Interpreting the electrical conductivity of deep earth by modelling the bulk property using constituent property at high temperature and pressure

Kui Han[1]*, Xinzhuan Guo[2], Simon Clark[1]

[1]*Australian Research Council Centre of Excellence for Core to Crust Fluid Systems (CCFS) and GEMOC, Department of Earth and Planetary Sciences, Macquarie University, Sydney, NSW 2109, Australia*
[2]*State Key Laboratory of Geological Processes and Mineral Resources, China University of Geoscience, Wuhan, Hubei 430074, China*

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*e-mail: kui.han@hdr.mq.edu.au

The magnetotellurics can be used to produce conductivity maps of the crust and mantle of the Earth. In order to interpret these maps in terms of mineralogy we need to know the conductivity of minerals suspected to be present in these regions and we need an appropriate method to combine these conductivities together to give whole rock values. I am testing the validity of the mixture models presently used in these calculations. I selected three single phase minerals, quartz, orthoclase and plagioclase, and produced two synthetic "rocks" by hot pressing mixtures of these phases. I measured the conductivity of the pure phases and the synthetic "rocks" at temperatures from 573K to 1273K and at a pressure of 1GPa using the complex impedance method, in the frequency range 0.1Hz to 1×10^{6}Hz, and a multi-anvil apparatus to generate high-pressures and temperatures (Fig 1). The electrical conductivities of the three single phase minerals were used to estimate the electrical conductivities of the synthetic "rocks" using five different mixing models. These calculated conductivities were compared with the measured values. None of the five calculated synthetic "rock" conductivity values matched the measured values for either synthetic "rock". The measured conductivities of the synthetic "rocks" were from 0.5 to 1 orders of magnitude higher than the calculated values. This calls into question the robustness of the current mixing models and suggests that a new model needs to be developed.

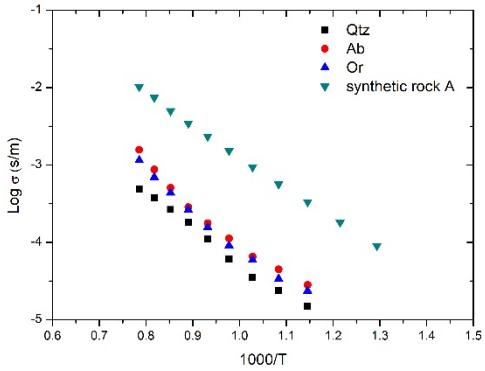

Fig 1. Electrcial conductivity of three single phase minerals--Quartz, Albite and Orthoclase, as well as the synthetic rock A

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