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Is the Martian crust thin or thick?

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The thickness of the Martian crust T_c is one of the key parameters to constrain geophysical models of the evolution and the global structure of the planet. In the absence of any seismic data one of our main tools to determine the crustal thickness is the analysis of the gravitational field and the corresponding topography. Planets like Venus, which show a global isostatic compensation of the surface structures on a scale less than 500 km, allow a good estimate of its average crustal thickness with spectral methods. For Mars, however, where the gravity and topography analysis indicates that e.g. the northern plains and the Tharsis rise were supported by an elastic lithosphere at the time of loading and are consequently not isostatically compensated, an estimate of the crustal thickness with spectral methods is not accurate.

In the case of Mars, a common practice is, therefore, to employ local (spatial) methods. At present, a number of different values for the average crustal thickness have been obtained by using the spatial approach, most of them reviewed in Wieczorek and Zuber (2004), ranging from $T_c \sim 30$ km to $T_c \sim 110$ km.

In the present study, we compare the methods and the results by Wieczorek and Zuber (2004) and Turcotte et al. (2002) who estimated an average crustal thickness of 50 ± 12 and 90 ± 10 km, respectively. We discuss several criteria which can be used to better constrain these methods, e.g. the importance of the reference level for appropriate topographic load estimation and of the crustal evolution. Furthermore, we study the dependence of an obtained T_c value on the harmonic degree (utilizing the newest Mars gravity model JGM95I01) for selected regions, where presumably the isostasy acts at a local scale. This can give us an insight into the mechanisms of compensation.

Reference:

Turcotte, D. L. et al. (2002), Is the Martian crust also the Martian elastic lithosphere?, J.Geophys. Res., 107(E11), 5091, doi:10.1029/2001JE001594. Wieczorek, M. A. and M. T. Zuber (2004), Thickness of the Martian crust: Improved constraints from geoid-to-topography ratios, J. Geophys. Res., 109, E01009, doi:10.1029/2003JE002153.