

**ANNUAL REPORT ON GEOTRACES ACTIVITIES IN CANADA**  
JUNE 2013 – JUNE 2014

***General overview***

- K. Orians, M. Maldonado (Al, Ti, Fe, Cu, Mn), R. Francois (biogenic Si, POC, TIC): International particle intercalibration program, lead by P. Lam
- Line P cruises, September 2013 & 2014 (K. Orians, J. Cullen, R. Francois, M. Maldonado, A. Ross)
- SCOR Working Group on chemical speciation modelling (Maldonado) & SCOR WG 139 (Cullen)
- GEOTRACES\_CCAR: Biogeochemical and tracer study of a rapidly changing Arctic Ocean. 2 cruises in the Arctic in 2015. Organized meetings:
  1. GEOTRACES Canada Modeling Meeting at UBC (April 25, 2014): P. Myers, X. Hu (U. of Alberta), N. Steiner, T. Sou (Fisheries and Oceans Canada, Victoria), S. Allen & D. Latornell (UBC, Vancouver)
  2. Cruise planning UBC-DFO (IOS/DFO, Sidney, BC) on May 22, 2014
  3. Cruise planning: October, 2014 (Quebec) to organize cruise with ArcticNet

Arranged a cross over station with the French program GEOVIDE in the Labrador Sea (55.842°N/48.093°W)

We will have a cross over station with the US in Canada Basin

***Individual achievements***

**Alfonso Mucci**, Professor of Geochemistry and Oceanography, Department of Earth and Planetary Science, McGill University.

***Refereed journal publications***

- Miller L.A., Giesbrecht K.E., Mucci A. and Zimmerman S. (2014) Changes in the marine carbonate system of the western Arctic: Patterns in a rescued data set. Polar Research (in press, accepted April 10, 2014)
- Giesbrecht K.E., Miller L.A., Zimmerman S., Carmack E., Johnson W.K., Macdonald R.W., McLaughlin F., Mucci A., Williams W.J. and Wong C.S. and Yamamoto-Kawai M. (2014) Measurements of the dissolved inorganic carbon system and associated biogeochemical parameters in the Canadian Arctic, 1974-2009. Earth System Science Data 6: 91-104. doi: 10.5194/essdd-6-91-2014.
- Else B.G.T., Papakyriakou T., Asplin M., Barber D., Galley R., Miller L. and MucciA. (2013) Annual cycle of air-sea CO<sub>2</sub> exchange in an Arctic Polynya Region. Global Biogeochem. Cycles 27: 388-398. doi:10.1002/gbc.20016
- Else B.G.T., Galley R.J., Lansard B., Barber D.G., Brown K., Miller L.A., Mucci A., Papakyriakou T.N., Tremblay J.-É. and Rysgaard S. (2013) Further observations of a decreasing atmospheric CO<sub>2</sub> uptake capacity in the Canada Basin (Arctic Ocean) due to sea ice loss. Geophys. Res. Letts. 40: 1132–1137, doi:10.1002/grl.50268.

*Abstracts and conference presentations*

- MUCCI A., MICHEL C., NIEMI A. and HÉLIE J.-F.(2014) Kinetic fractionation of stable hydrogen and oxygen isotopes upon sea-ice formation.Contributed poster presentation.24rd V.M. Goldschmidt Conference, June 8-13, Sacramento, California.
- MUCCI A., MICHEL C., NIEMI A. and HÉLIE J.-F.(2014) Kinetic fractionation of stable hydrogen and oxygen isotopes upon sea-ice formation.Contributed oral presentation.Annual Congress of the Canadian Meteorological and Oceanographic Society, June 1-5, Rimouski, Quebec.
- EVANS W., MATHIS, J., CROSS, J., FREY K., ELSE B., PAPAKYRIAKOU T., BATES N., DEGRANPRE M., PETERSON B., CAI W.-J., CHEN B., MUCCI A., YAMAMOTA-KAWAI M., MILLER L., CARMACK E., WILLIAMS B., and TAKAHASHI T. (2014) A synthesis of Arctic coastal sea-air CO<sub>2</sub> fluxes surrounding the Canada Basin. Contributed oral presentation.Ocean Sciences Meeting, February 23-28, Honolulu, Hawaii.
- CULLEN J., ZHOU J., LANSARD B. and MUCCI A. (2013) Dissolved iron in the Beaufort Sea and Canada Basin, Arctic Ocean. Contributed poster, Gordon Research Conference in Chemical Oceanography, August 4-9, University of New England in Biddeford, Maine, U.S.A.

