Goldschmidt 2021 Abstract
https://doi.org/10.7185/gold2021.3803

How can we use the detrital rutile record to elucidate crustal and tectonic processes?

INÊS PEREIRA[1], CRAIG STOREY[2] AND HUGO MOREIRA[3]

[1]Universite Clermont Auvergne
[2]University of Portsmouth
[3]Université de Montpellier

Presenting Author: ines.pereira@uca.fr

Rutile is a common accessory mineral in metamorphic rocks of variable grades. It incorporates reasonable amounts of U (1 to 100 ppm) and Zr (20 to 9000 ppm) making it suitable for U-Pb dating and Zr-calibrated geothermometry, respectively. Since rutile is often found as a detrital mineral in sedimentary rocks, it can be used as a proxy to interrogate the weathered metamorphic crust.

While rutile is more stable under HP conditions, it is also found at high-temperature conditions (upper amphibolite, granulite facies, leucogranites) and associated with ore minerals. The discrimination of detrital rutile is, therefore, paramount. Several efforts have been made over the years, looking at trace element discrimination systematics, that include elements such as Nb, Ta, Sn, Sb, W, Fe and V. We present a thorough evaluation of the caveats and thresholds of estimating peak metamorphic conditions using detrital rutile. We reviewed published Zr-in-rutile geothermometry data from metamorphic rocks to evaluate the uncertainties of estimating temperatures from single grains. Our investigation is based on a) the natural variability of Zr concentrations in a given sample's rutile population; b) the occurrence of Zr diffusion due to cooling or overprinting as a result of post-crystallisation tectonometamorphic events. We verify that estimation using a single rutile grain derived from high-grade rocks can yield an uncertainty of c.100 ºC, while from eclogite this falls to less than 40 ºC. This implies that single temperatures estimated below 600 ºC are more precise than estimates at 800 ºC. Moreover, diffusion during slow cooling (2.5 ºC/Ma) or metamorphic overprinting above 600 ºC with a duration of c.25 Myr leads to resetting of Zr to concentrations equivalent to 650 ºC. Considering analytical and methodological uncertainties, single grain Zr-in-rutile temperatures estimated to be below 580 ºC correspond to the true peak metamorphic temperatures of source terranes. Since rutile grains formed under such low temperatures are restrictedly stable at pressures above 13 ± 1 kbar, Zr-in-rutile calibration in detrital grains that yield T < 580ºC must represent low geothermal conditions. Consequently, low temperature rutile grains serve as a proxy for sustained cold subduction.