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Zircon recrystallisation microstructures andthe implications for U-Pb dating

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Uranium-lead dating of zircon has been used extensively in geochronological studies based on the widespread occurrence of zircon and its resistance to chemical and physical weathering. Previous research has shown that despite their apparent robustness, many zircons contain evidence for recrystallisation, such as the replacement of the primary oscillatory zoning by unzoned zircon. This replacement is characterised by rims, patches and embayments of unzoned zircon which can either completely replace the primary zoning or preserve faint remnants within the unzoned zircon. In some samples, the unzoned zircon contains lower U and Pb concentrations, implying that the zircon U-Pb age may be reset during the replacement (Pidgeon, 1992). Interestingly, zircons have also been found in which there is no apparent difference in U-Pb age between the zoned and unzoned zircon (Schaltegger et al., 1999). To better understand the replacement of zoned by unzoned zircon, it is important to study the microstructures present within recrystallised zircon to understand possible mechanisms causing recrystallisation. Multiple mechanisms may explain the trace element distribution within (partially) recrystallised zircon: annealing of radiation damaged (metamict) zircon, annealing of lattice strain imposed by alternating U concentrations in oscillatory zoning, enhanced diffusion along fast-diffusivity pathways (such as low-angle subgrain boundaries or fractures) and coupled dissolution-reprecipitation. The mechanism(s) by which zircons recrystallise remain poorly understood, as well as the effect of the formation of different microstructures on corresponding zircon U-Pb dates. Understanding these phenomena is therefore of vital importance for correctly interpreting U-Pb ages in zircon.

This work focusses on investigating the microstructures that are present within recrystallised zircons from both metamorphic and igneous environments from the Jack Hills, Australia (Pidgeon, 1992) and the island of Lewis and Harris, Scotland (Van Breemen et al. 1971). Suites of zircons from these areas have been imaged with cathodoluminescence, which is a powerful tool for obtaining high resolution images of the internal structures of zircons. Within these suites, zircons are present which show complex zoning patterns and (partial) recrystallisation; these will be studied in greater detail using EDS, EBSD and SHRIMP. Preliminary results of EDS on the inclusions show that inclusions are composed of feldspars, thorite, quartz and apatite, which were most likely included during the primary crystallisation of the zircon. EBSD measurements will provide additional data on the crystallographic orientation of recrystallized zones and the state of metamictization of the zircons, and may show if zircon has deformed crystal-plastically forming subgrain boundaries.

References

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