Pseudosection modelling of eclogite-facies microdomains in metapelites and metagabbros using calculated 'micro' bulk compositions

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Pseudosection modelling is a powerful tool for monitoring the metamorphic evolution of rocks as a function of *P-T-X-n*H_2O. Usually these calculations are done using the bulk rock composition of a sample but this approach is then meaningless when it comes to partially equilibrated samples where metamorphic reactions take place only on a very local scale. One way to circumvent this problem is to calculate „synthetic" bulk compositions by considering only the minerals where reactions take place. This can easily be achieved by using the software Rock Maker (Büttner, 2012) where one can calculate any bulk composition based on the stoichiometry of the minerals involved. In this study this approach was used in 1.) partially equilibrated metapelites and 2.) experimental investigations of the gabbro-eclogite transformation at 700°C and 2 GPa.

In the metapelites at Val Savenca in the Sesia-Lanzo Zone, Italy Alpine eclogite-facies metamorphism and restricted fluid flow led to partial transformation of Variscan amphibolite-eclogite facies metapelites (garnet + biotite + sillimanite + K-feldspar + plagioclase + quartz) to zoisite ± jadeite + kyanite + phengite + quartz. This transformation took place under *P-T* conditions of 1.7 – 2.1 GPa at 600°C and low *a*(H_2O) of 0.3-0.6. The textures in the Val Savenca metapelites show relict igneous biotite which is replaced by the assemblage phengite + omphacite ± kyanite ± garnet if it is adjacent to former plagioclase. These omphacitic areas contain no zoisite. Thermodynamic modelling of biotite-plagioclase microdomains was done by calculating pseudosections of stoichiometric mixtures of biotite and plagioclase using the ratios 1:1, 1:2, 1:3, 1:5 and 1:10 using the program THERIAK-DOMINO (DeCapitani & Petrakakis, 2010). Calculations using a biotite-plagioclase ratio of 1:1 yielded biotite still to be stable. The ratio 1:2 yielded the mineral assemblage garnet + omphacite + phengite + zoisite + rutile but no kyanite. The ratio of 1:3 yielded the same assemblage but with kyanite stable only at low H_2O contents. Higher ratios yielded only more complex assemblages also involving two micas. The calculations reveal that 1.) plagioclase reacts to a higher extent than biotite which is obvious since no relict plagioclas is left anymore and 2.) the amount of coexisting H_2O was very low since kyanite occurs in the microdomains.

The experimental investigations of the gabbro-eclogite transformation using drilled cores of a fine-grained gabbro from the Odenwald at 700°C and 2 GPa yielded the mineral assemblage omphacite/jadeite + zoisite + paragonite ± garnet ± hornblende. Thermodynamic modelling was only successful when orthopyroxen-plagioclase micro-domains were considered. Calculations always yielded the assemblage omphacite/jadeite + zoisite + + garnet + kyanite but the jadeite contents of the newly grown omphacites could only be sufficiently reproduced when the plagioclase : orthopyroxen ratio was higher than 3 :1. This study shows that reproduction of the observed mineral assemblage in the plagioclase-biotite microdomains is quite successful and provides estimates on the amount of fluid present during eclogitization.

References:

Büttner, S. (2012): Mineralogy and Petrology, 104, 129-135.

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