Trace element variation in young igneous zircon on the micron scale suggests shared histories

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Zircon has become an essential tool for examining the timescales of magmatic processes. Through U-Pb and U-Th anaylses of zircon, we have been able to peer into long- and short-term processes such as crystallization, recycling and assimilation in magmas. However, although the zircon ages have added constrains to how we perceive these magmas, it has also opened the question of what the age distribution of zircon represents and what other information can be gleaned from the compositional variation within single zircons. This study of zircon from the 1305 A.D. Kaharoa eruption of Tarawera Volcano, New Zealand finds that the trace element variation within a single zircon can be large, but it is possible to correlate the variation between zircon grains, allowing for an examination of the processes within the magma system during the growth and storage of the zircon population.

Ages derived from ^{230}Th-^{238}U analyses via SHRIMP-RG in the Kaharoa rhyolite show a protracted history recorded in zircon, from within error of the eruption age to greater than 300 k.y. This is in contrast to the bulk plagioclase ages from ^{226}Ra-^{230}Th-^{238}U analyses that are within error of the eruption. A closer examination of the zircon ages reveal that only a small fraction (< 10%) are within error of the eruption age although the rhyolite is zircon-saturated. Electron microprobe trace element analyses (Hf, Y, Yb, U, Th, Dy, Sc and Lu) of a suite of zircon from the Kaharoa Rhyolite were performed. These zircon have a wide variation in trace element composition from the cores to the rims. Kaharoa zircon can be divided into two, age-indepedent populations, one with a complex trace element history, the other with simple trace elements history. Certain zircons of differing age appear to have similar trace element variations, indicating that the zircons have at least seen some of the same magmatic history. Hf is especially useful in tracking the history of the zircon and can be used a proxy of temperature in the magma. Most of the zircons analyses see a marked increase in Hf content from core to rim (as much as a 20% increase), suggesting that many of the Kaharoa zircon formed in hotter magmas and the last 10 microns of zircon crystallized in cooler conditions. This implies that the young growth component in the zircon may be housed in the last few microns of zircon and thereby obscured from most ion microprobe spot analyses.

Thermodynamic modelling of Cr-bearing garnets in diamond-bearing peridotites

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A new approach is presented for modelling Cr-rich peridotite compositions and garnet-spinel compositions found in diamonds and xenoliths at conditions relevant to the deep continental Earth. Using recent experimental data (e.g., Klemme and O'Neill 1997, Girnis *et al.* 1999, Klemme *et al.* 2000, Girnis *et al.* 2003, Klemme 2004, Klemme *et al.* 2005 [1-6]), it is now possible to calculate phase relations and mineral compositions relevant to pressures, temperatures, and compositions of the deep lithospheric Earth using free energy minimization techniques. Here we present calculated phase relations in Cr-rich mantle compositions from pressures of 20-60 kbar, and temperatures 800-1400°C. The model is successful at modelling a wide range of natural mineral compositions, which are found as xenoliths in diamond-bearing kimberlites from South Africa, and is illustrated using suites of Cr-rich xenoliths from near Kimberley, South Africa. The model can explain and quantify instances of garnet zonation in naturally occurring mantle rocks as a consequence of pressure-temperature re-equilibration without the need for metasomatic processes. This sheds further light on peridotitic diamond inclusions and their abundances, and allows further quantitative constraints to be applied to diamond-indicator mineral chemistry.

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