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Benthic sediments are a primary source of dissolved trace metals to Antarctic waters: Case studies from various Antarctic continental shelves

JESSICA N. FITZSIMMONS[1], JANELLE M. STEFFEN[1], TEAGAN BELLITTO[1], VENKATESH CHINNI[2], TIM M. CONWAY[3], AMBER ANNETT[4] AND ROBERT M SHERRELL[2]

[1]Texas A&M University
[2]Rutgers University
[3]University of South Florida
[4]University of Southampton

The Southern Ocean plays a disproportionate role in both the global carbon cycle, accounting for ~25% of atmospheric carbon dioxide (CO_2) uptake from just 10% of the global ocean surface, and climate, as Southern Ocean carbon sequestration has been implicated in the CO_2 drawdown driving glacial-interglacial cycles. However, Southern Ocean primary production is well known to be limited by iron and sometimes other micronutrients such as manganese, zinc, and vitamin B12. Thus, metal fluxes to the Southern Ocean are critical to quantify and understand. Potential metal sources to the Southern Ocean include upwelling of deep waters, dust, sediments, glacial melt, and sea ice melt. Notably, many of these fluxes are supplied directly to Antarctic continental shelf basins, which are known biological hotspots and can serve to attenuate iron fluxes reaching offshore Southern Ocean waters. Here, we will combine new dissolved metal data from the West Antarctic Peninsula (WAP) and Amundsen Sea (AS) with historical data from the Ross and Weddell Seas to show that sediments are a nearly universal primary source of dissolved trace metals to Antarctic shelf systems. New data from the WAP shows that multiple metals are supplied to Circumpolar Deep Waters (CDW) as they transit continental shelves as modified CDW. The added metal suite suggests that both reductive and non-reductive benthic sediment fluxes provide metals to mCDW. Additionally, new data from the AS shows that water flowing into and out of ice shelf cavities have similar dissolved metal concentrations, such that glacial melt cannot be a significant dissolved metal source. Instead, benthic sediments supplying dissolved metals to inflowing mCDW is responsible for the majority of the elevated metal signature attributed to glaciers, with the glacial freshwater simply lifting metal-rich deep waters to the surface. We will conclude with a summary of how integrative studies of metal concentrations, isotopes, speciation, biological drawdown, and Antarctic circulation are required to fully understand how metals from the Antarctic continent are transported offshore into the Southern Ocean, a question of critical impact for past, current and future estimates of global carbon cycling and climate.