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Electrical conductivity of transition zone minerals: wadsleyite and ringwoodite

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The earth's mantle transition zone would be a large water storage because wadsleyite and ringwoodite can store significant amounts of water in their crystal structure. Water content in the transition zone could be quantified using electrical conductivities of hydrous wadsleyite and ringwoodite. Although the correct interpretation of water content depends on accurate knowledge of two conduction mechanisms (small polaron and proton conductions) in these minerals, early studies failed to distinguish them (Xu et al., 1998; Huang et al., 2005). In the present study, electrical conductivities of wadsleyite and ringwoodite were measured as functions of water content and temperature, rendering it possible to separate contributions of small polaron and proton conduction mechanisms. Their electrical conductivities by small polaron conduction are remarkably lower than previously considered. The contributions of proton conduction are small at temperatures corresponding to the mantle transition zone. Conductivity of wadsleyite is considerably lower than that of ringwoodite for both mechanisms. For dry mantle, conductivity jumps in association with the olivine-wadsleyite and wadsleyite-ringwoodite transitions have similar magnitude ($\sim$0.7 log unit). The dry mantle model well explains the current semi-global conductivity-depth profiles obtained from the recent geoelectromagnetic studies (Kuvshinov et al., 2005). There is no necessity to introduce water in the transition zone.

References

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