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Electrical conductivity of San Carlos clinopyroxene as a function of water content
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The high conductive region (50-100 km) obtained from magnetotelluric data at Southern East Pacific Rise has been interpreted by the high electrical conductivity of hydrous olivine. Though the fact that water could enhance the electrical conductivity orders of magnitude, the conductivity enhanced by hydrous olivine and orthopyroxene seems to be insufficient to account for this anomaly convincingly. Clinopyroxene, one of the main constituent minerals in the upper mantle, could be a possible candidate to raise the conductivity in this region because water tends to partition into this phase rather than olivine and orthopyroxene. In this study, we measured the electrical conductivity of clinopyroxene as a function of temperature and water content under the P-T condition corresponding to the conductivity anomaly region in the upper mantle.

Clinopyroxene aggregates with water contents ranging from ~0 to 2000 wt. ppm were synthesized from Scan Carlos clinopyroxene powder at 1270-1370 K and 1.5 GPa in a piston cylinder apparatus. The double capsule technique was used to realize the Ni-NiO buffer. The electrical conductivity measurements were performed at the same pressure and temperatures from 600 to 1200 K at the same oxygen fugacity, using a DIA-type apparatus. The water content of the sample both before and after electrical conductivity were determined by FTIR using Paterson calibration.

The electrical conductivity increases with increasing water content. Two conductive mechanisms were identified, i.e. proton conduction and hopping conduction. For hopping conduction, the activation energy is ~1.44 eV. For proton conduction, the activation energy differs by water content. At low water content, the activation energy is 1.28-1.36 eV; while at high water content, the activation energy is ~0.92 eV. All these data were fitted using the formula $\sigma=\sigma_{h0}\exp(-H_h/kT)+\sigma_{p0}C_w{}^r\exp(-H_p/kT)$. Compared with the electrical conductivity of olivine (Yoshino et al., 2006) and orthopyroxene (Zhang et al., 2012) under the same oxygen fugacity, electrical conductivity of hydrous clinopyroxene is comparable to those of the other major constitute minerals. To estimate electrical conductivity beneath the oceanic lithosphere as a function of water content, the Hashin-Shtrikman lower and upper bounds were used, and water-partitioning coefficients among olivine, orthopyroxene and clinopyroxene were also assumed. The model showed no obvious advantage to explain the high conductive anomaly. Thus, the conductivity anomaly predicted near the mid-ocean ridge cannot be originated from hydrated mantle. The conductivity anomaly region beneath the oceanic lithosphere should be explained by a presence of other conductive agents such as partial melt.

Yoshino et al. (2006), *Nature* **443**, 973-976.
Zhang et al. (2012), *EPSL* **357-358**, 11-20.

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