Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.17378

Electrical conductivity of potassium-bearing hydrous silicate melts and supercritical fluids

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In subduction zone, the mass transfer from the subducted slab to the overlying mantle wedge is controlled by a hydrous mobile phase, which is considered as aqueous fluid, hydrous silicate melt, or supercritical fluid. The three hydrous phases have different physicochemical properties such as viscosity, wetting capability, and electrical conductivity. Even though the electrical conductivity of aqueous fluid and hydrous silicate melt are well known in literature, the electrical conductivity of supercritical fluid is still unclear. This impedes the understanding of conductivity anomaly in subduction zones detected by magnetotelluric surveys. In order to investigate the electrical conductivity of supercritical fluid, we performed electrical conductivity measurement on potassium-bearing silicate melt with H_2O contents from 6 wt% to 35 wt% at 1173-1573 K and 1.5 GPa in the piston cylinder apparatus using sweeping frequency impedance analyses. The experimental results indicate that the electrical conductivity rapidly increased with H_2O content for the hydrous potassium-feldspar melt. The increase of ~10 wt% H_2O (from 6 wt% to 16 wt%) can enhance the electrical conductivity by 0.8 log units. The electrical conductivity of supercritical fluid is higher than that of hydrous melt, but its increase with H_2O content gradually slows down. The increase of ~20 wt% H_2O (from 16 wt% to 35 wt%) can only enhance the electrical conductivity by 0.2 log units. Such a change is consistent with that of viscosity [1], which decreases exponentially with lower H_2O contents but linearly at > 20 wt% H_2O. By comparing to other hydrous silicate melt, the electrical conductivity of supercritical fluid is obviously higher. It is inferred that the anomaly high conductivity in subduction zones detected by magnetotelluric survey [2] may be caused by the existence of small amount of supercritical fluid.

[1] Goldschmidt, Audetat & Keppler (2004), *Science* 303, 513-516.

[2] Goldschmidt, McGary et al. (2014), *Nature* 511, 338-340.