The effect of melting on electrical resistivity for iron at high pressure and implications for the Earth's core conductivity

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The Earth's core comprises solid and liquid iron alloy in inner and outer parts. The Earth's magnetic field protects the planet from high-energy cosmic rays and solar wind; the magnetic field is generated by the dynamo action, which is powered by the convection of the liquid outer core. The convection of the outer core is currently dominated by both thermal convection due to the vertical heat flow and compositional convection due to the release of light elements along with the crystallization of the inner core. Such dynamics and thermal evolution of the core are mainly controlled by its electrical and thermal conductivities.

However, in spite of a large body of research, the conductivity of Earth's core is still highly controversial. Although Earth's outer core is composed by molten iron alloys, the effect of melting on electrical resistivity (inverse of conductivity) for iron has been determined up to only 24 GPa using a large-volume press apparatus [e.g., 1,2]. Here, we measured the electrical resistivity of molten iron with the DAC at higher pressures than previous studies. To suppress a change in sample shape in a DAC due to melting, we developed and introduced a "capsule-type sample" that consists of a single crystal sapphire plate and iron sample. The effect of melting increased the electrical resistivity of iron by approximately 14.1% at the core mantle boundary pressure. This result does not refute the high conductivity of the Earth's core.

[1] Silber, R. E., Secco, R. A., Yong, W., & Littleton, J. A. (2018). *Scientific reports*, 8(1), 10758.

[2] Yong, W., Secco, R. A., Littleton, J. A., & Silber, R. E. (2019). *Geophysical Research Letters*.