Geol. Paläont. Mitt. Innsbruck, ISSN 0378–6870, Band 25, S. 1–242, 2001

THE P-T-t-D EVOLUTION OF CRETACEOUS METAMORPHISM IN THE CENTRAL SCHNEEBERG COMPLEX (EASTERN ALPS, ITALY/AUSTRIA): ANDALUSITE-FORMATION DURING DECOMPRESSION

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The metamorphic evolution of the Upper Austroalpine Schneeberg Complex (SC) in the southern Ötztal basement comprises pressure-dominated metamorphism with subsequent static (re)crystallization (KONZETT & HOINKES, 1996). This metamorphic event is correlated with eclogite facies metamorphism in the SE Ötztal crystalline basement S of the SC.

New findings of andalusite in the „Monotone Serie" (garnet-micaschists from the core of the SC synforms) allow to constrain the metamorphic evolution after the pressure peak. An interdisciplinary (petrological, geochronological and structural) investigation of metapelites was performed to decipher the tectonometamorphic evolution of the central SC.

Metapelites from the "Monotone Serie" have a common whole rock (WR) composition with mainly insignificant Ca and Mn content. They can be described in the KNFMASH (+ms +qtz $+H_2O$) system, with Ab and Pg representing the only Na-bearing phases. The Al_{WR}-content varies locally and allows a distinction of Al-rich (Als-bearing) and Al-poor (Als-free) metapelites.

A continuous succession of four mineral (re)crystallization phases (K1 to K4) is recorded by compositional zoning of mineral phases and microstructures. K1 minerals grew syn-, inter-, and/or postkinematically relative to D1 (mylonitisation and penetrative microfolding with NW to WSW dipping stretching lineations and fold axes). K2 minerals formed synkinematically relative to D2 (large-scale tight S-vergent folds with E-W-striking fold axes), while K3 and K4 are characterized by static mineral growth, which took place postkinematically relative to D2.

Al-rich metapelites:

K1: Idioblastic Grt1 is the only Ca-bearing phase (Xgrs = 0.12), with slightly increasing X_{Mg} $=Mg/(Mg+Fe^{2+})$ from core to rim. Inclusions are fine-grained Qtz, Ilm, Mt and rare Ab and St. The matrix contains phengitic WM1 (Si^{IV} 3.20–3.23 per 11 oxygens), Pg, Qtz, Bt, Chl, Ky, Ab and Ilm.

K2: Grt2 formed idioblastic rims around Grt1, with decreasing Ca-content and X_{Mg}-ratio. A second Mn maximum in Grt reflects Chl-breakdown by overstepping the KFMASH univariant reaction grt+chl+ms = bt+st+qtz+H_2O. Coarse-grained Ky2 and St2 grew due to Pg-breakdown. The matrix consists of phengitic WM2 (Si^{IV} 3.15–3.18 per 11 oxygens), Qtz, Bt, Pg, Ab and Ilm.

K3: Mineral growth continued postkinematically to the ductile deformation. Idioblastic Grt3 rims display again increasing X_{Mg}, at further decreasing Ca-content. Coarse-grained Bt, Ab and Ky as well as medium-grained St (re)crystallized in the matrix.

K4: Dm-sized andalusite grew along with oligoalbite by Pg-breakdown, as indicated by reaction rims of Pl between andalusite and the matrix.

Al-poor metapelites:

In contrast to the Als-bearing rocks, Al-poor metapelites only show the first garnet generation (Grt1). During K2 and K3 garnet was resorbed. St is rarely present, and aluminosilicate does not occur.

PT-conditions:

Phase equilibrium calculations with the program THERMOCALC (POWELL & HOLLAND, 1988, HOLLAND & POWELL, 1998) show, that the garnet stability in andalusite-bearing rocks is confined to conditions near the pressure peak (at P > 0.7GPa). New data concerning the pressure peak correlate with the results of Konzett & Hoinkes (1996; 580–600°C/0.8–1GPa). The K1 assemblage formed in the KFMASH-divariant field Grt–St–Chl. Due to local variations of the equilibrated WR composition, the assemblages Ky–Chl–St locally have been stable in the matrix surrounding Grt, and a first Bt generation was formed in Al-poor domains. First Ky-formation obviously was a product of continuous reactions in the KFMASH-system rather than Pg-breakdown, which is probably the main Ky-forming reaction in the SC, as described in the literature (HOINKES, 1981).

At the onset of decompression (=K2-D2), the KFMASH-univariant reaction Grt+Chl+Ms = St+Bt+Qtz+H_2O was overstepped, leading to the stability of the divariant assemblage Grt–St–Bt. This reaction induced the disappearance of Chl, indicated by a second Mn maximum in Grt2, and an increase in St modal abundances. For an H_2O-activity of 1 this reaction occurs at about 600°C/0.75GPa. This mineral reaction may have also been induced by a reduction of the H_2O-activity during the first decompressional stage, which would shift the dehydration reactions towards lower T-conditions. Assuming a reduced H_2O-activity of 0.7, the univariant Chl-breakdown reaction would have taken place at about 565°C/0.75GPa.

Postkinematic mineral formation already started in the divariant field Grt–St–Bt (=K3). Grt3 shows a continuous but significant increase of X_{Mg} towards the rim. During decompression this zonation may be explained by continuous reduction of the H_2O-activity, as the $X_{Mg}{}^{Grt}$ isopleths have a very shallow positive slope in the Grt–St–Bt field and are therefore rather T-insensitive. Coarse-grained Ky and Ab overgrew the D2 structures statically due to the Pg-breakdown-reaction Pg+Qtz = Ab+Ky+H_2O. During nearly isothermal decompression the KNFMASH-divariant mineral reaction Bt+Pg+Qtz = Ab+St+Ms+H_2O probably took place, which led to the reequilibration of Bt and St with higher X_{Mg} than the previous assemblage with Grt3. It is important to note, that the Grt3 rim does not show any diffusional reequilibration, retrograde zoning or corrosion.

A second phase of static mineral growth took place in the andalusite stability field, where the Pg-breakdown reaction to Als and Pl continued, now producing coarse-grained andalusite. As Bt is part of the stable assemblage with andalusite instead of Chl, T-conditions higher than about 500°C (aH_2O=0.5) to 540°C (aH_2O=1) are required at low-pressure (0.2–0.4GPa). As the only observed univariant mineral reaction in the andalusite stability-field is the Pg-breakdown reaction, the absolute metamorphic conditions at the low-pressure stage are strongly dependent on the H_2O-activity.

Geochronology

In order to constrain the age of metamorphism, 0.5–1cm sized garnet grains were used for Sm-Nd geochronology. The Fe-poorer fraction (= Grt1) yielded 94.1±2.2 Ma, the Fe-richer fraction (= Grt2/3) 92.7±1.2 Ma. The period of garnet growth therefore ranges between 96.3 and 91.5 Ma, constraining an eo-Alpine age for the metamorphic peak and the major deformation phases. Eo-Alpine cooling below 300°C is indicated by a Bt-whole rock Rb-Sr age at 79.5±0.8 Ma, derived from the same sample.

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