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Fine structure of boundaries of the Earth's core

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The fine-scale seismic features at the core–mantle boundary (CMB) and inner core boundary (ICB) provide critical insights into the physico-chemical characteristics and dynamic evolution of Earth's deep interior. At the CMB, ultralow velocity zones (ULVZs) have been primarily detected within and at the edges of large low-velocity provinces (LLVPs), offering clues to the presence of partially molten materials. Using SKKKP and its B-caustic diffractions from 60 large deep-focus events recorded across North America, Europe, and China, we identify ULVZs not only beneath the Pacific and Africa but also in high-velocity lowermost mantle regions, including Central America, Alaska, Greenland, and West and Central Asia. These findings suggest that ULVZs in high-velocity regions may be linked to subducted oceanic crust in the deep lower mantle[1]. At the ICB, pre-critical PKiKP waveform analysis reveals a complex fine structure, with a sharp boundary beneath Mongolia and Northeast Asia but a locally laminated structure beneath Central Asia, Siberia, and parts of Northeast Asia [2]. This complexity may result from a kilometer-scale mushy zone or the coexistence of bcc and hcp iron phases, indicating significant lateral variations in dendrite growth processes. These variations likely reflect the intricate thermochemical and geodynamical interactions between the liquid outer core and solid inner core. Together, these findings advance our understanding of the fine structure and dynamic processes at the boundaries of Earth's core, shedding light on the thermal, chemical, and evolutionary mechanisms governing the deep interior.

Reference

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[2] Zhang, B., Ni, S., Wu, W., Shen, Z., Wang, W., Sun, D., & Wu, Z. (2023). Small-scale layered structures at the inner core boundary. *Nature Communications*, *14*(6362), 1–9. https://doi.org/10.1038/s41467-023-42177-7