GEOTRACES SCIENTIFIC STEERING COMMITTEE
ANNUAL REPORT TO SCOR 2015/2016

May 2016

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ANNUAL REPORT ON GEOTRACES ACTIVITIES IN AUSTRALIA

June 1st, 2015 to April 30th, 2016

New scientific results

New research by PhD student Holly Winton investigating sources of soluble atmospheric iron in the Australian sector of the Southern Hemisphere has shown that variance in the observed fractional iron solubility is due to a combination of different soluble iron sources including mineral dust and biomass burning emissions. The research investigated differences in atmospheric iron solubility over tropical northern Australia, the Southern Ocean and in Antarctic snowfall. These locations were used to investigate iron in aerosols transported over continental and marine areas at different spatial scales relative to sources. The results of the study suggest that aerosol iron derived from mineral dust is relatively insoluble regardless of atmospheric transport time. However, the interaction of mineral dust with biomass burning emission plumes may increase fractional iron solubility episodically. This indicates that fire emissions are not a major source of soluble iron, but that they may indirectly enhance the solubility of iron derived from mineral dust. An inverse hyperbolic relationship was observed between total iron concentration and fractional iron solubility at all the study areas, including tropical continental, marine and remote polar locations. Differences in this relationship were observed with respect to the constant fractional iron solubility at high total iron concentrations. Contrary to expectations, higher constant fractional iron solubility was found in northern tropical Australia and may be due to the presence of higher concentrations of organic acids emitted by biomass burning.

During the HEOBI voyage on *RV Investigator* in early 2016 (see below), micronutrient trace elements including dissolved iron concentrations were measured at sea in the water column on and around the Kerguelen plateau, specifically focussing on nearshore waters close to the volcanic Heard and McDonald Islands, waters that have not been sampled previously for these oceanographic parameters. Along two broadly east-west transects of the northern plateau, dissolved iron was largely depleted (<0.2 nmol/L) in surface waters, with enrichment near the seafloor from sediments, consistent with the results from the KEOPS voyages. Conversely, in the shallow (100-200 m deep) waters near Heard and McDonald Islands, dissolved iron was elevated (up to 3.0 nmol/L) throughout the well-mixed water column. Interestingly, iron(II) was also elevated close to the McDonald Islands, in the vicinity of acoustic plume signals (indicative of bubbles rising from the seafloor and potentially associated with hydrothermalism), accounting for up to 30% of the dissolved iron concentration. This feature was not as evident in the samples collected near acoustic plumes close to Heard Island. Studies are continuing in 2016 to trace the source of the iron, in both reduced, dissolved and particulate forms.

New publications (published or in press)

- Boyd, P.W., R. F. Strzepek, M. J. Ellwood, D. A. Hutchins, S. D. Nodder, B. S. Twining, S. W. Wilhelm (2015) Why are biotic iron pools uniform across high- and low-iron pelagic ecosystems? Global Biogeochemical Cycles, 10.1002/2014GB005014
- Hanington, P., Rose, A., & Johnstone, R. (2016). The potential of benthic iron and phosphorus fluxes to support the growth of a bloom forming toxic cyanobacterium Lyngbya majuscula, Moreton Bay, Australia. Marine and Freshwater Research.

- Lannuzel, D., Grotti, M., Abelmoschi, M. L., & Van Der Merwe, P. (2015). Organic ligands control the concentrations of dissolved iron in Antarctic sea ice. Marine Chemistry, 174, 120-130.
- Lieser, J. L., Curran, M. A. J., Bowie, A. R., Davidson, A. T., Doust, S. J., Fraser, A. D., Galton-Fenzi, B. K., Massom, R. A., Meiners, K. M., Melbourne-Thomas, J., Reid, P. A., Strutton, P. G., Vance, T. R., Vancoppenolle, M., Westwood, K. J., and Wright, S. W.: Antarctic slush-ice algal accumulation not quantified through conventional satellite imagery: Beware the ice of March, The Cryosphere Discuss., 9, 6187-6222, doi:10.5194/tcd-9-6187-2015, 2015.
- Rajah L., Nicol S., Meinder K., Lannuzel D., