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On the Crustal Architecture of the Terrestrial Planets

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The crust is the outermost solid layer of a rocky body with a composition that substantially differs from the deeper interior (mantle and core). Due to its lower thermal conductivity, the crust thermally insulates the interior, and thus the thickness of the crust controls the rate at which a planet cools in time (Plesa et al., 2022). The crust preserves a record of a planet's geologic history, hosting remanent magnetization from interior dynamos (e.g., Langlais et al., 2010), and has been scarred by tectonic (e.g., Andrews-Hanna & Broquet, 2023), impact (e.g., Melosh et al., 2013), volcanic (e.g., Carr & Head, 2010) and erosional processes (e.g., Hynek et al., 2010). For these reasons, understanding the structure and composition of the crust is fundamental for uncovering the diverse geologic pathways of rocky bodies in the solar system.

In this work, we provide a broad overview of our current knowledge of the composition and structure of planetary crusts following Broquet et al. (2025). We summarize the different geophysical approaches to characterize the shape of the crust and propose improvements to existing inversions of observed gravity and topography for crustal thickness from both conceptual and theoretical perspectives. In particular, we discuss how the gravity field resolution, data filtering, crustal density as well as the elastic and dynamic support of topography all affect crustal thickness inversions. Based on these improvements, we propose refined crustal thickness models for Mercury, Venus, Mars, and the Moon.

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