Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.34024

Dirty Melts, Tracking Sedimentary Fingerprints in Ancient Magmas

CHRIS SPENCER

Queen's University

The evolution of Earth's crust and the magmatic systems responsible for its formation have led to the evolution of distinct compositional reservoirs. Hafnium and oxygen isotopes in zircon assist in characterizing four dominant endmembers that provide evidence of compositional differentiation through geologic time, viz., depleted mantle, hydrothermally altered oceanic crust, lower continental crust, and sedimentary rocks of various composition. Identifying sedimentary contributions to early magmas is crucial for understanding crust-mantle interactions and magma petrogenesis. Still, it remains challenging due to the secular evolution and compositional expansion of crustal reservoirs through time.

Isotopic evidence from Hf-O systems in detrital zircon reveal the growing influence of sedimentary materials in early Earth magmatic systems, with a secular expansion in the compositional fingerprints of crustal endmembers. This evolving detrital zircon signature aligns with that of sediment-derived granitoids, establishing a direct link between the hypothesized sediment contributions to the magmas from which the detirtal zircon originated. These findings indicate that the isotopic distinction between these endmembers becomes more fractionated from the bulk Earth over time as contributions from sedimentary and crustal sources diversify. This complexity requires that interpretations of early magmas incorporate a nuanced approach that includes petrologic, compositional, and mineralogical context to accurately differentiate sedimentary input from other crustal reservoirs.

These results demonstrate an expansion in the range of source compositions available for melting, particularly during three key phases in Earth history, consistent with evolving geodynamic regimes. Isotopic evidence reveals a progressive increase in sedimentary contributions to magmas, with a potential state shift in the early Paleoproterozoic when the composition and volume of subducted sediment is theorized to have changed. As the evolving nature of crustal reservoirs obscures the identification of sedimentary contributions to ancient magmas, a more integrated approach is needed when distinguishing these signals in early Earth systems. This work provides a framework for future studies aiming to unravel the sedimentary influence on early magmatism and underscores the importance of integrated isotopic and petrologic approaches for understanding the complexities of crustal evolution.