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The geochemistry of rutile in modern sediments from the Erzgebirge, Germany

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Due to its high physical as well as chemical stability and widespread occurrence in many metamorphic rock types exposed on Earth's surface, rutile is a prime candidate for single-mineral provenance analysis. Unlike zircon, rutile is always newly formed in high-grade metamorphic rocks and thus does not contain information from previous metamorphic cycles. Trace elements inherited during growth give clues about source rock lithology and metamorphic formation conditions: High Cr contents point to mafic host rock compositions, while rutiles with high Nb contents derive from metapelites. As Zr contents are directly related to growth temperatures, rutile can also be used as a single-mineral thermometer. In order to evaluate the potential of rutile geochemistry for provenance analysis, the Erzgebirge (Germany) was chosen as study area. The Erzgebirge exhibits eclogites, para- and orthogneisses, micaschists and phyllites generated during the Variscan orogenesis, non-metamorphic Ordovician sediments, and post-tectonic granitic intrusions. The exposed rocks range up to more than 29kbars and 850°C in formation conditions, as found by conventional thermobarometry. Sand samples for this study were collected from quarries, small creeks and rivers draining all major geological units. Additionally, rock samples representative for the sands' drainage areas provide a tool for comparison and quantification. Rutiles from mineral separates and thin sections were analysed by electron microprobe for Nb, Cr, and Zr, with detection limits of 70, 35, and 45 ppm, respectively. The results show that mafic and pelitic source rock lithologies can indeed be distinguished with the aid of Cr and Nb contents. Combining both elements in one log(Cr/Nb) ratio provides an easy way for quantification of the inferred source lithologies, and it allows an easy graphical comparison to, e.g., temperatures calculated from Zr contents. Peak metamorphic tem-

peratures obtained by the Zr-in-rutile single-mineral thermometer are identical with temperatures obtained by conventional methods above 550°C formation temperatures. Metamorphic units below this temperature limit show an increasing fraction of rutiles being characterised by a much higher calculated temperature than expected. We conclude that these rutiles are detrital minerals having survived metamorphic conditions $<$550°C. These relic rutiles mirror erosion of pre-Variscan high-grade metamorphic terranes that may allow for drawing conclusions on Early Paleozoic paleogeography.