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Fluid-induced eclogitization of gabbros: comparison between natural observations and gabbro-H_2O and gabbro-H_2O-NaCl experiments

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The aim of this study is 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. Previous investigations obtained Permian ages for the magmatic protoliths and an Eo-Alpine age for the eclogite-facies metamorphic overprint of these rocks. Textural and petrographic investigations showed that the primary magmatic assemblage plagioclase (An60-76) + clinopyroxene1 + orthopyroxene (XMg = 71-76) reacts in microdomains to form spinel, clinopyroxene2, garnet, kyanite, hornblende and corundum. Fluid influx lead to the progression of reactions involving plagioclase such as Anorthite = Grossular + Kyanite + Quartz and Anorthite + H_2O = Zoisite + Kyanite + Quartz, which led to the formation of Ca-rich garnets (XCa = 53-91) as well as zoisite and kyanite. Reactions along the plagioclase/orthopyroxene interface such as Anorthite + Enstatite/Ferrosilite = Diopside/Hedenbergite + Kyanite led to the formation of clinopyroxene2 and kyanite. Within this domain, Mg-rich garnet (XMg = 33-35) forms via the model reaction Anorthite + Enstatite/Ferrosilite = Pyrope/Almandine + Diopside/Hedenbergite + Quartz. Model reactions involving the An-component led to an increase in the Ab-component in the remaining plagioclase, which eventually breaks down via the reaction Albite = Jadeite + Quartz. Geothermobarometry of fully equilibrated metagabbros yielded P-T conditions of 670-700°C and 1.7-2.1 GPa for the Eo-Alpine eclogite-facies overprint assuming $aH_2O = 1$.
The experimental investigations using natural starting materials were aimed at reconstructing the observed mineral assemblages not only as a function of P and T but also as a function of fO_2 and $a(H_2O)$ using drilled cores of fine-grained gabbros from the Odenwald. In all experiments H_2O was present and buffered (NNO, HM) as well as unbuffered experiments with regard to fO_2 were conducted. Experimental conditions in the piston-cylinder were 700°C and 2 GPa. The experiments in the system H_2O-NaCl, were conducted at NNO using the following compositions of XH_2O: 1, 0.95, 0.9, 0.8 and 0.7. Buffered (HM, NNO) and unbuffered experiments with aH_2O = 1 resulted in the mineral assemblage omphacite/jadeite + zoisite + paragonite + rutile ± garnet ± hornblende ± melt. In the HM experiments, garnet as well as hornblende were absent, but garnet + hornblende occur in the NNO experiments, which represent fO_2 conditions much closer to the natural observations. In the NNO experiments with $XH_2O<1$, the assemblage jadeite + zoisite + paragonite + quartz, but no melt occurs. The natural reaction textures could only be partly reproduced due to extremely high reaction progress. Recalculation of the mineral assemblages assuming relevant buffer assemblages was only partly successful. The experiments have shown that it is 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.