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Key Points:

- We calculate the residual melt fraction of liquid in the inner core for different growth scenarios
- An uppermost mushy layer is maintained, of thickness of about 1 km for a viscosity of 10^{20} Pa·s
- Supercooling at the center of the core cannot have been larger than 100 K

Supporting Information:

- Supporting Information S1

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Abstract The growth history of the inner core is inherently linked to the thermal history of the Earth. The crystallization of the inner core may have been delayed by supercooling and gone through an initial phase of fast growth after the nucleation barrier has been passed, but so far no evidence or constraint has been proposed to time this possible event. With two-phase flow dynamics, we explore the effect of different growth scenarios for the inner core to determine their effects on its liquid fraction structure. Seismic observations on the melt fraction inside the inner core at present limit the porosity to a maximum of 10% of liquid. Our model provides constraints for the delay in nucleation compared to the time where the first crystal may have started to nucleate, and we find that the supercooling cannot have exceeded 100 K.

Plain Language Summary The magnetic field of the Earth is maintained by the turbulent convection in the liquid outer core. As the inner core grows, latent heat and light elements are released into the liquid outer core, generating upwelling of material and driving the convection. The timing for