ANNUAL REPORT ON GEOTRACES ACTIVITIES IN CANADA

April 1st, 2019 to April 30th, 2021

During the last year Canadian PI's continue to work closely with US 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. Cullen is coordinating US colleagues to qualify the trace element sampling program for EXPORTS as a GEOTRACES compliant activity. The vast majority of data from GEOTRACES sections GN02 and GN03 were submitted and accepted into the IDP2021.

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

GEOTRACES or GEOTRACES relevant cruises

- Feiyue Wang (UManitoba) Participated in the GEOTRACES Intercalibration - TONGA project for mercury and methylmercury (led by Lars-Eric Heimbürger-Boavida, France).
- 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 2020-08 (August 12-24, 2020) and 2021-001 (January 30 – February 18, 2021) as part of the Line P Iron Program, a GEOTRACES Process Study (GPpr07).

New projects and/or funding

- 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).

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

- AMAP, 2021. AMAP Assessment 2021: Mercury in the Arctic. Arctic Monitoring and Assessment Programme (AMAP), Oslo, Norway (in press).
- Beaupré-Laperrière A., Mucci A. and Thomas H. (2020) The recent state and variability of the carbonate system of the Canadian Arctic in the context of ocean acidification. Biogeosciences 17: 3923–3942. https://doi.org/10.5194/bg-17-3923-2020.
- Bundy, R.M., A. Tagliabue, N.J. Hawco, P.L. Morton, B.S. Twining, M. Hatta, A. Noble, M.R. Cape, S.G. John, J.T. Cullen and M.A. Saito. (2020). Elevated sources of cobalt in the Arctic Ocean. Biogeosciences. https://doi.org/10.5194/bg-2020-84
- Colombo, M., B. Rogalla, J. Li, S.E. Allen, K.J. Orians, M.T. Maldonado. Canadian Arctic Archipelago shelf-ocean interactions: a major iron source to Pacific-derived waters transiting to the Atlantic. Submitted to Global Biogeochemical Cycles June 2021
- Colombo, M., S.L. Jackson, J.T. Cullen and K.O. Orians. (2020). Dissolved iron and manganese in the Canadian Arctic Ocean: On the biogeochemical processes controlling their distributions. Geochimica et Cosmochimica Acta. 277: 150-174. https://doi.org/10.1016/j.gca.2020.03.012
- Colombo, M., J. Li, B. Rogalla, S.E. Allen, M.T. Maldonado. Particulate trace element distributions along the Canadian Arctic GEOTRACES section: shelf-water interactions, advective transport and contrasting biological production. Submitted to Geochimica et Cosmochimica Acta April 2021
- 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. (In press) Anthropogenic lead pervasive in Canadian Arctic seawater. Proceedings of the National Academy of Sciences.
- Mears C., Thomas H., Henderson P.B., Charette M., Macintyre H., Dehairs F., Monnin C. and Mucci A. (2020) Using 226Ra and 228Ra isotopes to distinguish water mass distribution in the Canadian Arctic Archipelago. Biogeosciences 17: 4937-4959. https://doi.org/10.5194/bg-17-4937-2020
- Meyer, ACS; Grundle, D; Cullen, JT. (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. et al. (submitted). Evidence for the production of copper-complexing ligands by marine phytoplankton in the subarctic northeast Pacific.
- Sedwick, P., A. Bowie, T. Church, J.T. Cullen, R. Johnson, M.C. Lohan, C. Marsay, D. McGillicuddy, B. Sohst, A. Tagliabue and S. Ussher. (2020). Dissolved iron in the Bermuda region of the subtropical North Atlantic Ocean: Seasonal dynamics, mesoscale variability, and physicochemical speciation. Marine Chemistry. 219 https://doi.org/10.1016/j.marchem.2019.103748
- Shaked, Y., B.S. Twining, A. Tagliabue and M.T. Maldonado. Probing the bioavailability of dissolved iron to marine eukaryotic phytoplankton using in situ single cell iron quotas. Submitted to Global Biogeochemical Cycles. February 2021.
- Whitby, H., E. Bucciarelli, G. Sarthou, N. Cassar, C.L. Osburn, D.J. Janssen, J.T. Cullen, A. Gonzalez, M. Tonnard and H. Planquette. (2020) A call for refining the role of humic-like substances in the oceanic iron cycle. Scientific Reports. 10: 6144 https://doi.org/10.1038/s41598-020-62266-7
- 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. Barium Cycling in the Arctic Ocean: A Basin-wide Perspective Reveals Strong Shelf Influences. Submitted to JGR. April 2021

Completed GEOTRACES PhD or Master theses

- University of Victoria Biochemistry and Microbiology graduate student Richard L. Nixon, whose thesis research was supported by the Canadian Arctic GEOTRACES program (CCAR-NSERC Grant RPGCC 433848-2012), successfully defended his PhD thesis on June 11, 2020.
- Nixon, R.L. 2020. Origins, distribution, and ecological significance of marine microbial copper ligands (http://hdl.handle.net/1828/12085).

GEOTRACES presentations in international conferences

- Copper ligand concentrations in samples collected along Line P in 2016, 2017 and 2018 as part of GEOTRACES Process Study GPpr07 were featured in the following presentation:
- Ross, A.R.S., Nixon, R.L., George, J., Jackson, S.L., Cullen, J.T., Simpson, K.G, Robert, M. 2020. Temporal and spatial variations in copper ligand concentration along Line P. North Pacific Marine Science Organization (PICES) 2020 Virtual Annual Meeting, 13-29 October.
- Anderlini T., J-E. Tremblay, J.T. Cullen. Distributions of Dissolved Trace Metals in Surface Waters of Baffin Bay in the Canadian Arctic. ArcticNet ASM 2020, Dec. 3-7.
- Anderlini T., J-E. Tremblay, J.T. Cullen. Distributions of Dissolved Trace Metals in Surface Waters of Baffin Bay in the Canadian Arctic. Goldschmidt Virtual 2020, Jun. 21-26.
- Taves R., D.J. Janssen, M.A. Peña, A.R.S. Ross, W. Crawford, J.T. Cullen. Relationship between Surface Dissolved Iron Inventories and Net Community Production during a Marine Heatwave in the Subarctic Northeast Pacific. Goldschmidt Virtual 2020, Jun. 21-26.
- Bergquist B., J. De Vera, P. Chandan, P. Pinedo-Gonzalez, S. John, S.L. Jackson, J.T. Cullen, L. William, A. Steffen. Tracing the Sources of Lead in the Canadian Arctic from the Atmosphere to the Ocean. Goldschmidt Virtual 2020, Jun. 21-26.

Submitted by Dr. Jay T. Cullen (jcullen@uvic.ca).