Dating prograde eclogite-facies metamorphism by trace-element transfer from epidote to zircon

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Zircon U–Pb and garnet Lu–Hf and Sm–Nd radiogenic isotope systems are the primary tools to track the chronology of eclogite-facies metamorphism in orogenic collisions. Zircon is advantaged by facility for rapid, spatially controlled, and acceptably precise measurement of U–Pb and trace elements by laser ablation ICPMS technologies. Its sensitivity to trace-element equilibria with garnet and plagioclase is widely utilized but chemical influences from epidote ± titanite equilibria are less explored. Combining time-integrated trace-element patterns in zircon with modal and *P*–*T* constraints from phase equilibrium modeling may resolve burial rates during prograde–peak metamorphism beyond precisions attainable by garnet chronological techniques.

Epidote consumption during prograde metamorphism in mafic rocks grows garnet and omphacite, and releases MREE (Gd–Er) and Y (Konrad-Schmolke *et al*., 2008). Mantles and rims of garnet are frequently enriched in these elements, and chondrite-normalized garnet REE patterns in many studies evolve toward a concave shape centered on the MREE. Zircon–garnet distribution coefficients for the MREE are between 1–10 at P > 2 GPa and T < 800ºC (Rubatto & Hermann, 2007), hence equilibrium growth or recrystallization of zircon during epidote breakdown could also find MREE more available relative to HREE. Hump-shaped M–HREE profiles are also notable in many eclogite zircon datasets; our hypothesis is that these might also catalog local consumption of epidote. This provides another monitor—in addition to Eu uptake from disappearing plagioclase—to usefully narrow the *P*–*T* significance of an “eclogite-facies age”.

We evaluate epidote–garnet–zircon systematics in several eclogites from the Western Gneiss Region of Norway. Robust MREE+Y redistribution from disappearing epidote to garnet mantles ± rims occurred in all samples during prograde metamorphism. Laser ablation split-stream analysis of accompanying zircon, however, yields variable indications of MREE fractionation relative to HREE across different samples. We discuss the potential controls of bulk composition, burial/heating paths, and metamorphic texture upon this indicator and recommend approaches to optimize its detection.

Konrad-Schmolke, M., Zack, T., O'Brien, P. J., Jacob, D. E., 2008. Combined thermodynamic and rare earth-element modelling of garnet growth during subduction: Examples from ultrahigh pressure eclogite of the Western Gneiss Region, Norway. *Earth and Planetary Science Letters* 272, 488–498.

Rubatto, D., Hermann, J., 2007. Experimental zircon/melt and zircon/garnet trace element partitioning and implications for the geochronology of crustal rocks. *Chemical Geology* 241, 38–61.