How good do simple experiments using natural rocks reproduce natural observations and theoretical calculations: selected examples ranging from high-P to high-T settings

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The metamorphic evolution of a rock can be deciphered using three approaches: 1.) the practical geothermobarometric approach, 2.) the theoretical pseudosection approach and 3.) the experimental approach. Whereas with the first two approaches it is possible to constrain several stages of the P-T-X evolution, the experimental approach allows mostly only the investigation of a distinct P-T condition of a rock. On the other hand, experimental investigations allow to put additional constraints on the evolution of a rock under defined P and T conditions. These constraints consider additional variables such as textures, aH_2O, nH_2O, fO_2 etc. In order to obtain results as close as possible to the natural rocks it is best to use natural rocks as starting materials. 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, a brief summary of three experimental investigations from a variety of P-T settings will be given with respect to the points discussed above.

The first example are the high-T low-P experiments concerning contact metamorphism of metapelites at the rim of the Permian Brixen Granite. In order to put experimental constraints on the temperature of contact metamorphism, experiments were performed in a hydrothermal apparatus at 0.3 GPa and temperatures of 580°C and 650°C using two natural quartzphyllite samples from the area as starting materials. The agreement between the observed textures and mineral compositions therefore allows putting additional constraints on the T conditions of this contact metamorphic event. On the other hand it was not possible to reproduce the variation of Na contents in cordierite throughout the contact aureole.

The second study deals with the experimental investigation of high-P/high-T granulites from the Bohemian Massif. Large bodies of felsic high-P/high-T granulites with the assemblage quartz + ternary feldspar (mesoperthite) + garnet + rutile ± kyanite occur in the Southern Bohemian Massif. They are thought to have formed during the Variscan orogeny in a Carboniferous subduction setting, at 950-1050°C and 1.5-1.9 GPa, from granitic protoliths. We used granitic gneiss as starting material whose chemical composition almost perfectly matches the main granulite type of the Southern Bohemian Massif. Although the natural phase assemblages were well reproduced, the presence of F in the starting material lead to severe inconsistent results concerning theoretical calculations.

The third study is concerned with the gabbro-eclogite transformation. The aim of this study was to provide experimental constraints on the gabbro-eclogite transition and compare the results to the locality Bärofen in the Koralpe (Styria, Austria) where a well-described gabbro-eclogite transformation has been observed. The experimental investigations using natural starting materials used drilled cores of fine-grained gabbros from the Odenwald. Recalculation of the mineral assemblages assuming relevant buffer assemblages was only partly successful. The experiments have shown that it was possible to reproduce 1.) microtextures, present in the Bärofen locality and 2.) mineralogical changes as a function of P, T, $a(H_2O)$ and fO_2.

Overall there is a surprisingly good agreement between the experiments and the natural observations, theoretical calculations are still hampered by minor elements (e.g. F) not considered in the claculations so far.