In-situ U-Pb dating of metamorphic garnet and accessory phases

L.J. MILLONIG[1], R. ALBERT[1*], A. GERDES[1], D. AVIGAD[2], C. DIETSCH[3], J.J. AGUE[4]

[1]Dept. of Geosciences, Goethe University Frankfurt, Germany, (*correspondence: albertroper@em.uni-frankfurt.de)
[2]Institute of Earth Sciences, Hebrew University of Jerusalem, Israel
[3]Dept. of Geology, University of Cincinnati, Cincinnati, Ohio, USA
[4]Dept. of Geology & Geophysics, Yale University, New Haven, USA

Due to its stability over a wide range of pressure-temperature (P-T) space and bulk rock compositions, garnet is the most widely used major metamorphic phase in geothermobarometric studies. In complementary work, garnet has been used as a geochronometer using Sm-Nd, Lu-Hf and, rarely, U-Pb dissolution techniques. However, in situ dating techniques, which provide texturally constrained ages and enable the detailed reconstruction of P-T-time paths of metamorphic rocks, have not been applied to regional-metamorphic garnet thus far.

In this study we applied LA-ICP-MS U-Pb dating to metamorphic garnet and accessory phases from The Straits Schist, Connecticut, located in the western New England (Appalachians). Our results indicate that garnet from two metapelitic samples grew at 408 ± 10 Ma and 406 ± 15 Ma (2σ). Furthermore, the oldest U-Pb ages obtained from metamorphic zircon, monazite and xenotime, are ~395-385 Ma, with monazite and xenotime U-Pb ages extending to ~360 Ma. Considering that garnet from The Straits Schist grew over a temperature range of ~200-300 °C, the combined data set is interpreted to indicate that prograde garnet growth commenced as early as ~410 Ma, during the onset of the Acadian orogeny, and lasted until ~390 Ma, when peak metamorphic conditions were reached. Garnet growth over several tens of million years is consistent with average heating rates of 5-15 °C/Ma, as inferred for collisional orogens. Monazite and xenotime U-Pb ages of ~390-360 Ma indicate mineral growth, or partial resetting of the U-Pb system, during prolonged slow cooling.

Our study demonstrates that U-Pb dating of garnet by in situ techniques can provide important time constraints about the prograde evolution of metamorphic rocks, which may not be available from the accessory phases.