

On the increase in thermal diffusivity caused by the perovskite to post perovskite phase transition and its implications for mantle dynamics

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The D'' region, at the base of Earth's mantle, is known to be both anomalous and crucial to our understanding of mantle dynamics and Earth's evolution. Since the discovery of a post-perovskite phase in MgSiO₃, stable at pressures in excess of ~ 110 GPa, the presence of this CaIrO₃-structured material has been able to explain many of the lowermost-mantle's properties. Even a relatively small difference between the thermal transport properties of perovskite and post-perovskite could have a significant effect on the heat flow across the core-mantle boundary, potentially influencing whole mantle convection and Earth's thermal evolution. CaIrO₃ has been used extensively in previous studies as a structural and mechanical analogue for both MgSiO₃-perovskite and post-perovskite. Here, however, we use it to investigate the relative thermal transport properties of perovskite and post-perovskite structure types.

The thermal diffusivities (κ) of the perovskite and post-perovskite phases of CaIrO₃ have been measured, at elevated pressure and temperatures up to 600 °C, using the X-radiographic Angström method at beamline X17B2 of the National Synchrotron Light Source. At high temperatures, we find that the thermal diffusivity of CaIrO₃ post-perovskite is approximately twice that of CaIrO₃ perovskite. Assuming a similar effect occurs in MgSiO₃ post-perovskite, the effect of the contrasting thermal transport properties between perovskite and post-perovskite on mantle dynamics would result in a reduction in extent and increase in depth of post-perovskite lenses, as well as increased core-mantle-boundary heat-flux, broader upwellings and more vigorous downwellings.

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