Zircon/garnet trace element partitioning: a tool for P-T-time paths.

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Garnet is the most commonly used mineral in thermobarometry, whereas zircon is the most robust chronometer to date high-grade metamorphic rocks. Empirical studies have shown that zircon and garnet growth can be correlated via the trace element partitioning between the two minerals.

Piston cylinder experiments were performed at 20 kbar and 800-1000°C in a synthetic system doped with trace elements. The main phases in the experiments are hydrous granitic melt, garnet and zircon. Direct trace element measurements with LA-ICP-MS were possible for garnet and melt. Zircon was too small in size to analyse and its composition was calculated from mixed zircon-melt analyses. A number of tests were performed to validate this approach, which was proven to return accurate concentrations. Partitioning was calculated for garnet and zircon within the same experiment, or from two experiments with similar composition that were run at the same conditions. Data indicate that zircon contains significantly more heavy-REE than coexisting garnet at temperatures of 800-850°C. Zircon/garnet partition coefficients of HREE decrease with increasing temperature; for example the partitioning for Lu varies from 12 at 800°C to 1.4 at 1000°C. Middle-REE partitioning is close to unity for the whole investigated temperature range. There is some evidence that zircon contains more light-REE than garnet.

Different empirically determined zircon/garnet partition coefficients from granulite and ultra-high temperature granulites can thus be explained by the experimentally determined change of partitioning as a function of temperature. The trace element partitioning data provide a tool to establish equilibrium partitioning between garnet and zircon in natural rocks and can assist the construction of detailed pressure-temperature-time paths in high-grade metamorphic rocks.