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Utilising mineral inclusions in detrital rutile

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Rutile has received considerable attention in the last decade as a key mineral in sediment provenance analysis, as it is one of most physically and chemically stable heavy minerals in the sedimentary environment. 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, capable of preserving phases from different metamorphic stages along the *P-T* path, due to properties which promote the preservation of mineral inclusions, such as being resistant to fracturing and fluid infiltration. This raises the possibility of being able to identify mineral inclusions within detrital populations, and utilise them alongside existing rutile geochemistry, to locate potential source rocks and gain insight into the tectonic evolution of the source terrane.

To assess the feasibility of this, detrital rutile from modern river sediments collected from six rivers within the Western Alps and Po Plain of Italy, have been investigated for mineral inclusions. Mineral inclusions have been characterized using electron microprobe analysis to compare inclusion chemistry to potential sources, and rutile 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 Zr-in-rutile thermometer.

Detrital rutiles from each of the sediment samples are found to contain mineral inclusions despite having been transported large distances in some cases, and comprise a variety of phases, including high-pressure minerals such as omphacite, garnet and phengite. In detrital populations where indicator minerals such as garnet are present, compositions can be compared to mineral assemblages found within nearby terranes to identify the source of the detritus.

The study of mineral inclusions in detrital rutile, when used in conjunction with rutile trace element chemistry and Zr-in-rutile thermometry, is a powerful tool in determining provenance and should be routinely sought out.