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CAPTURING THE THERMAL FINGERPRINT OF SOURCE AREAS WITH DETRITAL RUTILE U-PB-HE DOUBLE-DATING: REFINING SOURCE-TO-SINK RELATIONSHIPS IN THE MURRAY BASIN, SOUTHEASTERN AUSTRALIA

Detrital rutile is receiving increasing attention as a valuable complement to detrital zircon due to its ability to record geological processes to which zircon is often unresponsive. As a primary metamorphic mineral, U-Pb dating of rutile provides insights into middle- to shallow-crustal processes, while rutile geochemistry has been applied to better understand protolith composition and growth temperatures. To better capture the thermal history of metamorphic source terranes, we present an integrated approach combining U-Pb geochronology and (U-Th)/He thermochronology ("double-dating") applied to detrital rutile from late Neogene heavy mineral sand deposits in the Murray Basin, southeastern Australia. In addition, we performed ^{4}He diffusion experiments on rutile of the same samples to understand the closure temperatures of the analyzed samples. Combined with trace element geochemistry, using Cr-Nb systematics and the Zr-in-rutile thermometer, U-Pb-He double-dating allows for the reconstruction of a thermal fingerprint for individual rutile grains, offering less ambiguous provenance information. In the Murray Basin, the application of double-dating and geochemistry aids in identifying the ultimate source terrane, and thereby resolves complex, multi-cycle sediment pathways from an exotic and distal ultimate source through near-surface intermediate storage units. This finding posits the recycling history as a key mechanism in upgrading the rutile grade in one of the world's most significant Ti resources. Incorporating (U-Th)/He systematics into the detrital rutile analytical toolkit enhances the mineral's versatility and highlights its potential in generating a more comprehensive understanding of sedimentary systems.