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An inverse modeling strategy and a computer program to model garnet growth and resorption

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GrtMod is a computer program that allows numerical simulation of the pressure-temperature (P-T) evolution of garnet porphyroblasts based on the composition of successive growth zones preserved in natural samples. For each garnet growth stage, a new reactive bulk composition is optimized, allowing for resorption and/or fractionation of the previously crystalized garnet. The successive minimizations are performed using a heuristic search method and an objective function that quantify the amount by which the predicted garnet composition deviates from the measured values. The automated strategy of GrtMod includes a two stages optimization and one refinement stage.

In this contribution, we will present several application examples. The new strategy provides quantitative estimates of the optimal P-T conditions whereas it was generally derived in a qualitatively way by using garnet isopleth intersections in equilibrium phase diagrams. GrtMod can also be used to model the evolution of the reactive bulk composition along any P-T trajectories. The results for typical MORB and metapelite compositions demonstrate that fractional crystallization models are required to derive accurate P-T information from garnet compositional zoning. GrtMod can also be used to retrieve complex garnet histories involving several stages of resorption. For instance, it has been used to model the P-T condition of garnet growth in grains from the Sesia Zone (Western Alps). The compositional variability of successive growth zones is characterized using standardized X-ray maps and the program XMapTools. Permian garnet cores crystalized under granulite facies conditions (T > 800°C and P = 6 kbar), whereas Alpine garnet rims grew at eclogite facies conditions (650°C and 16 kbar) involving several successive episodes of resorption. The model predicts that up to 50 vol% of garnet was dissolved before a new episode of garnet growth.