Rutile: A recorder of extreme conditions

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Rutile is a robust accessory mineral that is stable over a large *P-T* range and found within a wide variety of high-grade metamorphic rocks, forming under both UHP and UHT conditions. It is a major host of HFSE (e.g. Nb, Ta and Cr), which can be used to discriminate between source rock lithology, and temperatures can be obtained using the Zr-in-rutile geothermometer. Recently, it has been shown that metamorphic rutile is an excellent container of mineral inclusions, due to properties which promote the preservation of mineral inclusions, such as being resistant to fracturing and fluid infiltration.

In this contribution, we discuss the identification of mineral inclusions within a range of high-grade metamorphic rocks, and how to utilise them alongside existing rutile geochemistry, to gain insight into the tectonic evolution of the source terrane. To do this, mineral inclusions within rutile from several (U)HP and UHT localities have been characterised using electron microprobe analysis. Trace element concentrations within rutile have also been measured using LA-ICP-MS to deduce the nature of the protolith (metamafic vs metapelitic) and to apply the Zr-in-rutile thermometer.

The systematic study of mineral inclusions has revealed that rutile has the capacity to record different stages along the prograde *P-T* path, with a variety of prograde and peak phases found as mineral inclusions in UHP and UHT samples. The discovery of coesite inclusions in UHP rutile, indicates that rutile has a low compressibility, acting as a robust pressure vessel. This demonstrates that not only is rutile is an excellent repository for mineral inclusions, but that the study of mineral inclusions in rutile may profoundly change how we investigate and recover evidence of both high-pressure and high-temperature events.