Semantics in stable isotopes - lessons from zirconium

Edward Inglis, Ph.D.
Senior Technical Specialist (Inorganic Mass Spectrometry), Analytical Instruments Group
Thermo Fisher Scientific; edward.inglis@thermofisher.com

So called non-traditional stable isotopes have dominated the field of isotope geochemistry for the past 20 years. Their applications to both high- and low- temperature natural settings have enhanced our understanding of planetary differentiation, early Earth evolution and the subsequent habitability and environmental change up to present day.

Zirconium, a high field strength element with 4 stable isotopes, is a relatively recent addition to the lineup of usual stable isotope culprits. The highly refractory nature of elemental Zr hints at a potential tracer immune to later stage modification and overprinting by metamorphic processes. Here we present a comprehensive Zr stable isotope (The $\delta^{94/90}Zr_{IPGP\text{-}Zr}$) inventory of silicate reservoirs to define the Zr isotope composition of earth's mantle, which, with the exception of N-MORB, display restricted isotopic variation, thus allowing us to conclude that Earth's mantle is homogenous with respect to Zr isotopes. This theme is further probed by evaluating komatiite samples displaying a range of crystallization ages - again this shows negligible isotopic variation over time, allowing us to conclude that the has been no secular Zr isotope change since ~3.55 Ga.

A series of magmatic differentiation suites are studied, and it is shown that Zr isotopes are fractionated along a line of liquid descent. This is explained by zircon crystallization, and precipitation of isotopically heavy zircon which is subsequently removed from the fractionated melt. This allows us to suggest that Zr isotopes are a powerful tracer of both modern and ancient magmatic differentiation. This idea is examined further with comprehensive study of ocean island basalts, which shows a clear influence of upper crustal recycling on specific OIB suites.

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About the Lecturer

Edward C. Inglis is a British isotope geochemist who completed his doctoral training at the National Oceanography Centre, Southampton (2009–2013), where he developed expertise in analytical geochemistry and MC-ICP-MS techniques. He subsequently held a postdoctoral position with Kevin Burton at Durham University on Fe and Zn isotope systematics in subduction-zone settings — notably tracking iron and zinc mobility through Western Alpine ophiolites and serpentinites. He then moved to the Institut de Physique du Globe de Paris (IPGP), collaborating extensively with Frédéric Moynier, where he became a key figure in establishing zirconium (Zr) stable isotope geochemistry as a new non-traditional isotope system, producing widely-cited reference datasets and constraining the Zr isotope composition of the silicate Earth, the mantle, and continental crust through time. Across roughly 35 publications, his contributions span Fe, Zn, Zr, K, and other non-traditional stable isotopes applied to mantle geochemistry, subduction, and planetary differentiation. He has since transitioned to Thermo Fisher Scientific, where he applies, as a chief mass spec engineer his deep analytical expertise to the development and support of high-precision mass spectrometry instrumentation for the Geosciences community.