**Jay Cullen, Associate Professor**, School of Earth and Ocean Sciences, University of Victoria, BC

*Refereed journal publications (\* indicates UVic graduate student/HQP)*

- \*\*Janssen, D. J., T. M. Conway, S. G. John, J. R. Christian, D. I. Kramer, T. F. Pedersen, and J. T. Cullen (2014), Undocumented water column sink for cadmium in open ocean oxygen-deficient zones, *Proceedings of the National Academy of Sciences*, 111(19), 6888-6893.
- \*\*Giesbrecht, T., N. Sim, K. J. Orians, and J. T. Cullen (2013), The distribution of dissolved and total dissolvable aluminum in the Beaufort Sea and Canada Basin region of the Arctic Ocean, *Journal of Geophysical Research-Oceans*, 118(12), 6824-6837.
- Taylor R. L., D. M. Semeniuk, C. D. Payne, \*\*J. Zhou, J. E. Tremblay, J. T. Cullen, and M. T. Maldonado (2013), Colimitation by light, nitrate, and iron in the Beaufort Sea in late summer, *Journal of Geophysical Research-Oceans*, 118(7), 3260-3277.

*Abstracts and conference presentations (\* indicates invited presentation, \*\* indicates UVic graduate student/HQP, \*\*\* indicates UVic undergraduate student)*

- 2014 Cullen, J.T., \*\*D.J. Janssen, J. Christian, T.M. Conway and S.G. John. An Undocumented Water Column Sink for Cadmium in Open Ocean Oxygen Minimum Zones.Goldschmidt 2014, Jun. 8-13, Sacramento, CA USA.
- 2014 Galer, S.J.G., W. Abouchami, R. Xie, \*\*D.J. Janssen, M. Rijkenberg, L. Gerringa, J.T. Cullen and H. de Baar. Global Oceanic Cadmium Isotope Distribution.Goldschmidt 2014, Jun. 8-13, Sacramento, CA USA.
- 2014 John, S.G., T.M. Conway, \*\*D.J. Janssen and J.T. Cullen. Cadmium Sulfide Formation in Low-Oxygen Waters of the North Atlantic. Goldschmidt 2014, Jun. 8-13, Sacramento, CA USA.

- 2014 \*\*Janssen, D.J., J.T. Cullen, W. Abouchami, S.J.G. Galer and H. de Baar. Cadmium Isotopes along the Line-P Transect in the Northeast Subarctic Pacific. Goldschmidt 2014, Jun. 8-13, Sacramento, CA USA
- 2014 \*Cullen, J.T. and \*\*J. Zhou. Deep-sea Loss of Dissolved Iron in the Arctic Ocean: Potential Insight into the Oceanic Budget of an Essential Trace Nutrient. Canadian Chemistry Conference and Exhibition, Jun. 1-5, Vancouver, BC Canada.
- 2014 Semeniuk, D.M., M.T. Maldonado, A. Posacka, C.P. Payne, J.T. Cullen, R.M. Bundy and K.A. Barbeau. Assessing Copper Nutrition of Natural Marine Phytoplankton Populations Using <sup>67</sup>Cu. Canadian Chemistry Conference and Exhibition, Jun. 1-5, Vancouver, BC Canada.
- 2014 \*\*D.J. Janssen and J.T. Cullen. Improvements to a Fluorescence-Based Flow-Injection Method For Shipboard Determination of Dissolved Zn. 2014 Ocean Sciences Meeting, Feb. 23-28, Honolulu, HI USA.
- 2014 \*\*Schallenberg, C., \*\*\*A.B. Davidson and J.T. Cullen. Iron(II) Variability in the Northeast Subarctic Pacific Ocean. 2014 Ocean Sciences Meeting, Feb. 23-28, Honolulu, HI USA.
- 2014 Vance, D., S. Little, Y. Zhao, J.T. Cullen, G. de Souza and M.C. Lohan. The Oceanic Cycle of Zinc and its Isotopes: The Key Roles of Southern Ocean Export and Vertical Biogeochemical Cycling
- 2013 Cullen, J.T., \*\*J. Zhou, R. Taylor, D. Semeniuk and M.T. Maldonado. Dissolved Iron and the Co-limitation of Phytoplankton Growth in the Beaufort Sea, Arctic Ocean. Goldschmidt 2013, Aug. 25-30, Florence, Italy.
- 2013 Cullen, J.T., \*\*J. Zhou, B. Lansard, A.L. Mucci. Dissolved Iron in the Beaufort Sea and Canada Basin, Arctic Ocean. Gordon Research Conference (Chemical Oceanography), Aug.4-9, University of New England, Biddeford ME USA.

