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THE APPLICATION OF THE GIBBS-METHOD TO GARNETS FROM THE BASEMENT WEST OF THE TAUERN WINDOW (ÖTZTAL-STUBAI CRYSTALLINE COMPLEX, SCHNEEBERG COMPLEX): INFORMATION VERSUS PRECAUTION

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The dominant amphibolite-facies Variscan and eclogite facies Alpine metamorphic event in the Austroalpine Ötztal Stubai basement complex (ÖSBC) and the Schneeberg Complex (SC) was studied on a large scale by means of interpretations of different zonation types in garnets in combination with *P-T* estimates, based on multi-equilibrium methods.

The Variscan metamorphic event can best be studied in the northwestern part of the ÖSBC, because further to the southeast, the grade of the subsequent Alpine metamorphic overprint increases, culminating in eclogite facies conditions in the SC. The investigations of the different types of garnet zoning yields two major groups of zonations: (1) continuous and (2) dicontinuous zoning types. The first type appears in most samples of this investigation, displays the typical "bell-shaped" elemental distribution with Ca- and Mn-rich cores and can clearly be related to the dominant Variscan overprint. The second type only occurs in samples from the southeastern part of the ÖSBC, adjacent to the Schneeberg Complex. This type is clearly related to the poly-metamorphic history, thus providing informations about the Variscan and Alpine event. Furthermore almost all garnets display a Mn-enrichment in the rims, related to later retrogression. The Mn enrichment is strongest in the western part of the ÖSBC and decreases towards the southeast, thus samples adjacent to the Schneeberg Complex lack the Mn enrichment in the rims. The depth of this enrichment also shows a positive correlation with the diameter of the garnets.

The investigated metapelites contain the assemblage garnet + staurolite + biotite + muscovite + plagioclase ± kyanite ± sillimanite ± andalusite were used to reconstruct pressure and temperature conditions with multi-equilibrium methods. During the Variscan metamorphic event, kyanite was the stable Al_2SiO_5 polymorph, and conditions of 470–710°C and 4–9 kbar were derived for garnet rim compositions, whereas no regional P-T trend could be found for the Variscan metamorphic overprint. Adjacent to the Schneeberg Complex, pressures increase at 8–9 kbar due to the subsequent eclogite facies Eo-Alpine overprint. Textural and chemical data clearly indicate a continuous pre-Alpine and Alpine metamorphic evolution.

In a metamorphic system mineral composition is a function of pressure and temperature and therefore it is possible to model pressure and temperature by using mass balance considerations within a mineral assemblage and compositional variables. The calculation requires the compositions and modal proportions of the mineral assemblage and a starting condition, which has been obtained by thermobarometry (SPEAR 1993). The computer software GIBBS (SPEAR et al. 1991a) has been applied to six samples with variably zoned garnets so far. The obtained thermobarometric estimates for garnet rim compositions range from 469°C and 4.2 kbar to 630°C and 7.3 kbar and were used as starting conditions. The Mn-enriched rims were excluded from the calculations, when no definitive sign of growth zonation (e.g. decrease in CaO) occurred

with the increase in MnO. The P-T path has been modeled with the compositions of the garnets by using X_{Alm}-X_{Gro}, X_{Alm}-X_{Spe} and X_{Sps}-X_{Gro} pairs as compositional variables. The results show no definitive answer. In most samples (Ö-492, Ö-526, 91-3), pressure increases with decreasing temperature in the first steps of the calculated path. Afterwards no general trend could be found. Two samples show an increase in pressure with temperature (II-91, P8-b), which is contrary to the results obtained BY TROPPER & HOINKES (1996), PERGHER (1997) and ZANGERL (1997). Sample 80-77 shows a decrease in pressure with a decrease in temperature, followed by a strong increase in pressure again. Since there is no information on the equilibrium assemblage during garnet growth because of the lack inclusion assemblages, the quantitative information obtained from these calculations must be considered with caution.

References

PERGHER, L. (1997): Kristallingeologische und petrologische Untersuchungen im vorderen Pitztal (Wildgrat, Zaunhof, Aifenspitze). – Unpubl. Ms. Thesis, University of Innsbruck, 87 pp.

SPEAR, F.S. (1993): Metamorphic Phase Equilibria and Pressure – Temperature – Time Paths. – Mineralogical Society of America, Monograph, Washington DC, 799 pp.

TROPPER, P. & HOINKES, G. (1996): Geothermobarometry of Al_2SiO_5-bearing metapelites in the western Austroalpine Ötztal-basement. – Mineral. Petrol., **58**, 145–170.

SPEAR, F. S, PEACOCK, S. M , KOHN, M.J., FLORENCE, F.P. & MENARD, T. (1991): Computer programs for petrologic P-T-t path calculations. – Am. Mineral., **76**, 2009–2013.

ZANGERL, C. (1997): Kristallingeologische und petrologische Untersuchungen im vorderen Pitz- und Kaunertal. – Unpubl. M.S. Thesis, University of Innsbruck, 101 pp.

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