On the lithosphere of Mars

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Using admittance analysis of the topography and gravity anomaly of Mars obtained by the Mars Global Surveyor (MGS), we evaluate global mapping of lithospheric thickness. With the value of reference crustal thickness 60 km, we calculate global distribution of lithospheric thickness using 2-D Fast Fourier Transform. We reveal that there exists significant variation of admittance, thus estimated crust densities and lithospheric thicknesses shows unique regionality. These characteristics are basically similar to those obtained in the previous studies(Nimmo 2002,McGovern et al 2002 and Kido et al,2003). Though these results all indicate thin lithosphere in the southern hemisphere, we conclude the admittance in this region is erroneous because the topography is not due to the surface loading but mostly supported by buoyancy. Apparently thin lithosphere seems incompatible with other observations such as crustal magnetic anomalies. The strong magnetic anomaly in this region observed by MGS requires magnetized bodies extending down to 50 km(Arkani-Hamed 2002). This indicates the temperature at the depth of 50 km should be below the Curie temperature when the body was magnetized. Since the magnetization age is estimated at the Noachian period, relatively cool and thick lithosphere should have already existed at the early time.

Considering plausible thickness of the present lithosphere is 130 km around the Tharsis Montes, heat flux is estimated as about 11 mW/m2, which is smaller than that of the Earth. The results that a reference crustal thickness is 60 km and a lithospheric thickness is 130 km are consistent with the theoretical estimate of the Martian thermal history with the degree of fractionation _=0.0005(Schubert et al,2000). Comparing with the value on the Earth (0.01), Mars has extremely low degree of fractionation, which implies Mars has been cooled so rapidly that it could not have sufficient time for differentiation and plate tectonics in its history.