

# **Biogeochemical controls on trace element concentrations in Antarctic meltwaters**

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Saline brines form in inland Antarctic environments through processes of evaporation (or ablation) and freeze concentration. If trace elements were to behave as conservatively as major ions such as chloride during brine formation, their concentrations would become elevated to a similar degree; in many cases to levels which could be toxic to aquatic organisms.

The concentrations of dissolved and particulate-bound trace elements; Cu, Pb, Zn, As, Cd, Mn and Ag were measured in a variety of saline brines and their source meltwaters in the Dry Valleys and on the McMurdo Ice shelf of Victoria Land. Matrix interference in the analysis of the saline brines was overcome by using matrix modified standards, and sample analysis was undertaken in triplicate (at various sample dilutions) using both graphite furnace AAS or hydride generation AAS (for As) and ICP-MS. Other parameters defining water chemistry were also measured including; major ions (by HPIC), Fe (by ICP-AES), pH, DO and H<sub>2</sub>S.

Manganese was the only trace element to consistently experience a similar degree of enrichment to that observed for conservative major ions, with concentrations of up to 6500 µg/kg. Factors potentially controlling the solubility of the other trace elements were assessed by;

- a) Geochemical modelling of the saturation indices of trace element mineral salts in the brine
- b) SEM/EDAX examination of sediments and cyanobacterial mats in contact with the brines
- c) Analysis of the degree of association with particulate phases
- d) Surface complexation modelling of adsorption onto Fe-oxide surfaces in suspended particulate material.

In oxic brines, adsorption onto particulate phases was identified as the principal process controlling the concentration of these trace elements. In the most saline brines, saturation with respect to various carbonate and hydroxycarbonate salts (Pb, Cu, Zn and Cd), or chloride salts (Ag) was predicted. Co-precipitation of Pb with carbonate biomineralization in a cyanobacterial mat was observed. However, the single most important factor controlling long term trace element concentrations (i.e., beyond a single freeze/thaw cycle) was predicted to be the precipitation of trace element-sulfide minerals. Anoxic, sulfidic conditions occur through the action of sulfate-reducing bacteria in the lower water column of deep lakes, but also within cyanobacteria biofilms in otherwise oxic, shallow pond environments.