

## ANNUAL REPORT ON GEOTRACES ACTIVITIES IN CANADA

April 1st, 2021 to April 30th, 2022

During the last year Canadian PI's continue to work closely with US and European colleagues on Arctic GEOTRACES synthesis projects and a number of jointly authored manuscripts are planned, in progress or published at this point. The Canadian GEOTRACES community continues to support an ongoing process study making observations of bioactive trace elements and trace element- microbe interactions on time-series cruises completed along Line P in the northeast Pacific. The Canadian community is examining the impact of recent marine heatwaves on chemical and biological fields along Line P. Of note is a new and historic agreement between the Université Laval and the Ifremer to foster collaboration between Canadian and French oceanographers in the Arctic and North Atlantic that should promote GEOTRACES relevant research. The partnership includes ship-time exchange between the icebreaker CCGS Amundsen and three science vessels of the French Fleet: the Pourquoi Pas?, the Thalassa and the Atalante. This sharing of research platforms will coordinate research efforts to study high latitude marine environments and their response to ongoing climate change in line with GEOTRACES research objectives.

Our new, GEOTRACES relevant scientific results, publications and presentations are summarized below.

### ***GEOTRACES or GEOTRACES relevant cruises***

- Jean-Eric Tremblay (ULaval) and Jay Cullen (UVic) conducted trace element and isotope sampling in the Canadian Arctic as part of the ArcticNet supported NTRAIN program (<https://arcticnet.ulaval.ca/project/nutrient-fluxes-and-living-marine-resources-in-the-inuit-nunangat/>) in the eastern, central and western Arctic Ocean.
- Jay Cullen (UVic), Maite Maldonado (UBC), Andrew Ross (DFO) Samples for trace elements and copper ligand measurement were collected using GEOTRACES protocols during Line P cruises in 2021 and 2022 as part of the Line P Iron Program, a GEOTRACES Process Study (GPpr07). Samples for Fukushima derived radionuclides were collected in collaboration with John N. Smith (DFO).

### ***New projects and/or funding relevant to GEOTRACES***

- A new project that overlaps with Line P (stations P16, P20 and P26) and expands monitoring of copper ligands in the subarctic NE Pacific to a zone encompassing 38 stations has been approved for funding by the North Pacific Anadromous Fish Commission (NPAFC) and BC Salmon Restoration Initiative Fund (BC SRIF):
- Cullen, J.T., Peña, A., Ross, A.R.S. 2021-2023. Linking salmon survival to climate change through its impact on primary production via nutrient and metal ligand distributions in the North Pacific. International Year of the Salmon (IYS) 2022 Pan-Pacific Winter High Seas Expedition. NPAFC/BC SRIF (\$69 K/yr).
- Funding from the new Fisheries and Oceans Canada (DFO) Competitive Science Research Fund (CSRF) to support sampling and analysis of trace metals and ligands along Line P (GEOTRACES Process Study GPpr07) has also been approved for the next 3 years:

- Ross, A.R.S., Peña, A., Christian, J. 2021-2024. Predicting marine productivity in a changing climate - linking phytoplankton biomass and ecology to ocean conditions and related changes in the availability of essential trace metals. DFO/CSRF (\$43 K/yr).
- Myers, P. (U. Alberta) and 7 others 2022-23 Ecosystems and Ocean Science Contribution Framework Open Call for Proposals. Understanding the bio-physical processes impacting the evolution of Tallurutiup Imanga and Pikialasorsuaq in a warming climate DFO \$717,063
- Else, B. (U. Calgary) and others 2022. FoxSIPP: The Foxe Basin Sea Ice Pump Project. NSERC Ship Time \$210,000
- Bhatia, M. (U. Alberta) and others 2022. The changing coastal environment in the Canadian High Arctic: Past, present, and future. NSERC Ship Time \$118,000

### ***GEOTRACES relevant workshops and meetings organized***

- Waterman, S. (UBC) 55<sup>th</sup> Canadian Meteorological and Oceanographic Society (CMOS) Congress, virtual, May 202. Primary Session Chair: “*The Changing Arctic Ocean*”
- Waterman, S. (UBC) ArcticNet Annual Scientific Meeting, virtual, Dec 2021. Primary Session Chair: “*Ocean dynamics in the Arctic: from coast to open ocean*”
- Maldonado, M. (UBC). BioGeoSCAPES Ocean metabolism and nutrient cycles on a changing planet. CSIR – National Institute of Oceanography, Goa, India. July 15, 2021
- Maldonado, M. BioGeoSCAPES community building in other countries. A US National Biogeoscapes Workshop supported by OCB November 10-12, 2021 (<https://www.us-ocb.org/ocb-scoping-workshop-laying-the-foundation-for-a-potential-future-biogeoscapes-program/>)

### ***Outreach activities conducted***

- Podcast (Maldonado); September 21, 2021. Episode 10: Unraveling the mysteries of the Indian Ocean by Nature India (<https://www.nature.com/articles/d44151-021-00050-w>)

