# Heat flow within terrestrial cores from electrical resistivity measurements of Fe-Si to 24 GPa

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**Abstract**

Within the Earth and other terrestrial planetary bodies, the convection of a liquid metallic outer core is the driver of the dynamo-produced magnetic field which surrounds these bodies. It is widely accepted that these cores are composed primarily of Fe, with ~10% Ni, and one or more potential light elements including Si, S, and C. The dynamo within the liquid outer core can be driven by either chemical convection—which occurs as pure Fe freezes onto a solid inner core and the residual light elements rise—or thermal convection—which occurs as heat rises from the solid inner core, through the liquid outer core, and into the mantle. By quantifying the thermal conductivity of core-relevant alloys, the adiabatic heat flow in the liquid core can be calculated. By comparing this value with the heat flow through the core-mantle boundary (from other studies), the likely mechanism of outer core convection may be inferred, along with the likely duration of this convection.

The physical properties, including electrical resistivity, of Fe-Si alloys have been investigated previously, as Si has been stated to be the most likely light element within the inner solar system. From compositional constraints provided in previous studies, Fe-13 wt% Si is within the range of Si suggested for the cores of Mercury and the Moon. Additionally, this composition is likely also applicable to Mercury-like exoplanets, based on formation models. However, the electrical resistivity of this particular composition has not yet been investigated at high pressures.

Experiments are underway to be conducted in a 3000-ton multi-anvil press at pressures up to 24 GPa and temperatures into the liquid state. Octahedral pressure cells will be used which will contain continuous, porosity-free Fe-13 wt% Si wires, confirmed by computed tomography (CT) scans. These wires were produced from sample powder of the same composition. Using two sets of thermocouples, the four-wire method will be used to measure electrical resistivity and temperature within the sample at constant pressure. Using the Wiedemann-Franz law, these measurements will be used to calculate the electronic component of thermal conductivity, which can then used to calculate core adiabatic heat flow and then be compared to estimates of heat flow through the core-mantle boundaries within these bodies.

By the time of the meeting in August, CT scans of sample wires, high pressure-temperature resistivity experiments, and electron microprobe chemical composition analysis of recovered samples are expected to be completed and the following results obtained. Adiabatic heat flow within the cores of Mercury, the Moon, and two Mercury-like exoplanets will be estimated, and the likely convection mechanisms and durations within them inferred. In addition to the electrical resistivity data, the pressure-dependent melting boundaries will be determined for Fe-13 wt% Si at varying pressures, and combined with those of previous studies on other Fe-Si alloys.