Goldschmidt 2024 Abstract
https://doi.org/10.46427/gold2024.23061

Exploring the initial thermal state of terrestrial planets using the SPH method

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Understanding how the Earth cools down is a pivotal question in the study of our planet's evolutionary history. The initial thermal state of the Earth's core plays a significant role because it determines when the geomagnetic field first emerged. To study this issue, we systematically investigated core heating during giant impacts using a Smoothed Particle Hydrodynamics (SPH) code. Each simulation runs a single giant impact under specific initial conditions. These simulations covered a range of impact angles, velocities, and impactor masses. First, we found that different giant impacts cause significant differences in the Earth's core temperature. Second, the temperature distribution within the core is highly heterogeneous, with high temperatures mainly concentrated at the outermost part of the core. This leads to the natural formation of a thermally stratified structure in the core. Such a stratified structure is very stable and will not undergo convection, which may delay the initiation of the Earth's earliest magnetic field.