### ***New GEOTRACES or GEOTRACES-relevant publications (published or in press)***

- Colombo, M., J. Li, B. Rogalla, S.E. Allen, M.T. Maldonado. 2022. Particulate trace element distributions along the Canadian Arctic GEOTRACES section: shelf-water interactions, advective transport and contrasting biological production. *Geochimica et Cosmochimica Acta*, 323: 183-201. doi.org/10.1016/j.gca.2022.02.013
- Colombo, M., B. Rogalla, J. Li, S.E. Allen, K.J. Orians, M.T. Maldonado. 2021. Canadian Arctic Archipelago shelf-ocean interactions: a major iron source to Pacific-derived waters transiting to the Atlantic. *Global Biogeochemical Cycles* 35 (10) id. e07058. <https://doi.org/10.1029/2021GB007058>
- Cooke M., M. Trudel, J.P. Kellogg, J.T. Cullen, J.F. Mercier and J. Chen. (2022). Radioactivity concentration measurements in fish samples collected (2011-2019) from the west coast of Canada after the Fukushima accident. *Journal of Environmental Radioactivity*.
- De Vera J. , P. Chandan , P. Pinedo-González , S.G. John , S.L. Jackson , J.T. Cullen , M. Colombo, K.J. Orians , B.A. Bergquist. (2021) Anthropogenic lead pervasive in Canadian

Arctic seawater. Proceedings of the National Academy of Sciences. 118(24)  
<https://doi.org/10.1073/pnas.2100023118>

- Jensen, J., J.T. Cullen, S.L. Jackson, L. Gerringa, D. Bauch, R. Middag, R.M. Sherrell, J. Fitzsimmons. (2022). A novel relationship between dissolved copper and nickel in the Arctic Ocean. *Journal of Geophysical Research – Oceans*.
- Krisch, S., M.J. Hopwood, S. Roig, L.J.A. Gerringa, R. Middag, M.M. Rutgers van der Loeff, M.V. Petrova, P. Lodeiro, M. Colombo, J.T. Cullen, S.L. Jackson, L. Heimbürger-Boavida, E.P. Achterberg. (2022). Arctic-Atlantic exchange of iron, manganese, cobalt, nickel, copper and zinc with a focus on Fram Strait. *Global Biogeochemical Cycles*.
- Kuang, C, M. Maldonado, J.T. Cullen, R. Francois. (2022). Factors controlling the temporal variability and spatial distribution of dissolved cadmium in the coastal Salish Sea. *Continental Shelf Research*.
- Meyer, A.C.S., J.T. Cullen, D. Grundle. (in revision). Nitrous oxide distributions in the oxygenated water column of the Sargasso Sea. *Atmosphere-Ocean*.
- Meyer, A.C.S., D. Grundle, J.T. Cullen. (2021). Selective uptake of rare earth elements in marine systems as an indicator of and control on aerobic bacterial methanotrophy. *Earth and Planetary Science Letters*. 558, <https://doi.org/10.1016/j.epsl.2021.116756>
- Nixon, R.L., M.A. Peña, R. Taves, \*D.J. Janssen, J.T. Cullen, A.R.S. Ross (2021). Evidence for the production of copper-complexing ligands by marine phytoplankton in the subarctic northeast Pacific. *Marine Chemistry* 237 <https://doi.org/10.1016/j.marchem.2021.104034>
- Shaked, Y., B.S. Twining, A. Tagliabue and M.T. Maldonado. 2021. Probing the bioavailability of dissolved iron to marine eukaryotic phytoplankton using in situ single cell iron quotas. *Global Biogeochemical Cycles*. 35, e2021GB006979. <https://doi.org/10.1029/2021GB006979>
- Taves, R., D.J. Janssen, M.A. Peña, A.R.S. Ross, K.G. Simpson, W.R. Crawford, J.T. Cullen. (2022). Relationship between surface dissolved iron inventories and net community production during a marine heatwave in the subarctic northeast Pacific. *Environmental Science: Processes and Impacts*.
- Whitmore, L.M., A.M. Shiller, T. Horner, Y. Xiang, D. Bauch, F. Dehairs, P. Lam, J. Li, M.T. Maldonado, C. Mears, R. Newton, A. Pasqualini, H. Planquette, R. Rember, and H. Thomas. 2022. Strong Margin Influence on the Arctic Ocean Barium Cycle Revealed by Pan-Arctic Synthesis *Journal of Geophysical Research: Oceans*, 127, e2021JC017417. <https://doi.org/10.1029/2021JC017417>

### ***GEOTRACES presentations in international conferences***

- Rogalla, B., Colombo, M., Li, J., Allen, S., Oriens K., Maldonado M.T. Shelf-ocean interactions in the Canadian Arctic Archipelago as a major source of iron to the Pacific derived waters transiting to the North Atlantic. Ocean Sciences Meeting 2022. Honolulu, HI, USA. February 27-March 4, 2022.
- Colombo, M., Li, J., Rogalla, B., Desai, D., LaRoche, J. Allen, S. Maldonado M.T. Particulate trace element dynamics in the Canadian Arctic Ocean. Ocean Sciences Meeting 2022. Honolulu, HI, USA. February 27-March 4, 2022.

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