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Impact of mineral fertility and bedrock erosion on single-mineral detrital studies: insights from trace-element and Nd-isotope systematics of detrital apatite from the Po River catchment

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The detrital record provides an archive of mountain erosion that preserves key information for paleotectonic and paleoclimatic reconstructions. Detrital studies are often based on single-mineral analyses (e.g., geo/thermochronologic analyses on apatite and zircon). Their geologic interpretation can be challenging, because the impact of each eroding source on the detrital record is controlled by a range of factors including the rate of erosion and the fertility of chosen minerals in eroded bedrock. Here, we combine (i) a state-of-the art dataset of trace element and Nd isotope fingerprints of detrital apatite, (ii) a comprehensive dataset of apatite-fertility measurements (Malusà et al. 2016), (iii) fission-track data, and (iv) cosmogenic-derived erosion rates from the Po River catchment (Wittmann et al. 2016), to test the impact of mineral fertility and bedrock erosion on the single-mineral detrital signal preserved in the final sediment sink. Our results show that the information provided by accessory minerals, when complemented with accurate mineral fertility measurements, are fully consistent with information provided by the analysis of more abundant framework minerals. We found that trace element and Nd isotope analyses provide a reliable tool to disentangle the complex single-mineral record of orogenic erosion, and demonstrate that such a record is largely determined by high-fertility source rocks exposed within the drainage. Detrital thermochronology studies based on the lag-time approach should thus preferably include independent provenance discriminations and a full mineral fertility characterization of the potential source areas, in order to ensure a correct identification of the sediment sources and of the exogenic and endogenic processes monitored in the stratigraphic archive.

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