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A review of novel insights and future challenges presented by oceanic iron isotope analyses

JESSICA N. FITZSIMMONS[1] AND TIM M. CONWAY[2]

[1]Texas A&M University

[2]University of South Florida

Presenting Author: jessfitz@tamu.edu

Since the first dissolved iron (Fe) isotope analyses of seawater in 2007, marine Fe isotope ratios have emerged as a transformative tool for diagnosing Fe sources to the ocean and tracing Fe biogeochemical transformations. Here, we will highlight the explosion of seawater Fe isotope measurements that have been made in the last fifteen years by reviewing the novel insights that Fe isotopes have provided marine biogeochemists [1]. We will summarize the end-member isotopic signatures of different Fe sources to the ocean and how these have been used to quantify Fe provenance, including distinguishing sedimentary dissolved Fe supply mechanisms and distinguishing anthropogenic and natural aerosol Fe sources. We will also describe how, under certain conditions, Fe isotopic fractionation can be used to constrain internal cycles of Fe in the ocean, including changes in dissolved Fe speciation, such as in hydrothermal plumes. We will conclude with a survey of where we need additional future research to help develop and interpret seawater Fe isotopic measurements, including efforts to constrain the Fe isotope effect associated with biological Fe uptake, photochemistry, and scavenging, as well as an improved understanding of the variability in local Fe isotope end members for individual source types. Overall, we hope to celebrate the novel insights that Fe isotope analyses of seawater have provided to marine biogeochemistry across the global ocean, and we look forward to what this tracer may continue to provide to our community into the future.

[1] Fitzsimmons & Conway (2023), *Annual Reviews of Marine Science*, 15:383-406, https://doi.org/10.1146/annurev-marine-032822-103431.