igneous protolith. After exsolution, the host and lamellae in the ternary feldspar grains may be stable throughout the following history as long as recrystallisation does not occur. Such a history can involve rehydration and metamorphism, even under H_2O-saturated conditions, with the compositions and proportions of the host and lamellae being modified to reflect the P-T conditions experienced. Some of the high-grade meta-igneous rocks from the Moldanubian of the Bohemian Massif that contain ternary feldspar preserve a substantial measure of their igneous heritage. Orthopyroxene-bearing gneisses include types that are barely affected by the metamorphism, whilst others require hydration of the igneous protolith prior to development of a metamorphic overprint. A key to establishing the igneous origin of the ternary feldspar grains is their preservation in garnets that are either themselves igneous, or of a relatively low temperature metamorphic origin

Decompression Plagioclase Rims around Metastable Kyanite Crystals in Moldanubian Granulites – a Clue to Equilibration Volumes in Water-Deficient Metamorphic Rocks

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Modern techniques of thermodynamic modeling and metamorphic condition estimates are critically dependent on knowledge of the effective bulk composition of the system in question. In the case of fluid-saturated rocks, the effective bulk composition is generally well approximated by the composition obtained by conventional whole-rock analysis. However, metamorphic reactions in water-deficient high-grade rocks, such as peridotites and granulites, are limited by chemical diffusion. In this case, the equilibration volume is small and the effective bulk composition must be estimated by other methods. Here we develop a method that is applied to constrain the equilibration volume and effective bulk composition that was relevant to the formation of a texture that evolved Moldanubian granulites as consequence of decompression.

The texture is manifest by plagioclase rims around metastable kyanite crystals. The domains over which this texture develops are often silica-undersaturated and contain mineral phases typical of low pressure/high temperature (LP/HT) metamorphism (spinel or corundum). These features also occur in felsic granulites collected in the NE corner of the Strážek Moldanubicum (Bohemian Massif). There, the high pressure (HP) mineral assemblage is composed of Grt-Ky-Bt-Plg-Kf-Qtz, but commonly kyanite is replaced by sillimanite suggesting the stabilization of the low pressure assemblage Grt-Sill-Bt-Plg-Kf-Qtz. In many low pressure (LP) samples, crystallization of plagioclase completely isolates metastable kyanite grains from the matrix.

In typical HP samples, kyanite is in direct contact with quartz and K-feldspar. Matrix is composed of randomly ordered small plagioclase (An_{18}), quartz and K-feldspar. Garnets are randomly distributed in the rock with no particular affinity with the kyanite domains. In several HP samples paragenetically early plagioclase coronas rim kyanite grains. In these samples it is possible to observe both reactants – quartz and kyanite – producing the plagioclase rim. In LP samples, kyanite grains are never in contact with quartz. The plagioclase is zoned, ranging from An_{22} at the kyanite side to An_{16} near the quartz side, in a radial thickness of 200–250 µm. This 'compositional gradient' is represented by an Al-rich/Si-poor and a Si-rich/Al-poor domain in the plagioclase that masks the primary contact between kyanite and quartz. The kyanite breakdown was not isochemical because the formation of plagioclase corona requires addition of Ca and Na to the Si and Al donated by reacting kyanite and quartz. Mg and Fe must also be supplied to the domain to form spinel and biotite.

Textural relationships indicate that plagioclase grains have partially replaced kyanite and that the formation of plagioclase aggregates between kyanite and quartz suggests reaction: $1Ky + 0.686\ Qtz + 0.965\ CaO + 3.435\ Na_2O = 1.462\ Plg$. For our analysis, Na and Ca are treated as mobile species because they must have been supplied from outside of the domain, and it is assumed that diffusion driven by chemical potential gradients was the main transport mechanism of these components. Although Na and Ca have high diffusion coeffiecients, the plagioclase coronas are thin (200 µm) and were probably limited by low diffusivities of Al and Si (Mongkoltip et al. 1983). These latter cations were thus relatively immobile and controlled the size of the plagioclase rim. Na and Ca must have been released from former plagioclase distributed in the matrix surrounding the kyanite crystals because plagioclase is the only phase containing the Na_2O component and its availability thus controls the development of the domain. This process was modelled thermodynamically (Connolly 1990) assuming local equilibrium. The resulting composition diagrams enables estimation of the equilibration volume around each kyanite grain, i.e., the matrix volume required to supply the nutrients Na and Ca.

