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Electrical conductivities of pyrolitic mantle and MORB materials up to the lowermost mantle conditions

Kenji Ohta[1*], Kei Hirose[1], Masahiro Ichiki[1], Katsuya Shimizu[3], Nagayoshi SATA[2], Yasuo Oishi[4]

[1]Tokyo Institute of Technology, [2]JAMSTEC, IFREE, [3]Osaka University, [4]JASRI

The electrical conductivities of natural pyrolitic mantle and MORB materials were measured at high pressure and temperature covering the entire lower mantle conditions up to 133 GPa and 265 0 K in a laser-heated diamond anvil cell. In contrast to the previous laboratory-based models, our data demonstrate that the conductivity of pyrolite does not increase monotonically but varies dramatically with depth in the lower mantle; it drops due to high-spin to low-spin transition of iron in both perovskite and ferropericlase in the mid-lower mantle and increases sharply across the perovskite to post-perovskite phase transition at the D'' layer. We also found that the MORB exhibits much higher conductivity than pyrolite. The depth?conductivity profile measured for pyrolite does not match the geomagnetic field data below about 1500-km depth, possibly suggesting the existence of large quantities of subducted MORB crust in the deep lower mantle. The observations of geomagnetic jerks suggest that the electrical conductivity may be laterally heterogeneous in the lowermost mantle with high anomaly underneath Africa and the Pacific, the same regions as large low shear-wave velocity provinces. Such conductivity and shear-wave speed anomalies are also possibly caused by the deep subduction and accumulation of dense MORB crust above the core?mantle boundary.

Keywords: Electrical conductivity, pyrolite, MORB, Diamond anvil cell, post-perovskite, spin transition