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# Electrical conductivity, thermal structure and composition of the earth's upper mantle

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We estimated electrical conductivity profiles predicted from the compositional models of the earth's upper mantle with calculating phase diagrams in the CFMAS (CaO-FeO-MgO-$Al_2O_3$-$SiO_2$) system, and compared with observed ones. The pyrolite (McDonough & Sun, 1995) and piclogite (Ita & Stixrude, 1992) compositional models were used for oceanic upper mantle, while on-craton and off-craton models (Rudnick, 1998) were adopted to sub-continents or tectosphere. Perple_X (e.g. Connoly & Kerrick, 1987) program was utilized for obtaining mineral proportions along depth with minimizing the total Gibbs free energy. The used thermodynamic data base was SFO05 (Stixrude & Lithgow-Bertelloni, 2005; Fabrichnaya, 1999; Oganov, 2005). The adiabat, which passes through the pressure and temperature conditions constrained by both of the olivine-wadsleyte (Katsura et al., 2004) and ringwoodite-perovskite (Ito & Takahashi, 1989) phase transitions, is regarded as an appropriate upper mantle one. The appropriate adiabat itself was regarded as the thermal structure of oceanic upper mantle. On the other hand, the thermal structure of sub-continents was obtained by incorporating the effect of the mechanical boundary layer and of the crustal double heat production layers into the appropriate adiabat by means of McKenzie et al.(2005). Newly compiled laboratory data for electrical conductivity of minerals were as followings: olivine (Constable, 2006), garnet-majorite (Romano et al., 2006), wadsleyte (Yoshino et al., 2008), ringwoodite (op. cit.), and illmenite (Katsura et al., 2007). We referred to Xu et al.(2000) for other minerals' data.

The calculation with pyrolite or piclogite model shows below 1.5 orders of magnitude of the conductivity jump at the depth of olivine-wadsleyte transition. The calculated profiles agree well with the observed one in the mantle transition zone (400-660km), while the property of the upper mantle except the mantle transition zone obviously higher than the observed. Yoshino et al.(2008) have revealed that even dry condition rather than wet condition is able to predict the observed conductivity profile in the mantle transition zone on the null hypothesis (pure olivine/wadsleyte/ringwoodite upper mantle). Allowing for the pyrolite or piclogite compositional model, dry condition again accounts for the electrical conductivity profile in the mantle transition zone.

With regard to sub-continents, allowing for mechanical boundary and the crustal layers in the thermal structure does not give rise to any change of mineral proportion. The result indicates that the electrical conductivity change by allowing for the mechanical boundary layer in the thermal structure is yielded by only thermal effect for conductivity of minerals. The calculated conductivity profiles with on- and off-craton models show significantly lower magnitude than the observed. Karato(2002) hypothesized the tectosphere should be dry, supposed that cratons remain stable through the earth's evolution. It is deduced from the Karato's hypothesis that graphite is the most plausible mineral, which enhances the conductivity of the observed profile (e.g. Duba & Shankland, 1982).