may be responsible for some of these troughs [6]. Edge effects do not explain the isostatic deficit along steep slopes, and are not the primary reason for the linear gravity troughs.

References

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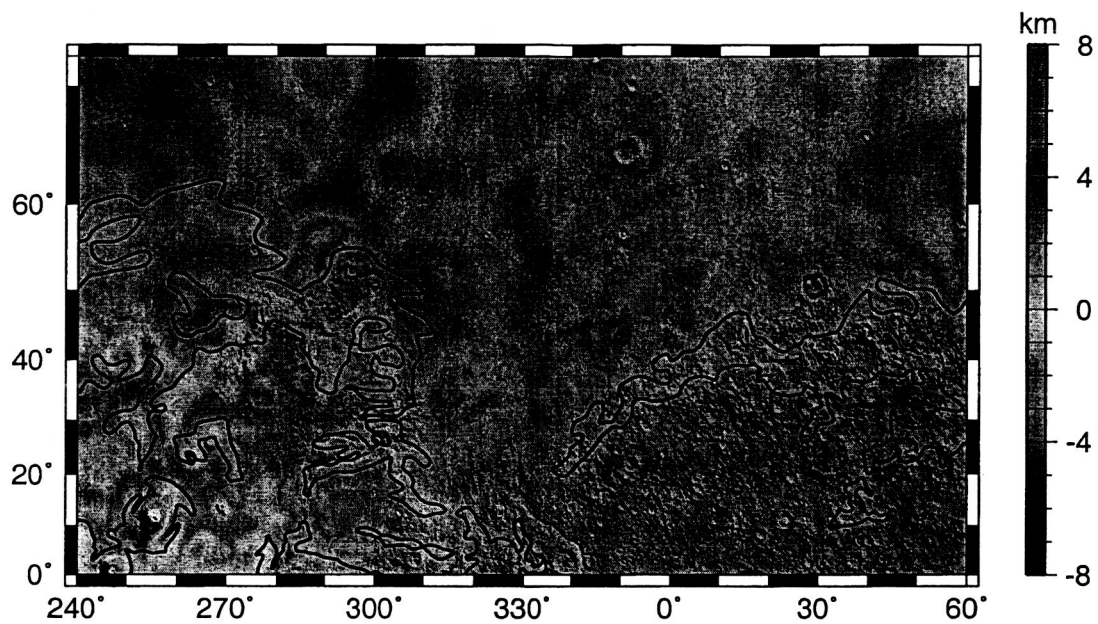


Figure 1: Isostatic topography, the residual topography above that which locally compensates moho relief, in color-shaded Mercator projection. Densities of 2900 and 3500 kg m^{-3} were assumed for the crust and mantle, respectively. Contours show steeper local gradients of terrain.