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Trace-element and Nd-isotope systematics in detrital apatite of the Po river catchment: implications for the lag-time approach to detrital thermochronology

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Detrital thermochronology is often employed to assess the evolutionary stage of an entire orogenic belt using the lag-time approach, i.e, the difference between the cooling and depositional ages of detrital mineral grains preserved in a stratigraphic succession. The impact of different eroding sources to the final sediment sink is controlled by several factors, including the short-term erosion rate and the mineral fertility of eroded bedrock. Here, we use apatite fertility data and cosmogenic-derived erosion rates in the Po river catchment (Alps-Apennines) to calculate the expected percentage of apatite grains supplied to the modern Po delta from the major Alpine and Apenninic eroding sources. We test these predictions by using a dataset of trace-element and Nd-isotope signatures on apatite grains from modern sand samples, and we use apatite fission-track data to validate our geochemical approach to provenance discrimination. We found that apatite grains shed from different sources are geochemically distinct. Derived provenance budgets point to a dominant apatite contribution to the Po delta from the high-fertility Lepontine dome, consistent with the range independently predicted from cosmonuclide and mineral-fertility data. Our results demonstrate that the single-mineral record in the final sediment sink can be largely determined by high-fertility source rocks exposed in rapidly eroding areas within the drainage. This implies that the detrital thermochronology record may reflect processes affecting relatively small parts of the orogenic system under consideration. A reliable approach to lag-time analysis would thus benefit from an independent provenance discrimination of dated mineral grains, which may allow to reconsider many previous interpretations of detrital thermochronology datasets in terms of orogenic-wide steady state.

Malusà et al. (2017) Trace-element and Nd-isotope systematics in detrital apatite of the Po river catchment: implications for provenance discrimination and the lag-time approach to detrital thermochronology. Lithos 290–291:48–59