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Electrical conductivity of hydrous silicate melt atop of the 410 km seismic discontinuity

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A low velocity layer (LVL) atop of the 410-km-deep seismic discontinuity in Earth's mantle has been considered as a deep-seated partial molten layer produced by dehydration melting of the upwelling mantle due to the significant difference in water storage capacities between mantle transition zone (MTZ) and the overlying upper mantle. Such melt can significantly enhance the electrical conductivity at that depth.The geoelectromagnetic studies have also suggested the presence of a 410-km-deep melt/fluid layer with excess conductance at this region. Therefore, Knowledge on the electrical conductivity of the hydrous silicate melt is indispensable to constrain the nature of this melt layer.

We measured the electrical conductivities of hydrous silicate melts with a composition expected from dehydration melting up to 2200 K at 13 GPa in a Kawai-type multianvil press. To suppress the water escape during the conductivity measurement, we used a single crystal diamond capsule which is sandwiched by Pt electrodes. The recovered sample contained quench minerals consisting of olivine and garnet with large porosity, which was filled with water after quench. The hydrous LVL melt showed a very high electrical conductivity that was several orders of magnitude higher than that of dry peridotite and comparable to the carbonate melt.

The present study demonstrates that the LVL melt with expected composition produced by dehydration melting of the upwelling mantle is extremely conductive phase in the Earth's upper mantle. If melt layer exists at the base of upper mantle, its thickness is estimated to be less than 200 m, which is hardly detected by seismological study, and cannot be considered as origin of the LVL. If the LVL is a partially molten layer, the dense hydrous melt must rise together with the upwelling mantle without gravitational separation.