# Potential of rutile as a U-Th-He thermochronometer

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We present a study of a megacrystal of rutile from a metamorphic rock in the Adelaide Geosyncline, near Strathalbyn, South Australia for the purposes of defining the parameters of a potential new low temperature thermochronometer. Step heating diffusion experiments on this crystal have yielded a preliminary closure temperature that appears to be higher than that published for zircon and titanite (ie. >180°C).

The age dating procedure involved laser heating (~2W) of several individual pieces of the crystal (~200µm) to yield the He and a multiple stage bomb dissolution procedure to obtain the U and Th contents. The average (U-Th)/He age of the rutile crystal is ~472 ±20 Ma which may represent the later stages of cooling of the Delamerian Orogeny (ie. 514-490 Ma) and is insensitive to Tertiary exhumation.

To ascertain if there was any zoning and/or inclusions within this large crystal (~10 x 50mm), a section across the c-axis was cut and polished and then multiple elements were scanned using the Nuclear Probe at CSIRO in Sydney. The scan data showed a homogeneous U and Th distribution across the grain, however other elements (eg. Nb, Ta) showed considerable zoning.

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# Chemical alteration of hot and cold desert meteorites

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Analyses of meteorites recovered in hot deserts or in Antarctica are increasingly used to gain constraints on the formation of interesting groups of meteorites (e.g., 18 of the 24 Martian meteorites, and 4 of the 6 angrites were found in such areas, where they typically spent over 10,000 yr since their fall on earth).

Here, we evaluate the impact of this long terrestrial residence on the chemical and isotopic compositions of hot and cold desert meteorites. We concentrated on the distribution of the lanthanides, because they are commonly used to decipher the petrogenesis and chronology of the meteorites, and that of elements diagnostic of terrestrial weathering processes (e.g., Sr and Ba). Elemental concentrations in individual grains were measured in-situ by secondary ion mass spectrometry. Data were obtained for 18 meteorites from these regions.

Antarctic meteorites spent a much longer time on earth than hot desert meteorites, but their chemical compositions were less modified. In Antarctica, chemical alteration occurs mainly when the meteorite is not encased in the ice and the sun's rays can promote the formation of meltwater that mobilizes the lanthanides. Oxidation produces $Ce^{4+}$, which is less soluble than the trivalent REE, resulting in Ce anomalies. The mineral most affected is low-Ca pyroxene. However, not all grains of a given mineral are, and distinct analyses of a single grain can even yield REE patterns with and without Ce anomalies. Clearly, microcracks and fractures, ubiquitous in shocked meteorites, influence the REE mobilization in a complex way. The effect is most pronounced for Antarctic eucrites in which Ce anomalies are even observed in whole rock samples.

Although Ce anomalies are also observed in hot desert meteorites, the most troublesome signs of chemical alteration are a LREE enrichment with a typical crustal signature, as well as Sr and U contaminations. These can modify the whole rock REE patterns and disturb the isotope systematics used to date these objects. The contamination is highly heterogeneous, affecting some grains and not others of a given mineral (mainly olivine and low-Ca pyroxene, the two minerals with the lowest REE concentrations). The highest levels of contamination are found in altered material filling veins and cracks. Data representing uncontaminated whole rocks and mineral separates will be extremely difficult to obtain for hot desert meteorites.