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Revealing Orogenic History through a Multi-Detrital Mineral Approach

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A multi-proxy approach to detrital mineral studies has recently become widely used for obtaining archives of orogenic history. Detrital zircon and monazite records offer valuable insights into continental crust evolution over geological time through Hf and Nd isotopic compositions, along with geochronological constraints. However, differences in their fertility within source rocks and their susceptibility to secondary processes influence both their preservation and the interpretability of age spectra. While detrital zircon can often be linked to igneous origins using cathodoluminescence (CL) imaging, detrital monazite classification relies on geochemical composition due to its lack of distinct CL features and complexity in backscattered electron (BSE) imaging.

Here, we demonstrate the utility of multi-proxy approach using the example of detrital zircons and monazites from river sands in North and South America [1]. The zircon and monazite age distributions were broadly consistent; however, differences in occurrence and preservation potential led to minor variations in peak ages. Compared to detrital zircon records, detrital monazite is more likely to capture the timing of the collision stage rather than the subduction stage, based on trace element and Nd isotope characteristics. Furthermore, we highlight the effectiveness of machine learning in developing a classification model to identify source rock types using trace element data.

[1] Itano, Yoshiya, Maruyama & Iizuka (2024), *Chemical Geology* 669, 122361.