Linking zircon age to metamorphic stage using U-Pb/REE depth-profiling of zircon combined with Lu-Hf garnet geochronology

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EGU2017-1568

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Motivation

Zircon is capable of recrystallising at any stage during metamorphism. Recrystallisation events are often preserved in thin (<10 μm) rims on inherited zircon grains in metamorphic rocks. Laser ablation split-stream (LASS) depth-profiling of unpolished zircon surfaces has enabled U-Pb isotopic and trace element analysis of these thin zircon domains. The potential value of this high spatial resolution method as a petrochronologic tool hinges on the question:

Can zircon depth-profile data be linked to specific metamorphic conditions and tectonothermal events?

We address this question by applying the depth-profiling method to zircon from amphibolite facies Alpine Schist (New Zealand) dated previously by Lu-Hf garnet geochronology and assessing (1) rare earth element (REE) partitioning between zircon and garnet; (2) independent constraints on the timing of garnet growth, and generation of anatexic pegmatites.

Geologic setting

The newly proposed geologic continent Zealandia is 94% submerged below sea level. U-Pb along the active Pacific–Australia plate boundary exposes the Alpine Schist accretionary wedge complex in the South Island. Zealandia was assembled at the paleo-Pacific–Antarctic margin during Mesozoic subduction. The Alpine Schist represents the metamorphosed sediments of the accretionary wedge complex, long thought to have been metamorphosed during Jurassic – Cretaceous subduction. New metamorphic dates show that the Alpine Schist record a complex history comprising coeval (or slightly discordant) tectonic events spanning a significant portion of Zealandia’s evolution.

Zinc was mounted on flat crystal faces in epoxy. Unpolished surfaces were analysed by LASS-ICP-MS using 35 μm spots for 40 seconds at 2 Hz ± 80 shots.

Data collection criteria:
1) ≥10 data points ‘plateau’ age
2) no mixing or incomplete re-equilibration
3) Th/U correlates with age
4) REE is reset, not inherited from core

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Implications

Depth-profiling is capable of resolving multiple growth-modification events spanning a signiﬁcant portion of a rock’s metamorphic history.

Zinc and garnet (re)crystallisation in the Alpine Schist are contemporaneous with the rifting of the Zealandia microcontinent from East Gondwana during 83 – 52 Ma, suggesting that compressional and extensional tectonic regimes existed in close proximity during the formation of the Zealandia microcontinent.

Refernces