The lunar solid inner core and the mantle overturn

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Abstract

Seismological models from Apollo missions provided the first records of the Moon inner structure with a low-velocity zone (LVZ) at the boundary between the core and the mantle. In addition, the resolution of these records prevent a strict detection of a putative lunar solid inner core and the impact of the lunar mantle overturn in the lowest part of the Moon is still discussed. Our work combines geophysical and geodesic constraints from Monte-Carlo exploration and thermodynamical simulations for different Moon internal structures. We show that only models with ilmenite-rich LVZ and an inner core present densities deduced from thermodynamic constraints compatible with densities deduced from tidal deformations. We thus obtain strong indications in favour of the lunar mantle overturn scenario and in this context, demonstrates the existence of the lunar inner core with a radius of (258 ± 40 km) and density (7,822 ± 1,615 kgm3). Our results question the evolution of the Moon magnetic field thanks to its demonstration of the existence of the inner core and supports a global mantle overturn scenario that brings significant insights on the timeline of the lunar bombardment in the first Gyr of the Solar System.

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