BOEM ENVIRONMENTAL STUDIES PROGRAM: Ongoing Studies

Region: Alaska

Planning Area(s): Beaufort Sea, Chukchi Sea

Title: Distribution and Abundance of Select Trace Metals in Chukchi and Beaufort Sea Ice (AK-13-03-04)

BOEM Information Need(s) to be Addressed: Anthropogenic contaminants from local, regional, or global sources can contribute to the abundance and distribution of trace metals in sea ice and therefore could significantly affect the distribution of dissolved trace metals in surface waters. Offshore exploration and development products (e.g. drilling muds, produced water or oil) are potential local and regional sources, while atmospheric emissions from industrialized regions captured in winter snow are potential regional and global sources. Results from this project will improve understanding of trace metal distribution and abundance in the Arctic sea ice environment, and on its role as a source of trace metals in the water column. BOEM analysts and decision-makers will use this information in NEPA analysis and documentation for Lease Sales, EPs and DPPs.

Total Cost: $262,073
plus Joint Funding ($262,073)

Period of Performance: FY 2013-2017

Conducting Organization: CMI, UAF

BOEM Contact: Dr. Heather Crowley

Description:

Background: Increased oil and gas activities in the offshore Alaskan Arctic can potentially lead to changes in the natural environment. Offshore exploration and extraction of mineral resources in the Alaskan Arctic under a changing sea ice environment emphasizes the need to better understand the role of natural environmental processes in the retention, transport, and subsequent release of trace metals in sea ice. Concentrations of trace elements in seawater and sediments in the nearshore Beaufort Sea development area have been well constrained by numerous studies during the last 20 years, including the ANIMIDA and cANIMIDA projects. In contrast, there are no data for dissolved trace metals in Alaskan Arctic sea ice and a very limited number of unpublished data points for particulate metals. Sea ice samples were collected during the cANIMIDA projects, but contamination issues stemming from the type of corer used precluded the measurement of dissolved trace elements.

The concentrations of certain trace metals are significantly elevated in sea ice relative to seawater, as indicated by results of previous studies in Antarctica and the Bering Sea. Consequently, sea ice melt has been shown to increase concentrations of some elements in surface waters, but the processes controlling the retention and subsequent release of trace metals in sea ice are not well understood. Possible mechanisms include: 1) trace metals mobilized into the dissolved phase from suspended sediments that were trapped

during sea ice formation; 2) trace metals mobilized from aerosols deposited onto the sea ice as snow begins to melt; 3) trace metals that vary only as a function of salinity and have limited particle reactivity (i.e. Barium and Aluminum); or 4) trace metals concentrated within brine channels during ice formation, and as the base of the sea ice interacts with the upper water column during the growing season. Understanding the relative importance of these mechanisms will provide the basis for understanding how trace metals (naturally occurring and anthropogenic) are retained, transported, and released by sea ice.

Objectives:

- Manufacture and test a trace metal clean ice corer.
- Conduct laboratory-based experiments on sea ice retention and release of trace metals.
- Collect aerosols and surface seawater samples in the Chukchi Sea and near ice floes.
- Quantify dissolved and particulate trace metals in laboratory grown sea ice and the resulting brine/seawater mixture.
- Quantify dissolved and particulate trace element concentrations in offshore surface seawater samples.
- Quantify particulate trace element concentrations and ratios in offshore atmospheric deposition (aerosol/snow) samples.
- Quantify dissolved and particulate trace metal concentrations and ratios in ice cores collected in Camden Bay.
- Quantify dissolved and particulate trace metal concentrations and ratios in snow samples collected in Camden Bay.
- Share project results with local communities.

Methods: The researchers will build a new corer using commercially pure titanium battery powered drill head to minimize potential contamination. Laboratory experiments to investigate the cycling of trace elements in sea ice will focus on 1) the effect of sediment inclusion and brine rejection during ice formation and growth and 2) the effects of sea ice degradation on the characteristics of material exported from sea ice. These experiments will be conducted under temperature-controlled conditions in plastic tanks, and the resultant concentration of the trace metals in the sea ice and underlying waters will be monitored. Changes in the dissolved and particulate fractions will be monitored as ice grows in both the ice and remaining seawater. The ice will be allowed to grow slowly and a time series of trace metal concentrations in both seawater and ice obtained.

Offshore surface seawater and aerosols samples will be collected on board the *R/V Mirai* in collaboration with the Japanese Agency for Marine-Earth Science and Technology (JAMSTEC). Snow will be collected onboard the ship opportunistically during snow events using wide mouth plastic bottles mounted on a polyethylene pole positioned as high and forward as possible on the ship. A total of ~80-100 cores samples will be

collected from 10 stations during the sea ice sampling effort in Camden Bay. Specially designed sampling techniques will be employed to minimize contamination.

Current Status: Ongoing

Final Report Due: December 2016

Publications Completed: None

Affiliated WWW Sites: http://www.boem.gov/akstudies/
http://www.sfos.uaf.edu/cmi/

Revised Date: August 2016

ESPIS: Environmental Studies Program Information System
All *completed* ESP studies can be found
here: http://www.data.boem.gov/homepg/data_center/other/espis/espisfront.asp