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# Isotopic insights for external iron sources and biogeochemical cycling in the Amundsen Sea Polynyas

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Seasonal phytoplankton blooms in the Antarctic Amundsen Sea Polynyas (ASP) are thought to be supported by an external supply of iron (Fe) from circumpolar deep waters, benthic sediments, and/or ice shelf meltwaters. However, largely due to the limited amount of Fe data reported for the ASP, understanding of the sources and processes that affect the biogeochemistry of Fe in this region (notably in the ice shelf system) remains limited. Here, we present the first investigation of dissolved Fe isotope distributions ($\delta^{56}$Fe) along the conveyer belt of waters into and through the Amundsen Sea, via the Dotson Ice Shelf. This dataset, collected during austral summer (2017-2018), allows us to characterize and compare the dissolved $\delta^{56}$Fe signatures of incoming modified Circumpolar Deep Water (mCDW) and of sedimentary sources from the continental shelf. The range in dissolved $\delta^{56}$Fe (–1 to +0.1‰), coupled with elevated dissolved Fe concentrations (up to 1.6 nM), observed close to the seafloor, suggests that Fe is released from shelf sediments via a combination of reductive (RD) and non-reductive (NRD) processes, with NRD being relatively more important (20-56%) than RD (4-12%) at this location. At the Dotson Ice Shelf, comparison of $\delta^{56}$Fe in the mCDW inflow (–0.70) with the mCDW outflow (–0.23), together with a negligible change in dissolved Fe concentrations, points to modification of Fe biogeochemistry underneath the ice shelf. We speculate that this shift in dissolved $\delta^{56}$Fe is driven by a combination of enhanced preservation (and addition) of lithogenic colloidal Fe(III), together with the differential loss of $Fe^{2+}$ and complexation with Fe-binding ligands. We also found distinct $\delta^{56}$Fe signatures in surface waters of the polynya, especially elevated dissolved $\delta^{56}$Fe associated with a haptophyte bloom (up to +0.68‰) and diatom bloom (up to +1.06‰), which suggests that haptophytes and diatoms distinctly fractionate Fe. In addition to biological uptake, other biogeochemical processes, notably the supply of lithogenic particles that could buffer the dissolved Fe pool, could also play an important role for surface dFe cycling in the ASP.