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Using Detrital Garnet Lu-Hf Geochronology to Study Subglacial Antarctica from Australian Shorelines

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Detrital garnet geochronology can be used to constrain the timing of metamorphic events in poorly accessible source terranes that lack an overt accessory mineral record. However, traditional Sm-Nd or Lu-Hf dating relies on time-consuming solution-based measurements and is hence not feasible for generating the large datasets required for provenance studies. Instead, individual garnet grains can be dated using laser-ablation Lu-Hf geochronology [1], which is a rapid and cost-effective method that requires minimal sample preparation, ensuring a large number of detrital garnet grains can be dated in a short timeframe.

To demonstrate the potential of garnet laser-ablation Lu-Hf geochronology for provenance analysis, we present a study of a garnet-rich placer sand sample collected from a beach adjacent to Palaeoproterozoic granulites (~1630 Ma) in South Australia. The Lu-Hf ages of detrital garnets in this placer sand define two distinct age populations at ~1625 Ma and ~580 Ma. The late Palaeoproterozoic age population illustrates that detrital garnet faithfully records the granulite provenance. The ~580 Ma detrital population, however, cannot be linked to regional metamorphic events in southern Australia. Instead, we suggest that these ~580 Ma garnets were recycled from local Permian glacial strata and erratics, which locally contain detrital garnet-rich intervals. To test this hypothesis, we analysed detrital garnets in placer sand samples from three other beaches flanked by Permian glacial units in South Australia, as well as detrital garnets from the glacial sand layers themselves. The results confirm an abundant detrital garnet population at ~590 Ma. Based on paleo-ice flow reconstructions, we suggest these ~580—590 Ma detrital garnet grains were ultimately derived from formerly contiguous parts of East Antarctica within Gondwana. The ~580—590 Ma detrital garnets may record metamorphism related to the initiation of the Ross Orogeny along the East Antarctic margin, which is otherwise only cryptically preserved in bedrock exposures. This study illustrates that we can sample the metamorphic history of Antarctica, which is largely inaccessible due to ice cover, directly from Australian shores, and highlights the potential of detrital garnet geochronology to reconstruct metamorphic histories in poorly exposed or preserved terranes.

References:

[1] Simpson, A., et al. (2021).