The results indicate equilibration volumes that extend ~400 to 500 µm around each kyanite. This is in good agreement with results from image analysis that shows significant depletion of the matrix in plagioclase around kyanite crystal on this spatial scale. Our results demonstrate that modelling of diffusion-driven metamorphic reactions requires careful estimate of equilibration volume because of the limited scale of equilibration at fluid-absent conditions.

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Correlation of Structural and Metamorphic Evolution of Metamorphic Rocks from the Svratka and Polička Crystalline Complexes

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In the present study, we considered a record of the tectono-metamorphic evolution of the high-grade metamorphic rocks from the south-eastern part of the Polička crystalline complex (PCC) – Vír area (VA). In addition, we compared our new data with the evolution of less metamorphic rocks (paragneisses, mica-schist and metagranites) from the western part of the PCC and the Svratka Crystalline Complex (SCC). The VA unit is composed of felsic to mafic granulites and high-grade migmatites and is surrounded by layers of anatectic amphibolites which lithologically contrast with the surrounding mica-shists and paragneisses. The dominant fabric observed in high-grade rocks from VA is represented by steeply dipping SW to NE metamorphic foliation. This foliation is sporadically overprinted by moderately dipping NE foliation accompanied by gently to moderately plunging NW–NNW stretching lineation and thrusting kinematic indicators. These younger structures were also detected as a dominant fabric in the central and western part of the PCC and in the central and eastern part of the SCC.

In the high-grade rocks, we have observed a succession of stable mineral assemblages, which can be described as follows. Samples from the central part of the Vír body represent the felsic granulites with stable mineralogy Grt-Ky-Bt-Plg-Kf-Qtz within the sub-vertical foliation. This mineral association is comparable with high pressure granulites in the Moldanubian zone of the Bohemian massif. More often, granulitic samples show extensive conversion of kyanite to sillimanite, suggesting stabilization of the mineral assemblage: Grt-Sill-Bt-Plg-Kf-Qtz. In several samples from the younger foliation, we observed a stable association of hercynite with quartz. Crd is absent in all the samples, which can be explained by higher amounts of Zn in spinels, which extends the stability field of hercynite with quartz towards lower temperatures. In the northern part of the body, the felsic granulites are surrounded by layers of mafic to intermediate granulites, with the stable mineral assemblage Cpx-Opx-Grt-Plg-Kfs-Q corresponding to the early steep fabric. It is obvious from the bulk composition that the felsic varieties are highly depleted in CaO. These samples contain albitic plagioclases and garnets with a maximum of 6 % of grossular contents in the core which makes the peak PT estimates difficult. More suitable samples consist of mafic granulites from this area, where preliminary peak PT conditions for the Cpx-Opx-Grt-Plg-Kfs-Q association were estimated at about 850–900 °C and 13–14 kbar using the pseudosection approach with the PERPLE_X thermodynamic software set (Connolly 1990). In addition, we have calculated the preliminary PT conditions for the mica-shists and paragneisses of the SCC. They show maximum pressures in a range of 7–9 kbars at about 680 °C.

Based on our structural data and the results of thermodynamic modelling from high-grade rocks (VA), mica-shists and paragneisses from PCC and SCC, we assume that HP/HT metamorphic conditions (850–900 °C and 13–14 kbar) in granulites reflect the early stage of the high-grade evolution of the PCC (VA). On the contrary, the petrological study of the mica-shists in the SCC (7–9 kbars and ~680 °C) shows that these rocks never experienced such HP/HT conditions.

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