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Experiments to constrain the garnet-talc join for metapelitic material at eclogite-facies conditions

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Increasing pressure due to the subduction of mica-dominated sediments results in a loss of biotite as garnet-talc becomes a stable assemblage. While this transition is observed in natural samples, it has not yet been well constrained experimentally. Previous experimental investigations into metapelitic compositions at the University of Milan (Poli and Schmidt 2002, Ferri et al., 2009) indicated that further work in the range of 600-700° C, 2-3 GPa was required to elucidate this tie-line transition. The assemblages leading to garnet-talc stability through tie-line flip reactions include biotite-chlorite, biotite-chloritoid, and biotite-kyanite. Furthermore the mutual stability of garnet-chlorite and chloritoid-biotite at relatively high pressure conditions below the garnet-talc field is reevaluated.

Current investigations on two synthetic compositions (NM, NP) in the model metapelitic system CaO-K2O-FeO-MgO-Al2O3-SiO2-H2O are carried out in a piston cylinder apparatus at pressures and temperatures up to 2.7 GPa and to 740°C. Experiments are buffered with graphite, and are generally run under fluid saturated conditions. Two capsules, one of each composition, are included within the pressure chamber for each experiment. The NM composition is representative of metapelites and the NP composition is representative of metagreywackes. Experiments are characterized by XRD, BSE images and EMPA.

The following summary includes both current investigations and the above mentioned previous work, undertaken on the same chemical compositions. All assemblages also contain quartz, white mica, fluid $\pm$ zoisite or lawsonite.

The assemblage garnet-chlorite-chloritoid $\pm$ staurolite is present at 500° C at pressures of 1.4 and 1.6 GPa. The assemblage biotite-staurolite-chlorite is present at 600° C, 1.2 GPa and at 625° C, 1.4 GPa. The assemblage biotite-chloritoid-chlorite is present at 600° C for pressures $\geq$ 1.3 GPa and $\leq$ 1.7 GPa. The assemblage garnet-chloritoid-biotite is present at 600° C at 1.8 2.0 GPa, and at 625° C at pressures $\geq$ 1.5 GPa and $\leq$ 1.8 GPa. The assemblage staurolite-garnet-biotite is present at 650° C and pressures $\leq$ 1.7 GPa. The assemblage garnet-biotite-kyanite is present at 650° C, 1.8 GPa. The assemblage garnet-chloritoid-carbonate $\pm$ kyanite is present at 625° C, 2.2 and 2.5 GPa. The assemblage biotite-chloritoid-talc is present at 600° C, 2.3 GPa, and the assemblage talc-carnet-chloritoid is present at 600° C, 2.5 GPa and 625° C, 2.7 GPa.

In conjunction with the experiments, isochemical modeling for both compositions was undertaken with Perple_X (Connolly, 2009). Comparison of these isochemical sections with our experiments shows biotite appearing at higher pressures than predicted for either composition. Our experiments wherein garnet was absent occur within the range that Perple_X predicts garnet to be stable. Both chloritoid and talc are observed in our experiments at higher temperatures than predicted for either composition, and staurolite is observed at higher pressures than predicted for composition NM (staurolite has not yet been observed for experiments run for composition NP, and is not predicted by Perple_X to be stable in this P/T range). Chlorite, on the other hand, is observed at roughly the same P/T conditions as predicted by Perple_X.

Literature

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