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P-T snap-shots into the metamorphic evolution of rocks: forward modelling of the gabbro-eclogite transformation using piston cylinder experiments

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The metamorphic evolution of a rock can be deciphered using three approaches: 1.) the practical geothermobarometric approach (inverse modelling), 2.) the theoretical pseudosection approach (forward modelling) and 3.) the experimental approach. Whereas with the first two approaches it is possible to constrain several stages of the P-T-X evolution but how do we know what assemblage is actually present at desired P-T conditions and hence the experimental approach allows the detailed investigation of a distinct P-T condition of a rock. Therefore, experimental investigations should be viewed as a forward modelling technique and allow to put additional constraints on the evolution of a rock under defined P and T conditions and hence represents a snap-shot of a P-T point of the evolution of a given rock! The power of experiments as P-T snap-shots lies in the fact that very often only little is preserved of a rock‘s history and only few rocks actually preserve more than one major stage of mineral growth and hence act as a geological „recorder“. In experiments, protolith and metamorphic phase assemblages often coexist, thus allowing inferences about a rock‘s reaction history! For this purpose, simple experiments using natural rocks as starting materials can easily be conducted by using as starting material the protolith of the metamorphosed rock under consideration or a rock close to the desired rock. By fixing P and T these experiments consider additional variables such as microdomains and nH_2O. The power of forward modelling involving experiments lies in: 1.) the potential to provide direct constraints on P-T conditions; 2.) dealing with the full chemical complexities of rocks since the experiments are tailored to a specific rock composition; and 3.) the potential to identify crucial prograde mineral reactions since non-equilibrium assemblages often do persist. The disadvantage of this method being the complex chemical compositions of the rocks and therefore the deviation from chemical end-member systems. Therefore these experiments need to be evaluated not only 1.) in terms of their ability to reproduce the natural observations but also 2.) in their ability to reproduce theoretical calculations. In this study experimental investigations of the gabbro-eclogite transformation at 700°C and 2 GPa were investigated. The aim of this study is to provide experimental constraints on the gabbro-eclogite transformation and compare the results to the locality Bärofen in the Koralpe (Styria, Austria). For the experimental investigations drill cores of compositionally similar fine-grained gabbros from the Odenwald were used. Thermodynamic modelling of the mineral assemblages in the experiments and natural rocks was successful when micro-domains were considered. The experiments have shown that it was possible to identify peak-metamorphic phases not present anymore such as melt and that it was possible to reproduce 1.) microtextures, present in the Bärofen locality and 2.) mineralogical changes as a function of microdomains, P, T, and $n(H_2O)$. This study also shows that besides the geothermobarometric and thermodynamic characterization of metamorphic rocks, forward modelling using whole-rock experiments allow the comprehensive characterization of peak-metamorphic assemblages.