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Martian Dichotomy from a Giant Impact: Mantle Convection Models

Kar Wai Cheng[1], Paul J. Tackley[1], Antoine B. Rozel[1], Gregor J. Golabek[2], Harry Ballantyne[3], and Martin Jutzi[3]

[1]Institute of Geophysics, ETH Zürich, Zürich, Switzerland
[2]Bayerisches Geoinstitut, University of Bayreuth, Bayreuth, Germany
[3]Center for Space and Habitability, University of Bern, Bern, Switzerland

The Martian crustal dichotomy is one of the most prominent features on the planet, featuring a ≈5.5 km difference in topography and a ≈25 km difference in crustal thickness between the southern highland and northern lowland [1]. It Is thought to have formed within the first 400-500 Myr of Martian history [2]. While its formation process remains unclear, there have been different hypotheses to explain it, including an endothermic degree-1 convection mode [3, 4], and the excavation of the lowland crust by a giant impact [5]. In this study we focus on the hybrid hypothesis, where an early giant impact created a magma pond, and subsequent mantle convection alters the internal mantle structure as well as crustal distribution in the next 4 billion years [6, 7]. By imposing a parametrized giant impact as a thermal anomaly as an initial condition, we simulate the long-term evolution of the crust and mantle using the thermochemical convection code StagYY [8]. In particular, we investigate the effect of physical parameters of both the solid mantle and the impact-induced magma pond, as well as those of the crust production process, on the crystallisation of such pond, its interaction with surrounding mantle and the preservation of impact signature. Diagnostics including topography and crust thickness from these different models will be presented and compared.

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