DURATION OF EO-ALPINE METAMORPHIC EVENTS OBTAINED FROM MULTI-COMPONENT DIFFUSION MODELING OF GARNET: A CASE STUDY FROM THE EASTERN ALPS

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Metamorphosed pelitic rocks from the Mica schist-Marble Complex of the Wölz Tauern, which are part of the middle Austroalpine unit, contain large (up to 2 cm) garnet crystals that show clear evidence of two stage growth. Isotopic dating indicates that a Variscan (~270 Ma) garnet core was overgrown by new garnet formed during Eo-Alpine metamorphism at Cretaceous times. The Pre-Alpine garnet in core has lower Ca and Mg (Alm_{71-83}, Grs_{3-16}, Sps_{0-15}, Prp_{5-9}) compared to the Eo-Alpine rim (Alm_{71-82}, Grs_{4-24}, Sps_{0-2}, Prp_{10-21}) and higher Mn. P-T conditions obtained using the method of pseudosections (POWELL & HOLLAND, 1998) for the Eo-Alpine metamorphism indicate a clockwise P-T path from 540 °C / 7.5 kbar to 600 °C / 10 kbar followed by cooling and exhumation to 540 °C / 4 kbar. These P-T conditions are consistent with earlier results from independent thermobarometry applied to metapelites and adjacent amphibolites (FARYAD & HOINKES, 2003). Due to the large size of the garnets, growth zoning was preserved during amphibolite facies metamorphism at both Variscan and Alpine times. The multicomponent diffusion profiles measured in the microprobe in the Alpine and Pre-Alpine garnets have been modeled using the approach, proposed by CHAKRABORTY & GANGULY (1991). Diffusion coefficient was calculated for Mn, Mg and Fe, where Ca was treated as dependent component. The advantage of such simultaneous calculation is that it allows subtle details of variations in compositional profiles to be interpreted and considerably reduces the uncertainty in retrieved time scales that may be obtained from using only one profile. The modeling suggests that a minimum subduction / exhumation rate of ~ 4 cm / a and heating / cooling rates on the order of 100 – 260 °C / Ma for a 60 ° subduction angle are required to preserve the observed compositional zoning overall while modifying the zoning at the interface between two garnets to the extent observed. Such rapid rates of burial / exhumation are consistent with results of direct GPS measurements of convergence rates at several orogenic belts as well as with inferred rates from modeling several generations of tectonic processes in the Alps and other areas. In combination, this indicates that such rapid rates during some stage of evolution of an collisional orogen where high pressure metamorphism occurs are the rule rather than the exception and places important constraints on the rheological behavior of crustal blocks in such orogens

References

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