#### *SCOR Working Groups*

- Associate Member SCOR WG-139 on Organic Ligands – A Key Control on Trace Metal Biogeochemistry in the Ocean

#### *Research Cruises*

- Continued involvement in Line P Time-Series Cruises in the subarctic Pacific (Chief Scientist Marie Robert, IOS DFO Canada)

**Susan Allen**, Associate Professor, Earth, Ocean & Atmospheric Sciences, UBC, Vancouver, BC.

#### *Modelling Meeting*

- Organized a GEOTRACES Canada Modelling Meeting at UBC on April 25, 2014. Participants: Paul Myers, Xianmin Hu (University of Alberta, Edmonton), Nadja Steiner, Tessa Sou (Environment Canada/Fisheries and Oceans Canada, Victoria), Susan Allen and Doug Latornell (University of British Columbia, Vancouver)

**Andrew Ross** (Environment Canada/Fisheries and Oceans Canada, Sidney, BC)

- Applied for the Line-P Iron Program to be recognized as a Process Study by GEOTRACES
- Method development for metal ligand extraction for the Canadian Arctic GEOTRACES project (in collaboration with M. Maldonado)
- Presented a poster on the Line-P Iron Program at the 2014 Ocean Sciences Meeting (see attached)
- Attended a Town Hall Meeting of the SCOR Working Group 139 on Organic Ligands during OSM 2014 (and getting added to their mailing list!).
- Responded to a request from the OSM Session 80 Chair (Rob Middag, UOtago) for papers relating to presentations made during that "Biogeochemistry of Trace Elements and their Isotopes" session; proposed title for paper: " The Line-P Iron Program: Exploring the Biogeochemistry of Trace Elements and Isotopes in the NE Pacific".

**Roger Francois**, Professor Earth, Ocean & Atmospheric Sciences, UBC, Vancouver, BC.

- Developing our method to measure Nd isotopes in seawater.
- Participated in the International particle intercalibration lead by Phoebe Lam, measured biogenic Si, POC, TIC

**Chris Holmden**, Professor and Director, Saskatchewan Isotope Laboratory

- Cr isotope profiles from the IPY cruise in 2009. A paper will be submitted by the end of June.

**Maite Maldonado**, Associate Professor, Earth, Ocean & Atmospheric Sciences, UBC, Vancouver, BC.

*Refereed journal publications*

- Taylor, R.L, D.M. Semeniuk, C. D. Payne, J. Zhou, J.E. Tremblay, J. T. Cullen, and M.T. Maldonado. 2013. Co-limitation by Light, Nitrate and Iron in the Beaufort Sea in Late Summer. JGR Oceans 118, 1–17, doi:10.1002/jgrc.20244.

*Abstracts and conference presentations*

- Schuback, N., C. Schallenberg, C. Duckham, P.D. Tortell, M.T. Maldonado. FRRF as a tool to assess Phytoplankton Photo-Physiology and Primary Productivity - Field Studies in the iron limited subarctic NE Pacific Ocean. Ocean Sciences Meeting. Honolulu, Hawaii, USA. February 2014.
- Semeniuk, D. M., A. Posacka, R. Bundy, K. Barbeau, M. T. Maldonado. Impact of Cu speciation on primary productivity in the northeast subarctic Pacific Ocean. Ocean Sciences Meeting. Honolulu, Hawaii, USA. February 2014.

### *SCOR Working Groups*

- Full Member of the proposed SCOR Working Group: chemical speciation modelling. Proposal submitted by Simon Clegg and David Turner on April 2014
- My PhD student, Carolyn Duckham has joined the SCOR Working Group(WG139) "Organic Ligands-A key control on trace metal cycling in the ocean"

### *Research Cruises*

- Participated in Line P Time-Series Cruises in the subarctic Pacific in August-September 2013 (Chief Scientist Marie Robert, IOS DFO Canada)

**Kristin Orians**, Associate Professor, Earth, Ocean & Atmospheric Sciences, UBC, Vancouver, BC.

- PhD student NariSim participated in the International Particle Intercalibration lead by Phoebe Lam, measured trace elements (Al, Ti, Fe, Cu, Mn)

### *Research Cruises*

- Participated in Line P Time-Series Cruises in the subarctic Pacific in August-September 2013 (Chief Scientist Marie Robert, IOS DFO Canada)

**Paul Myers**, Professor, Earth & Atmospheric Sciences, University of Alberta, Edmonton, Alberta, CA.

### *Presentations*

- Arctic-Subarctic Ocean Fluxes (ASOF) Workshop, Helsinki, Nov. 2013
- Danish Meteorological Institute Seminar, Copenhagen, Nov. 2013

