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Growth mechanisms for decompression plagioclase rims around metastable kyanite from high-pressure felsic granulites (Bohemian Massif): A thermodynamic approach

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Samples of high-pressure felsic granulites from the Bohemian Massif (Variscan belt of Central Europe) characterized by a peak metamorphic (high pressure) mineral assemblage of Grt-Ky-Pl-Kfs-Qtz±Bt contain various locally equilibrated domains which where developed during decompression around metastable kyanite crystals. The variability depends on the local source of important components in the vicinity of the metastable kyanite grain, which in some case, may result in crystallization of spinel or spinel-plagioclase symplectite if former garnet or biotite was present in the kyanite domain. All these domains are silica undersaturated and it was shown that plagioclase rim serves as an important barrier which conserves the silica undersaturated conditions and thus allows for further local crystallization of spinel. The present work is focused on the development of the plagioclase rim as the mineral reaction responsible for the formation of decompression plagioclase and the mechanisms that lead to the typical corona structures are still enigmatic. In particular, cases, where plagioclase crystals from the rock matrix are decomposed in the vicinity of metastable kyanite porphyroblasts and the so liberated components serve for crystallization of the decompression plagioclase rim at the kyanite interface, are puzzling, because the driving force for such material transfer in a system that is saturated with respect to plagioclase is not obvious.

The studied samples show well developed plagioclase reaction rims around kyanite grains in two microstructural settings where kyanite is randomly distributed in the polyphase matrix in one setting and enclosed within large perthitic K-feldspars in the other setting. Kyanite is regarded as a relic of an earlier high-pressure metamorphic assemblage, which became metastable during low pressure overprint. Plagioclase rims from both microstructural settings show continuous changes in composition from $An_{32/25}$ at the contact to kyanite to $An_{20/19}$ at the contact to the matrix or to the K-feldspar respectively. Mass balance considerations show that either only a small amount of kyanite or no kyanite was consumed to provide the Al_2O_3 component for the plagioclase growth. In majority, Al_2O_3 and SiO_2 were supplied together with CaO and Na_2O from the surrounding matrix material. A thermodynamic analysis reveals that kyanite became metastable at the interface with the host perthite at pressures as high as the peak metamorphic pressure and therefore the plagioclase rim started to grow immediately at high-pressure conditions. On the contrary, kyanite remained stable in the polyphase matrix down to pressures of about 16 kbar and started to grow only at a relatively late stage during the decompression. The chemical variation across the plagioclase rim from more anorthitic at the kyanite interface to more albitic at the interface to the host or matrix is similar for both microstructural settings. From the phase equilibria point of view, the most anorthitic part of the rim (i.e. the inner part) should have crystallized under lower-most pressure conditions. The epitactic nature of the plagioclase rim however indicates outward growth which is documented by the inheritance of structural elements form the host feldspar. A kinetic fractionation model is suggested here to explain the chemical zoning across the rim.