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ANCIENT HEAT FLOW AND CRUSTAL THICKNESS AT THE AMENTHES REGION, MARS.

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The Amenthes region is adequate for analyzing the thermal structure and thickness of the Martian crust, since estimations of both the brittle-ductile transition depth [1,2, this work] and the effective elastic thickness of the lithosphere [3-5, this work] are possible for the Late Noachian/Early Hesperian time. As such, we analyze the Late Noachian/Early Hesperian surface heat flow of the Amenthes region by considering homogeneously distributed crustal heat sources (and linear thermal gradients for the upper mantle), which have abundances based in the latest GRS data reported in [6], and crustal and lithospheric mantle contributions to the total strength, and hence to the effective elastic thickness, of the lithosphere [7,8]. This permits us to constrain the thickness of the Martian crust in a way independent from previous works. We also consider dry and wet rheologies for the lithosperic mantle.

The depth to the brittle-ductile transition deduced from modeling of the topography of Amenthes Rupes is 25-40 km (with values of ~25-30 km being the most probable), and the associated surface heat flow is 26-36 mW m^{-2} (for a crustal thermal conductivity of 2 W m^{-1} K^{-1}). On the other hand, the effective elastic thickness in this region is 19-33 km: the surface heat flow deduced by considering crustal and lithospheric mantle contributions to the total lithospheric strength, as well as wet or dry olivine for lithospheric mantle rheology (and a lithospheric mantle thermal conductivity of 3.5 W m^{-1} K^{-1}), is 34-45 mW m^{-2} .

It is clear the narrow range of values for which the heat flow obtained for the Amenthes region from the effective elastic thickness is consistent with that deduced from the depth to the brittle-ductile transition. By taking simultaneously into account calculations based on both metodologies, a surface heat flow of 35-36 mW m^{-2} (with a high fraction originated from crustal heat sources), a wet mantle rheology, and a local crustal thickness is 45-60 km are obtained.

A wet lithospheric mantle rheology is consistent with results of comparisons of effective elastic thickness evolution through time with thermal history models for Mars [9,10]. On the other hand, our results suggest an average thickness of ~40-60 km for the Martian crust (the thickness of the crust in this region is ~0-5 km thicker than the average planetary value [11]), which is consistent with the range of 38-62 km obtained for [12] from simultaneously considering several geophysical and geochemical arguments.

The obtained mantle heat flow, ~4-9 mW m^{-2}, is low compared with the predictions from mantle convection models for Mars [13], which could be a local (and maybe temporal) phenomenon. Alternatively, the emplacement of a substantial fraction of radioactive heat sources in the crust could have contributing to the slugging of mantle convection [14].

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