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Rutile: More than just titanium dioxide

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Rutile is the most common naturally occurring titanium dioxide polymorph. It is widely distributed as an accessory mineral in metamorphic rocks ranging from greenschist to eclogite and granulite facies, but also occurs in igneous rocks, mantle xenoliths, lunar rocks and meteorites. It is also one of the most stable heavy minerals in the sedimentary cycle and commonly occurs both in ancient and modern siliciclastic sedimentary rocks. This presentation aims to give an overview about rutile and its applications in Earth Sciences, with special focus on detrital rutile and its applications in sediment provenance analysis. Rutile has long been used in conventional heavy mineral analysis for determining rutile–zircon indices to record changes in sediment provenance. Great interest has recently focused on its mineral geochemistry because, besides titanium and oxygen, rutile may incorporate a range of trace elements, among others Cr, Nb, Sb, Sn, Ta, W, Zr and U. For example, the Cr and Nb contents of rutile allow discrimination into metamafic and metapelitic rutile. Elevated contents in Sb, Sn, Ta and W identify rutile derived from ore mineralisation. The Zr content incorporated into the rutile lattice during crystallization can give constraints on the temperature of rutile formation. Importantly, rutile from high-grade metamorphic rocks can contain sufficient uranium to allow U–Pb geochronology. A number of studies have already shown that rutile geochemistry and Zr-in-rutile thermometry can yield diagnostic data on source-rock lithology and metamorphic facies even in highly modified sandstones that may have lost significant amounts of provenance information. Rutile may therefore be a key mineral in sediment provenance analysis in the future, similar to zircon, which has received widespread attention in the last decades. Besides that, rutile is also of great economic importance because it is one of the favoured natural minerals used in the manufacture of white titanium dioxide pigment, which is a major constituent in various products of our daily life. Heavy mineral sands containing a significant percentage of rutile are therefore the focus of exploration worldwide.