### *Posters*

- North-Atlantic Arctic Planning Workshop, Washington, D.C., April 2014

### *SCOR activities*

- Chair of the Canadian National Committee for SCOR

**Diana Varela**, Associate Professor, School of Earth and Ocean Sciences, University of Victoria, BC

- Sutton, J.N., D.E. Varela, M.A. Brzezinski and C.P. Beucher. 2013. Species-dependent silicon isotope fractionation by marine diatoms. *Geochimica et Cosmochimica Acta* 104, 300-309, doi:10.1016/j.gca.2012.10.057.
- Varela, D.E., M.A. Brzezinski, C.P. Beucher, J.L Jones and K.E. Giesbrecht. Silicon isotope composition of silicic acid and biogenic silica on the Beaufort shelf and in the Canada Basin of the Arctic Ocean. In prep (last stages)

- Brown, K.A., et al. . 2014. Determination of particulate organic carbon sources to the surface mixed layer of the Canada Basin, Arctic Ocean. *Journal of Geophysical Research* "Oceans" 119(2), 1084-1102, DOI: 10.1002/2013JC009197.

**Bridget Bergquist**, Department of Earth Sciences, University of Toronto.

My GEOTRACES activities include Fe and Pb isotopes in seawater along with aerosol collection, which involves aerosol collection, metal analyses and dissolution studies. In preparation for collection of aerosols at sea, we (me and one PhD student) have deployed aerosol collectors at Station Alert in the Arctic starting in spring 2013 in collaboration with Environment Canada. These samples will be used to develop our procedures for trace metal and isotope analyses and dissolution studies. Two sets of aerosol filters have been returned and are frozen, and the collectors were re-deployed in March 2014. We also collected snow samples in order to assess the challenges of trace metal sampling of natural samples and in preparation for sampling of sea ice. One PhD student is currently analyzing the first and second set of filters for total metals and Hg isotopes. I also started a masters student who is developing the methods for measuring Pb and Pb isotopes in our laboratory. Along with metal and isotope analyses, the PhD student will also assess different methods to estimate the dissolvable or bioavailable fraction of metals in seawater. Equipment has been purchased for the metal analyses and for the dissolution studies. The filter collection rigs are currently being borrowed from Environment Canada to assess what filter collection system will work best for trace metals and for the low aerosol loads that are expected. The second PhD student will start preparing bottles for trace metal clean seawater collection this year and assist in snow metal analysis. One PhD student will also travel to Florida State for training on the aerosol collection equipment.

**Jack Cornett**, Department of Earth Sciences, University of Ottawa.

#### *I-129, Cs-135/137 and U-236*

The measurement of I-129 in sea water is well established so the analytical development work for the GEOTRACES program is focused upon developing techniques to measure the Cs-135 and U-236 isotopes. An MSc student (Cole MacDonald) has successfully developed and tested an accelerator mass spectrometry technique to produce a Cs negative ion beam. His method uses a CsF- PbF<sub>2</sub> target matrix. This work has improved the current of the Cs-135 beam by more than 5 fold. His experiments also determined methods to improve the stability of the Cs ion beam. The figure below shows the spectrum from an AMS measurement. This work has been submitted to *Rapid Advance in Mass Spectrometry*. Two presentations have also been accepted for this work and they are summarized below.

A second MSc student (Daniel Sauve) started his thesis work in September 2013. He has worked with Zakir Kazi (PDF) to develop the precipitation and column extraction methods that are needed to measure Cs and U isotopes in sea water. He is participating in the Bedford Institute for Oceanography cruise to the Labrador Sea to test these methods. Upon return his samples will be analyzed by AMS for U and I isotopes and the Cs will be determined by gamma counting.

*List of Publications and Presentations*

- MacDonald Cole, Charles, Christopher, Zhao Xiaolei, Kieser, William, Cornett, Jack, 2014.
- Development of a Cs Isotope Measurement Technique for AMS.AMS 13 Abstract GAA28, Aix-en Provence France, 2014
- MacDonald Cole, Charles, Christopher, Zhao Xiaolei, Kieser, William, Cornett, Jack, 2014.
- Measurement of Cs-135 by AMS.CAP-2014 Abstract M01, Sudbury, Canada
- MacDonald, C., C. R. J. Charles, J. Cornett, X.L. Zhao, W.E. Kieser, A. E. Litherland. 2014
- Development of a Cs Isotope Measurement Technique for Accelerator Mass Spectrometry.Submitted to Rapid Advances in Mass Spectrometry.

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