Geophysical Research Abstracts,
Vol. 11, EGU2009-7600, 2009
EGU General Assembly 2009

Role of deformation on phase changes in Metapelites: insights from torsion experiments

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Most of the petrological grids derived after experiments in pelitic system do not consider mineral reactions in presence of deformation. Natural rocks, however, generally experience metamorphism simultaneously with tectonic stress. In this study, we investigated dry, synthetic quartz-muscovite (Fe-rich) system to explore the role of deformation on the metamorphic reactions. Through metamorphism at different conditions, this pelitic system can yield different mineral assemblages, which is helpful for monitoring reaction processes. Torsion experiments were conducted in an internally heated gas medium deformation apparatus at 750°C and at confining pressure of 300 MPa with a constant strain rate of 3x10-4/s (1 shear strain ĩ hour). Static experiments were performed under same P-T conditions as for the deformation ones.

We observed the reaction of disequilibrium breakdown of muscovite (Fe-rich) and examined the effects of deformation on the kinetics of reaction. After 1 hour we observed two phases – muscovite (Fe-rich) and quartz, however, diffusion leads to exchange iron and aluminium. Consequently, two types of muscovite formed (Fe-rich and Fe-poor). With progressive time (after 1.5-2 hours), the phases started to produce melt at the grain boundaries, in association with the occurrence of very fine new crystals (sillimanite, biotite and spinel). With increasing experiment time (5-7 hours) the amount of melt and new crystals increased. Furthermore, a new phase is observed – K-feldspar. In experiment at =16 (around 15 hours) old mica is completely molten and the melt production finished.

The rate of melting and crystallization is independent of imposed conditions (static/dynamic) during the first 1.5 hours of experiments. After this time, imposed conditions gradually become effective, which can be explained by additional energy in the system during dynamic experiments. We have made some thermodynamic calculations for the KFASH system in the equilibrium conditions. From these models, compared with experiments, we can see the effect of deformation on reactions behavior.