Trace elements in Arctic sea ice and snow

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Statement of interest for attending the US GEOTRACES Arctic implementation workshop

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The nature of the work we are interested in conducting during the Arctic cruise deals with the trace-metal-clean collection of sea ice, brine, and snow, and the analysis of key trace elements (Fe, Al, Zn, Mn, Cd, Cu) as well as Pb in these samples. Data collection will include: 1) the vertical distribution (every 5 to 10 cm) of the particulate and dissolved trace metal fractions within the sea ice column; 2) particulate and dissolved trace metals in brine (gravity-driven collection) and in snow; 3) Auxiliary parameters such as ice thickness, ice temperature and salinity profiles, snow thickness, snow temperature, brine salinities; 4) opportunistic on-board snow collection during snow events. We have experience collecting, processing, and analyzing sea ice and snow for the determination of iron (Aguilar-Islas et al., 2008) and other trace elements (Rember and Trefry, 2004). We have worked in several ice covered regions such as the Bering Sea, the Beaufort Sea, and the Ross Sea.

A second aspect of our interest in this cruise is the collection of samples for the community in order to extend sea ice and snow analysis to other key parameters. Our current ice core sampling technique includes a time-intensive cleaning step which could limit our ability to provide samples for the community. We have been working on a clean corer design that would remove this time-consuming post-cleaning step. The opportunistic on-board snow collection will tie in with the atmospheric deposition work that Bill Landing's group is proposing.

Justification in terms of GEOTRACES objectives

Our sea ice/snow work would relate directly to objectives 1 and 2 of the GEOTRACES program (GEOTRACES Science Plan), in particular to sections highlighted in italic.

1. "To determine global ocean distributions of selected trace elements and isotopes – including their concentration, chemical speciation and physical form – and *to evaluate the sources, sinks, and internal cycling of these species to characterize more completely the physical, chemical and biological processes regulating their distribution*."
2. "*To understand the processes involved in oceanic trace-element cycles sufficiently well that the response of these cycles to global change can be predicted*, and their impact on the carbon cycle and climate understood."

The movement and the formation/melting cycle of sea ice are processes likely important in regulating the distribution of TEIs in the Arctic Ocean. How changes in sea ice distribution, extent and thickness in the Arctic Ocean affect TEIs needs to be understood if we are to predict future changes in TEI cycling in the Arctic. Sea ice is heterogeneous by nature, and a first step in evaluating the role of sea ice in TEI cycling in the Arctic is to quantify the physical partitioning and concentration ranges of TEIs within sea ice and the snow layer above.

References:

Aguilar-Islas A.M., R. Rember, C. Mordy, and J. Wu. 2008. Sea ice-derived dissolved iron and its potential influence on the spring algal bloom in the Bering Sea. *Geophysical Research Letters, 35*, doi:10.1029/2008GL035736.

Rember R.D., J. H. Trefry. 2004 Increased concentrations of dissolved trace metals and organic carbon during snowmelt in rivers of the Alaskan Arctic. *Geochimica et Cosmochimica Acta, 68*, doi:10.1016/S0016-7037(03)00458-7