Geophysical Research Abstracts,
Vol. 10, EGU2008-A-07550, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-07550
EGU General Assembly 2008
© Author(s) 2008

In situ electrical conductivity measurements on hydrous diopside-anorthite-albite mixtures at high pressure and temperature: Atomistic transport properties and partial melting

J.H. terHeege (1,2) and J. Renner (2)

(1) Now at BU Geo energy & Geo information, TNO Built Environment & Geosciences, the Netherlands, (2) Institute for Geology, Mineralogy & Geophysics, Ruhr-University Bochum, Germany (Jan.terHeege@tno.nl / Phone: +31 30-2564432)

Many studies have shown that the electrical conductivity of rocks present in the deep Earth is influenced by grain size, second phase content, the presence of hydrous phases, and partial melting. The presence of hydrous phases is of particular interest, because they affect intracrystalline and grain boundary transport processes as well as melt properties, such as melting point, miscibility between silicate melts and hydrous fluids and melt topology. Several microphysical models address the individual effects of these phenomena, but few account for the interdependence of the effects or quantify the relative importance of the effects on electrical conductivity.

In this study, we have investigated the effect of composition, grain size, partial melting, and water on electrical conductivity of hydrous diopside-anorthite and diopside-albite samples. For this purpose, impedance spectroscopy was performed on mixtures of synthetic glasses with relevant composition and water content at pressures up to 3 GPa and temperatures up to 1200°C in a solid medium piston-cylinder apparatus. This diopside-anorthite-albite mineral system was selected because phase equilibria of different mixtures at the relevant (hydrous) conditions are well understood, so that changes in electrical conductivity can be related to partial melting with confidence. Also, the system is iron-free so that problems with buffering oxygen fugacity at high pressure and temperature can largely be avoided.

Nucleation of grains in the glasses, grain growth, and partial melting could be detected in the experiments, and differences in electrical conductivity between samples of different composition could be determined. Hence, the relative magnitude of the effect of grain size, composition, and partial melting on electrical conductivity could be quantified. We compare the results with diffusivities of possible charge carrying species to identify the atomistic transport processes controlling electrical conductivity of the samples in solid state. In addition, we use the results to evaluate existing models that quantify the effect of partial melting and grain size on electrical conductivity. Such models are essential for the interpretation of magnetotelluric signals in terms of composition and physical state of inaccessible parts of the Earth, for example to discriminate between partial melting and dissolution of hydrogen in olivine as the cause for high conductivity in the asthenosphere.