Experimental determination of trace element partition coefficients between zircon, garnet and melt

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The problem of relating ages, as calculated by zircon U-Pb geochronology, to processes and hence geoological events is central to understanding mountain building and crustal evolution. Accurate P-T-t paths can only be produced if zircon growth can be linked to specific rock and mineral processes used to establish pressure and temperature values for metamorphic episodes.

As a major metamorphic mineral in crustal events, garnet is widely used as a thermobarometric tool, and linking garnet growth to zircon formation could be used to refine the interpretation of U-Pb ages.

Attempts to resolve this issue have focussed on REE partitioning between zircon and garnet, both of which strongly incorporate the HREE into their structure, and so it is possible there is a distinct REE partitioning signature which will highlight whether the two minerals have grown at the same time. There are two complementary methods to obtaining this information, empirical and experimental.

Empirical methods of determining this signature using carefully selected rocks have proved troublesome, with a wide range of partitioning signatures found.

This project has used experimental techniques to produce zircon-melt, garnet-melt and zircon-garnet-melt partition coefficients at a range of P-T conditions in melt compositions relevant to natural rocks. Zircon and garnet are grown in trace element equilibrium with a water-undersaturated granitic melt, which represents partial melts formed in the lower crust during anatexis. Temperature ranges from 850°C to 1050°C at a pressure of 5Kbar were produced using internally heated gas apparatus. Trace element concentrations were measured using SIMS analysis at the Ion Microprobe Facility at the University of Edinburgh.

The experimental data produced will be applied to interpret chemical signatures of zircon in garnet-bearing metamorphic rocks, and will provide an objective basis for interpretation of the timing of growth or recrystallisation of zircon in many high-grade terrains.

New insights into peralkaline magma chamber processes in the Naivasha area, Kenya Dome

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The Naivasha area, located in the central Kenya rift, comprises three quaternary-recent peralkaline salic volcanic complexes: the caldera Longonot volcano, the Great Olkaria Volcanic Complex, and the Eburru Volcanic Complex (EVC) [1].

In order to further constrain the genesis of peralkaline magmas in this area, the most recent EVC peralkaline trachytes and rhyolites have been the subject of an integrated multi-isotope approach (Sr, Nd, Hf, Pb, U/Th, Rb/Sr, Ar/Ar) coupled with major and trace elements. A model is presented in which an OIB-like parental magma undergoes extensive Assimilation-Fractionation-Crystallisation (AFC) in the upper crust. Subsequent feldspar-dominated fractionation in an upper crustal reservoir increases the peralkaline character of the evolved magma, resulting in isotopic disequilibrium between amphibole, clinopyroxene, feldspars and glass. Pb and Sr isotopes show that the feldspar is the first major phase to crystallise, prior to amphibole and/or clinopyroxene. The oldest rhyolites (<400ka) are succeeded by trachytes (150-95ka) and rhyolites (65-7ka). This temporal evolution is associated with decreasing Sr isotopes ratios (0.7089-0.7047), suggesting the establishment of a mature magmatic plumbing system, preventing extensive crustal contamination. In addition, timescales of magma production and residence in the crust will be discussed using combined Rb/Sr, U-series and Ar/Ar data.

References

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