Constraints on the Martian lithosphere from gravity and topography data and implication for volcanism and possible mantle heterogeneities

P.Lognonné, V.Belleguic and M.Wieczorek

Institut de Physique du Globe de Paris, Equipe Planétologie et Etudes Spatiales, 4 Avenue de Neptune, 94100, Saint Maur des Fossés, email : lognonne@ipgp.jussieu.fr

Localized spectral admittances of the large Martian volcanoes are modeled by assuming that surface and subsurface loads are elastically supported by the lithosphere and with a precise forward modeling of the gravity. The comparison of the observed and modeled data provides contraints on the elastic thickness, crustal thickness, load density and crustal density. We find that densities of the Martian volcanoes are generally well constrained with values of 3200ś100 kg mˆ3 and reache 3270ś150 kg mˆ3 beneath the Elysium rise. If these densities are representative of the Northern lowlands and that lower densities can be found in the southern hemisphere, then Pratt compensation is likely responsible for the approximately 6 km elevation difference between the Northern and Southern hemispheres. We illustrate this effect with crustal models with and without lateral density variations between the northern and southern hemisphere The elastic thicknesses associated with Martian volcanoes are found between 56ś20 km for Elysium rise and 105ś40km for Ascraeus Mons. We found that all volcanoes except Pavonis are better modeled with the presence of less dense material in the upper mantle, which is either indicative of a mantle plume, a depleted mantle composition or a hot upper mantle. These results are in agreement with the Mars Express HRSC data. We finally discuss how these observations provide constraints on the amplitude of lateral variations in the upper mantle