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Provenance analysis of detrital rutile: pitfalls and solutions

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The growing number of publications dealing with rutile in sedimentary provenance analysis in the last few years documents the widespread applicability and large potential of this method. Both, Zr-in-rutile thermometry aspects and lithology discrimination based on Cr and Nb contents have been refined.
It is generally thought that rutile is transformed into other Ti-bearing phases under greenschist facies conditions, and therefore, unlike zircon, rutile characteristics reflect the last metamorphic event only. However, conclusions from rutile thermometry in modern and Paleozoic (meta)sediments from the Erzgebirge (Germany) suggest that rutile may be recycled, and relicts contain information about former metamorphic cycles.
Investigation of rutile samples from different geological settings shows that the occurrence of anatase is more widespread than previously thought and can hardly be predicted. Optical methods and Raman spectroscopy cannot always discern rutile from its polymorphs. Furthermore, linear discriminant analyses of trace element contents obtained by electron microprobe analysis in rutile and its polymorphs show that trace element contents in genetically related rutile, anatase, and brookite exhibit large contrasts indicating that anatase and brookite cannot be used for thermometry or lithology classification purposes substitutional for rutile.
On the other hand, for certain elements (Cr, V, Fe, and Nb) these differences are systematical and can be used for discrimination. On the basis of a calculation applied to each analysis employing prior probabilities for rutile, anatase, and brookite obtained from a natural sample composition, as well as phase group means and coefficients of linear discriminants from a linear discriminant analysis applied to a well-defined compilation of samples, we obtain correct-classification rates for rutile of > 0.97.
Based on these findings we present a recipe for state-of-the-art rutile provenance analysis.