Geophysical Research Abstracts,
Vol. 10, EGU2008-A-07498, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-07498
EGU General Assembly 2008

In situ impedance spectroscopy on pyrophyllite and $CaCO_3$ at high pressure and temperature: Phase transformations and kinetics of atomistic transport

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)

In situ impedance spectroscopy in laboratory experiments at high pressure and temperature can provide crucial quantitative information on properties of rock materials at depth as well as on physical and chemical processes occurring in the deep Earth.

We developed an experimental setup for in situ electrical impedance measurements in a piston-cylinder apparatus and applied it to study the kinetics of charge carriers and phase transformations in pyrophyllite and $CaCO_3$ aggregates. From comparison with previous studies, we found that absolute values of electrical conductivity and pressure-temperature conditions for dehydration reactions in pyrophyllite and phase transformations in $CaCO_3$ can be accurately determined using our setup. Dehydration of pyrophyllite significantly enhances the transport kinetics and the effect is more pronounced under undrained conditions than under drained conditions. When dehydroxylation and decomposition temperatures for pyrophyllite under undrained and drained conditions are combined, they appear independent of pressure rather than increasing with pressure as previously suggested. Electrical conductivity of $CaCO_3$ varies with impurity content and grain size, and is most likely controlled by diffusion of oxygen along wet grain boundaries.

When applied to the Earth, the results on pyrophyllite suggest that the increase in electrical conductivity in rocks that undergo dehydration should be taken into account in interpreting magnetotelluric surveys of regions with anomalously high conductivity found above subducting plates. The results on $CaCO_3$ indicate that grain boundary transport controls the electrical conductivity in fine-grained calcite rocks; hence calcite mylonites may be detected using magnetotelluric methods. Order-disorder transformations, such as occurring in calcite, possibly affect the physical properties of rocks (e.g., rheology) by changing the kinetics of atomistic transport processes.