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Determining PT paths from garnet zoning using a brute-force computational method

Hans Vrijmoed and Brad Hacker
UC Santa Barbara, Earth Science, Santa Barbara, United States (hvrijmoed@geol.ucsb.edu)

Reconstruction of the pressure-temperature (P-T) path a rock experienced during its metamorphic history is fundamental to the understanding of orogenic processes. By careful examination of petrographic textures, mineral assemblages and compositions, the P-T path of metamorphic events may be derived. Garnet is particularly useful because it is important in barometry, its activity models are well understood, and slow diffusion allows preservation of the compositions developed during its P-T evolution. In principle (e.g., the Gibbs method of Spear and Selverstone), the garnet compositional variation can be inverted to derive the P-T path.

Another approach is to take advantage of the speed of thermodynamic calculators and simply calculate mineral modes and zoning for possible P-T paths and then compare to the mineral modes, textures, and zoning preserved in rocks. We do this using PerpleX and a simple Matlab script. The input parameters are the rock bulk composition, final P-T condition, the range of possible P-T starting conditions, the mineral modes, the garnet zoning, and activity models. The calculations are completed assuming complete fractionation of the garnet from the rock bulk composition. The output is the mineral modes and the garnet zoning. The calculated compositional zoning patterns are then compared to the measured mineral compositions and the best fit is found by the sum of squares. The initial results indicate that combining Mg#, Ca, and Mn zoning in garnet with mineral modes yields precise constraints on the PT path of the rock. This promises to be a powerful new tool in the reconstruction of P-T paths from metamorphic rocks.