**Mantle melting productivity on Mercury and the relation with crustal thickness**

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The crust of Mercury was built over its first billion years by intense volcanic activity. Mantle melting and emplacement of lava to the surface produced a secondary crust varying spatially and over time in composition and mineralogy. In this study we consider lateral density variations of the crust obtained from global mineralogical mapping (1) to calculate a new map for the thickness of the crust using the MESSENGER gravity and topography data (2-3). The construction of the global map of crustal thickness relies on the inversion of free-air gravity anomalies, which are due to surface topography, relief at the mantle-crust boundary, and lateral variations of crustal and mantle densities. This study focusses on the effect of lateral variations of crustal density. The mineralogy at the surface translates to pore-free crustal densities of 2,800-3,150 kg.m-3. Maximum crustal density (3,100-3,150 kg.m-3) is found in High-Mg regions that are forsterite-dominated and plagioclase-poor. The lightest crust (2,750-2,800 kg.m-3) is found in Al-rich regions such as the North Volcanic Plain that are plagioclase-dominated. We find that local crustal thickness is statistically correlated with the degree of partial melting of the mantle obtained from surface composition measured by MESSENGER. The highest degree of mantle melting in the equatorial ancient High-Mg region (40-55% partial melting of the mantle) produced the thickest crust (52±12km in a model with 35 km mean crustal thickness) and low-degree melting in the polar North Volcanic plain (20-30%) produced a thinner crust (18±3km in the Low-Mg NVP). The thinnest crust is found in the Caloris impact basin. The correlation of local variations of crustal thickness with mantle melting productivity could be consistent with the geodynamics and mantle convection style with many tiny plumes in the thin silicate shell of Mercury.

(1) Namur O, Charlier B (2017) Silicate mineralogy at the surface of Mercury. Nature Geoscience 10(1): 9-13; (2) Mazarico E et al. (2018) The crust of Mercury after the MESSENGER gravity investigation. Mercury: Current and Future Science 6027. (3) Neumann GA et al. (2016) Mercury shape model from laser altimetry and planetary comparisons. 47th Lunar Planet Sci Conf Abstract 2087.

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