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Mineral physics constraints on the seismic observations and thermal evolution of the Earth's core

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Recent seismic studies have revealed complex seismic signatures in the inner core and inner-outer core boundary including velocity gradient at the inner core boundary, lateral variations in east-west hemispheres, and depth-dependent velocity isotropy. These observations represent physical manifestations of the thermal, compositional, and textural evolutions of the constituent iron alloys in the region. Therefore, laboratory measurements on the elasticity, phase diagrams, thermal transport properties, and textures of iron and its light element alloys can provide valuable constraints on the seismic observations, which in turn can help understand the thermal evolution of the metallic core. In this presentation, I will report recent experimental results on the textures, velocity, and thermal conductivity of iron and light elements measured in a high-pressure diamond anvil cell. Together with literature values and thermodynamic modelling, this presentation focuses on mineral physics constraints on the seismic observations and thermal evolution of the Earth's inner core and inner core boundary. Specifically, I will use laboratory measurements on the electrical and thermal conductivity of iron alloys to discuss the validity of Wiedemann-Franz law in the region. I also address the alloying effects of light element(s) on the thermal conductivity and liquidus-solidus phase loop that are pertain to our understanding of the formation of the inner core and the evolution of the inner core boundary.