Iron cycling in the upper Southern Ocean - insights from Fe isotopes

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Nutrient cycling in the Southern Ocean plays a central role in global primary productvity [1], as well as being a key driver of the global distribution of trace metals throughout the oceans [2]. The essential miconutrient iron (Fe), is present at very low concentrations in surface Southern Ocean waters, and limits primary productivity over much of this region [3]. Dissolved stable isotope ratios of Fe (δ^{56}Fe) can help to better understand the regional cycling of Fe and trace the influence of Fe on phytoplankton ecology. δ^{56}Fe can also help identify sources of Fe to the Fe-starved surface Southern Ocean. However, while concentration data have been available for several decades, δ^{56}Fe measurements in this region remain scarce.

Here, we present high-resolution water column profiles of dissolved δ^{56}Fe from the uppermost 1000 m of the Pacific and Atlantic sectors of the Southern Ocean, using samples from the recent Antarctic Circumnavigation Expedition during the Austral Summer of 2016/17. Surface waters south of the Polar Front are extremely low in Fe (<0.1 nmol kg^{-1}) and exhibit high δ^{56}Fe values, pointing to the strong influence of biological cycling. At depth (below 200 m), Fe increases and δ^{56}Fe becomes near-crustal. In the upper ocean north of the Polar Front, vertical mixing plays a more important role in setting the Fe and δ^{56}Fe distribution in the upper ocean. Light δ^{56}Fe signatures reveal shallow Fe sources near the Mertz Glacier, on the Antarctic Peninsula and near the Balleny Islands. Shallow subsurface waters in the Weddell Gryre exhibit remarkably light Fe, consistent with previous observations [3]. We suggest these are likely sourced from margin sediments. These differences across different Southern Ocean zones point to distinct processes influencing the isotope systematics and the oceanic cycle of Fe in the Southern Ocean.

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[2] Vance *et al*., *Nat. Geosci.* **10**, 2020-206 (2017).
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[3] Abadie *et al., PNAS* **114**, 858-863 (2017).