Bioactive trace metals in phytoplankton assemblages of Western Antarctic Peninsula (WAP) shelf waters

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Uptake of bioactive trace metals by phytoplankton is a fundamental process in the overall trace metal biogeochemistry of the ocean. Iron limitation is relieved in coastal Antarctic regions by continental inputs, but the details of the sources and timing of natural Fe fertilization are poorly known, as is the multi-element metal composition of the extant phytoplankton assemblages. Here we present surface water (2m) dissolved (dTM) and particulate (pTM, >0.45μm) distributions for Fe and a suite of bioactive metals over much of the WAP shelf, covering the sampling grid during the Palmer LTER 2010, 2011 and 2012 programs. A novel finding is that a large portion of the northern half of the grid is characterized by low dFe (~100pM) and low pFe (~200pM), similar to levels in the open Southern Ocean. Macronutrient distributions suggest Fe removal by early season diatom blooms, creating apparent Fe-limiting conditions across broad swaths of the shelf region in January. This low Fe region is larger and spreads further south with each successive sampling year.

Metal quotas of natural phytoplankton assemblages can be inferred from ICP-MS determined particulate metal/P ratios, after correcion for co-sampled inorganic particles. We find surface distributions of metal/P that are spatially and temporally coherent, generating mostly smooth and moderate gradients over the grid and between sampling years. We will interpret the magnitude and variability of these Me/P quotas as a function of dissolved metal availability, degree of Fe stress, water column stratification, macronutrient drawdown, glacier and sea ice meltwater inputs, and taxonomic information. Approximate overall median values are: Fe/P<5, Zn/P~6, Mn/P~0.8, Cu/P~0.8, Cd/P~0.8, Ni/P~0.6, V/P~0.6, Co/P~0.02, and Mo/P~0.02 (all in mmol/mol). Variability about these median values is ~2-fold in some cases, but the data also contain evidence for remarkable metal homeostasis. We discuss these metal distributions in the context of ongoing rapid climate warming in this region.