EGU21-8980
https://doi.org/10.5194/egusphere-egu21-8980
EGU General Assembly 2021
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Alternatives to zircon in sedimentary provenance analysis: A case study in detrital garnet U-Pb and trace-element analysis

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Provenance analysis of clastic sediment is a powerful tool to track the evolution of hinterland tectonics and sediment routing systems, for which detrital U-Pb geochronology has proved a popular and rapidly-growing technique. However, >90% of published studies employ zircon (3,691/3,933 results for the keywords detrital geochronology; Clarivate Analytics Web of Science), a mineral which exhibits strong fertility bias towards felsic to intermediate igneous sources, and is rare in metamorphic settings in the absence of anatexis (e.g., Moecher & Samson, 2006). Thus, the development of complementary proxies is desirable. Garnet group minerals are particularly promising because garnet is dominantly formed in metamorphic settings and is a rock-forming mineral in several common metamorphic lithologies; it is thus typically abundant in clastic sediment sourced from orogenic terranes. Moreover, it can incorporate sufficient U to be dated in-situ by the U-Pb method (e.g., Millonig et al., 2020).

Here we focus on the Oligo-Miocene pro-foreland basin of the European Alps. Evolving from a distal marine to a fluvial-alluvial environment affected by at least one major marine incursion, the basin preserves a rich record of tectonic and climatic change in the hinterland. We report detrital garnet U-Pb and trace-element data acquired by laser ablation inductively coupled plasma mass spectrometry (LA-ICPMS), which we integrate with compositional data obtained by energy- and wavelength-dispersive X-ray spectroscopy (Stutenbecker et al., 2019), and crystallographic data from Raman spectroscopy. We integrate these results with detrital apatite, rutile, and zircon U-Pb data, and discuss the implications for Alpine tectonics and drainage evolution, and future potential for detrital garnet U-Pb analysis.

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Stutenbecker, L., et al., 2019, Solid Earth 10, 1581–1595, doi: 10.5194/se-10-1581-2019