Fe availability and bioactive metal dynamics in Antarctic shelf systems: Amundsen Sea Polynya vs. Western Antarctic Peninsula

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The Fe-limited waters of the Southern Ocean (SO) receive injections of Fe in Antarctic shelf regions and polynyas, leading to intense productivity and CO_2 influx. However, the coastal regions of West Antarctica are currently undergoing rapid climate warming, driving increased shelf intrusion of warm Circumpolar Deepwater (CDW), accelerated melting of glaciers and ice shelves, and modified water column structure, with as yet poorly understood effects on Fe supply, productivity and biogeochemical fluxes.

Here we compare bioactive metal distributions and temporal dynamics in the Amundsen Sea Polynya (ASPIRE program; 2010-11) and the shelf ecosystem of the Western Antarctic Peninsula (WAP; Palmer LTER program; 2010, 2011, 2012). We argue that vigorous circulation of modifed CDW under the Dotson Ice Shelf delivers glacial and sedimentary dissolved and particulate Fe to large regions of the polynya, making the system largely Fe-replete and highly productive. In contrast, glacial meltwater inputs to the WAP consist of surface runoff and subsurface melting of marine glacier termini, producing strong offshore gradients in δ^{18}Osw and glacier sourced metals. We discovered that a large area of the northern WAP shelf surface waters have strikingly low dissolved and particulate Fe, similar to the open SO, and that the spatial extent of this low-Fe shelf region spread south and increased from 2010 to 2011 to 2012.

These systems form a useful natural laboratory for exploring mechanisms of Fe delivery, and also for testing the controls on quantitative uptake of all bioactive metals by the phytoplankton assemblage, a primary step in the overall biogeochemical cycling of metals. We will summarize our extensive dissolved and particulate dataset to systematically explore controls on, and variability in the Fe, Mn, Zn, Cu, Cd, Ni, Co, V, and Mo content of surface water cellular assemblages, inferred from particulate metal/P ratios.