Subduction and exhumation rates in crustal rocks from textural relations and diffusion modelling

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We have carried out multicomponent diffusion modelling of zoned garnets from metamorphic rocks in two different terrains with different thermal evolutions: the Austroalpine units from HP amphibolite facies and the Bohemian Massif that experienced eclogite/granulite facies conditions. Metamorphosed pelitic rocks from the middle Austroalpine units in the Eastern Alps contain large Variscan garnet crystals overgrown by new garnet formed during Alpine metamorphism at Cretaceous times. The Pre-Alpine garnet in core has lower Ca and Mg compared to the Eo-Alpine rim. The rim garnet was formed due to a medium grade metamorphism with clockwise P-T path history from 540 °C /7.5 kbar to 600 °C /10 kbar, followed by cooling and exhumation to 540 °C /4 kbar. Multicomponent diffusion profiles measured in the Alpine and Pre-Alpine garnets have been modeled and simulated for a time scale associated with the observed P-T path. The modeling suggests that a minimum subduction / exhumation rate of ~ 4cm/a and heating / cooling rates on the order of 100 - 260°C/Ma for a 60 °C 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.

The Bohemian Massif as part the European Variscid contains numerous occurrences of garnet peridotite, eclogite and high-pressure felsic granulite, indicating subduction and subsequent collision. Eclogites are present both with garnet peridotite and granulite and are affected briefly by granulite facies overprint. The rocks under investigation come from the Moldanubian zone east of Prague. Prograde history of the rocks is preserved only locally in eclogites. Garnet from eclogite shows prograde growth zoning with increase of X_{Mg} and decrease of Ca, but similar to the homogeneous garnet from granulites, the rim part is effected by diffusion during cooling. Diffusion modeling of these garnets indicate cooling from maximum temperatures and show strong relations to textural varieties and reaction products formed during their exhumation. In spite of granulite facies metamorphism, mineral-reaction history and diffusion modeling indicate a relatively fast cooling that mostly occurred in the kyanite stability field.

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