

Electrical conductivity of hydrous Al-bearing orthopyroxene in the upper mantle

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It was reported that the top of the asthenosphere shows high conductivity anomaly. Although this kind of anomaly has been often explained by olivine hydration, it is reported that hydrous olivine is unable to account for this conductivity anomaly (Yoshino et al. 2006). Orthopyroxene is thought to be one of the main constituents of the upper mantle. Although it is less abundant than olivine, Mierdel et al. (2007) observes aluminous pyroxenes can contain strikingly high amount of water, reaching close to 1 wt. % at pressure of 1 to 3.5 GPa. Hence, it can be the most important host of water in the shallow part of the upper mantle. It is necessary to measure electrical conductivity of hydrous aluminous orthopyroxene.

To investigate the effects of water on the electrical conductivity of aluminous orthopyroxene, a series of high temperature and high pressure experiments were conducted at corresponding to the upper mantle condition. Starting materials were prepared from finely ground mixtures of MgO, Fe₂O₃, SiO₂ and Al₂O₃, melted at 1600 C with oxygen fugacity controlled to be QFM buffers to form glass. Orthopyroxene samples containing 3, 6 and 10 wt. % of Al₂O₃ were then synthesized from the powdered glass with or without adding water at pressure of 1 GPa and temperature from 900 C to 1200 C for up to 128 h using a piston cylinder apparatus. The synthesized samples were examined using X-ray diffraction (XRD), electron probe microanalysis (EPMA) and Fourier transform infrared spectroscopy (FT-IR). The electrical conductivities of aluminous orthopyroxene with 526 ppm wt. % of water were measured at pressure of 3 GPa and temperatures from 500 to 800 K by means of impedance spectroscopy in a multi-anvil apparatus. It is found that the activation energy for proton conduction is 0.67 eV. Proton conduction of aluminous orthopyroxene is comparable with that of olivine.

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