Mineral inclusions in rutile: Novel recorders of extreme metamorphism

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Rutile (TiO_2) is a common accessory mineral found within high-grade metamorphic rocks and its mineral chemistry can provide insight into *P-T* conditions and processes occurring within subduction zones and collisional orogens. To develop the utility further, we have undertaken a detailed study of mineral inclusions found within rutiles from HP-UHP and UHT rocks. Constraining peak metamorphic conditions from such rocks is often compromised by the effects of retrogression but great progress has been made by careful investigation of mineral inclusions (such as coesite and microdiamonds) shielded within robust minerals such as garnet and zircon. So far, this approach has not been widely used within rutile.

In this contribution, we have studied rutile from a number of localities (HP-UHP: Syros, Greece; Sesia Zone and Dora Maira Massif, Western Alps; UHT: east Antarctica). Trace element concentrations have been measured using LA-ICP-MS in order to deduce the nature of the protolith (metamafic vs metapelitic) and to apply the zirconium-in-rutile thermometer. Electron microprobe analysis of mineral inclusions and their matrix counterparts has been used to assess the comparability of mineral chemistry and the viability of applying conventional barometry to mineral inclusions in order to constrain *P-T* conditions. Raman spectroscopy has also been applied to silica inclusions to identify the polymorph.

So far, our study has shown that in HP-UHP rutile, the nature and mineral chemistry of the inclusions match the minerals in the matrix of the respective samples and are thus reliable recorders of metamorphic conditions. In turn, this permits the application of conventional geothermobarometry and average pressure-temperature (Av*PT*) calculations to be applied directly to the inclusions. Raman spectroscopy has also shown that rutile in UHP rocks can retain preserved coesite, therefore it is a good repository to look for evidence for UHP metamorphism in otherwise retrogressed samples. Preliminary obervations in UHT rutile suggest that mineral inclusions may also be useful for geothermobarometry.

The study of mineral inclusions in conjunction with trace element analysis of rutile provides a novel method for recovering peak *P-T* conditions of UHP (and potentially UHT) rocks.