University of Victoria | Graduate Studies

Notice of the Final Oral Examination
for the Degree of Master of Science

of

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BSc (Victoria University of Wellington, 2011)

"The Distribution of Dissolved Cadmium in the Canadian Arctic Ocean"

School of Earth and Ocean Sciences

Friday, November 3, 2017
8:30 A.M.
Bob Wright Centre
Room A319

Supervisory Committee:
Dr. Jay T. Cullen, School of Earth and Ocean Sciences, University of Victoria (Supervisor)
Dr. Diana E. Varela, School of Earth and Ocean Sciences, UVic (Member)
Dr. Roberta C. Hamme, School of Earth and Ocean Sciences, UVic (Member)

External Examiner:
Dr. Erik Krogh, Department of Chemistry, Vancouver Island University

Chair of Oral Examination:
Dr. Sara Beam, Department of History, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

Abstract

The biogeochemical cycling of oceanic dissolved cadmium (dCd) has been an active area of research for the past ~40 years, due in part to the close correlation with phosphate (PO4). The global Cd:PO4 relationship has led to the use of microfossil Cd/Ca as a paleoproxy for ocean circulation and nutrient utilization; however considerable spatial and temporal variability in the relationship - particularly in surface waters - limits the utility of the proxy. Understanding the global biogeochemical cycling of Cd is an active area of research; however the Arctic Ocean is largely omitted from global models due to lack of data. This work presents depth profiles of dCd and Cd/PO4 ratios from 18 individual stations in the Canadian Arctic, collected during the Canadian GEOTRACES cruises GN02 and GN03, which connects the Arctic Ocean to the North Atlantic through the Canadian Arctic Archipelago (CAA). Salinity-driven water mass stratification exerts a primary control on the spatial distribution of Cd in the region, with elevated dCd and high Cd/PO4 ratios (~0.37 pM/µM) associated with waters of Pacific-origin. The elevated dCd and Cd/PO4 ratios are used as a tracer of Pacific-origin waters, identifying the presence of Pacific-origin water through the CAA and into Baffin Bay. High surface Cd/PO4 ratios were observed across the transect, consistent with a general global increase in surface water Cd/PO4 with increasing latitude.

The analysis of Cd and other bioactive trace metals (Mn, Fe, Ni, Cu, Zn and Pb) still presents considerable analytical challenges due to the high-risks of contamination, low concentrations and complex matrices. I present a novel multi-element analytical method, which combines the commercially-available seaFAST pico preconcentration system with ICP-MS/MS analysis. In this work, we demonstrate that ICP-MS/MS, which combines two mass-selecting quadrupoles separated by an octopole collision/reaction cell, effectively removes common interferences (ArO+ on 56Fe and MoO+ on Cd) when pressurized with O2 gas. Accurate and precise measurements ofthe consensus references standards SAFe S and SAFe D and the certified reference material NASS-6 are presented as validation of the method. This thesis presents a novel method for the analysis of trace elements in seawater discusses the biogeochemical cycling of Cd in the Arctic Ocean.