Zircon behaviour in hot orogens

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The definition of prolonged HT/UHT event histories in the deep interiors of hot orogens requires the use of mineral chronometers that are responsive to reactions occurring in the rocks and which have diffusional closure temperatures in exceess of the UHT range of interest (>900°C). Zircon is the most important of the small number of accessory minerals that fulfil these criteria, particularly as it may also provide information on temperature (Ti in zircon thermometry) and the context of its formation in relation to major mineral phases such as garnet (REE partitioning, O-isotopes). The processes that govern zircon behaviour in HT/UHT environments include zircon crystallisation from partial melts locally and transiently saturated in Zr; coupled dissolution-precipitation in the presence of both melts and fluids, often driven by mineral and mineral-melt-fluid reactions, and; zircon precipitation that is decoupled from in-situ dissolution (e.g. Zr exsolution from high-T rutile). Two examples that serve to demonstrate the variety of 'messages' that can be carried by zircon in UHT belts are presented here.

Very long-lived UHT is demonstrated for the Archaean Napier Complex, Antarctica, from U-Pb, REE and Ti microanalysis of anatectic zircons. UHT occurred from 2586±8 Ma at T > 914±28°C (Ti: 47±10 ppm) as recorded in one leucosome, to 2557±5 Ma for zircon in a second leucosome at T> 945±20°C (Ti: 59±9 ppm), and to 2510-2480 Ma in leucosomes crystallised at >850°C. Post-UHT cooling through 800°C at 2510-2430 Ma is recorded by lower-Ti irregular zircon rims. UHT metamorphism in the Napier Complex was prolonged: >950°C for at least 30 Ma, followed by slow cooling over 70-100 Ma at 2°C/Ma.

In the Trivandrum Block of India in-situ U-Pb and REE microanalysis of zircons, complemented by garnet and monazite chemistry, demonstrates initial crystallisation of skeletal-planar zoned zircons, with hollow tubular core regions in which micro- and nano-granite former melt inclusions are now preserved, under initially open-system conditions from ca. 570-550 Ma. Further precipitation of zircon to partially or completely infill the tubes occurred in equilibrium with melt, garnet and monazite only by 535 Ma – indicating some 40 Ma of melt migration and residence under HT/UHT conditions (860-940°C) in this hot orogen