Rutile geochemistry in ore systems – considerations for metal exploration

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Rutile is an important indicator mineral for some ore types, retaining trace element geochemistry and U-Pb isotopes related to its formation environment. Formed in hydrothermal environments, rutile is commonly associated with metal deposition and may 'fingerprint' ore-types through incorporation of a unique set of trace elements including U which allows age determination.

Like zircon, rutile is mechanically and chemically robust, surviving sediment transport and weathering, potentially preserving ore formation information in distal sediments. Hence, rutile may serve as a means to extend the footprint for metals exploration through analysis of detrital sediments and their lithified and metamorphosed equivalents, potentially exposing traces of mineral deposits that are currently undetectable at the current surface.

In a case study of the utility of rutile, siliciclastic rocks (mainly meta-sandstones and quartzites) from basins in Western Australia have been analysed and compared with rutiles sourced from known Au deposits. While some detrital rutiles can be > 1 mm in size, many rutiles found in Au deposits are commonly < 25 μm and may not be preserved in the detrital rock record. Increased frequency of other TiO_2 polymorphs (anatase and brookite) in detrital samples are distinguished using EBSD (electron backscatter diffraction) and likely reflect burial, diagenesis, weathering and/or metamorphism in the history of detrital samples. In addition to trace element fingerprinting of the formation environment, other internal structures can also be identified using EBSD, providing further information on grain and/or host rock history.

Rutile trace element signatures were determined in situ using LA-ICPMS, calibrated to glasses and natural rutile standards. Trace elements concentrations of W ± Sb are assessed as the most reliable Au ore indicators. Combined with Zr-in-rutile geothermometry, U-Pb ages derived from LA-ICPMS and SHRIMP, and the geological context of the sample, the trace elements in rutiles provide important information on the provenance, history and metal associations of detrital rutile-bearing siliciclastic rocks.