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Adiabatic Heat Flow in Mercury with a Fe-8.5wt%Si Core

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Recent theoretical studies have tried to constrain Mercury's internal structure and composition using thermal evolution models. The presence of a thermally stratified layer of Fe-S at the top of an Fe-Si core has been suggested, which implies a sub-adiabatic heat flow on the core side of the CMB. In this work, the adiabatic heat flow at the top of the core was estimated using the electronic component of thermal conductivity (k_{el}), a lower bound for thermal conductivity. Direct measurements of electrical resistivity (ρ) of Fe-8.5wt%Si at core conditions can be related to k_{el} using the Wiedemann-Franz law. Measurements were carried out in a 3000 ton multi-anvil press using a 4-wire method. The integrity of the samples at high pressures and temperatures was confirmed with electron-microprobe analysis of quenched samples at various conditions. Unexpected behaviour at low temperatures between 6-8 GPa may indicate an undocumented phase transition. Measurements of ρ at melting seem to remain constant at 127 μΩ·cm from 10-24 GPa, on both the solid and liquid side of the melting boundary. The adiabatic heat flow at the core side of Mercury's core-mantle boundary is estimated between 21.8-29.5 mWm^{-2}, considerably higher than most models of an Fe-S or Fe-Si core yet similar to models of an Fe core. Comparing these results with thermal evolution models suggests that Mercury's dynamo remained thermally driven up to 0.08-0.22 Gyr, at which point the core became sub-adiabatic and stimulated a change from dominant thermal convection to dominant chemical convection arising from the growth of an inner core. Simply considering the internal structure of Mercury, these results support the capture of Mercury into a 3:2 resonance orbit during the thermally driven era of the dynamo.