

Quantifying the supply of reactive silicon and iron from Antarctic Peninsula glacially-influenced shelf sediments

RHIANNON JONES¹, HELENA PRYER², AMBER ANNETT³, SIOBHAN FODEN¹, JON R HAWKINGS⁴, LISA FRIBERG⁵, SANDRA ARNDT⁶, HELEN M. WILLIAMS²
AND KATHARINE R HENDRY⁵

¹British Antarctic Survey

²University of Cambridge

³University of Southampton

⁴University of Pennsylvania

⁵University of Bristol

⁶The Arctic University of Norway

Silicon (Si) and iron (Fe) are essential (micro)nutrients for the growth of marine primary producers. The supply and cycling of Si and Fe to and within the ocean are therefore key drivers of marine productivity and associated carbon cycling, and long-term carbon sequestration. In the polar regions, glaciers deliver large quantities of sediment to the marine environment, rich in Si, Fe, and other nutrients. Recent work suggests that these Si- and Fe-rich glaciogenic particles can be highly reactive, and at least partially bioavailable to marine primary producers. Conversely, the interaction of Si and Fe in sediments may modulate the supply of both nutrients to the water column.

We investigate the driving processes behind Si and Fe supply to the West Antarctic shelf water column, utilising sediments collected from King George Island, Elephant Island, and the eastern side of the West Antarctic Peninsula shelf. Resolving fluxes of Si from sediment pore waters to the overlying water column through ship-based and laboratory incubations, we determine that the total flux of Si ranged from 0.06 – 0.35 mmol m⁻² d⁻¹. Diffusive fluxes comprise only 2 – 15 % of this flux, highlighting the importance of advective processes, bioturbation, and bioirrigation in supplying bioavailable Si to the water column. The range in diffusive fluxes are comparable to regional estimates (e.g. Cassarino et al., 2020). Elemental fluxes from sediments are somewhat driven by the redissolution of reactive sediments into the pore waters. The total reactive Fe(II) fraction of surface sediments was highest in glacier-proximal surface sediments (200 µg g⁻¹) and lowest in sediments further out on the shelf (~50 µg g⁻¹). The Si fraction bound to iron (oxyhydr)oxides represented 2.5 – 7.5 mg g⁻¹, and the amorphous Si fraction extractable with a weak alkaline solution ranged from 5 – 20 mg g⁻¹, but Si fractions generally exhibited a less clear gradient from fjord head to outer shelf than Fe. Stable Si isotopic measurements and reactive transport modelling further elucidate the drivers of Si and Fe supply from sediments to the overlying water column.

Cassarino, L., et al. (2020) *Global Biogeochemical Cycle* 34(12).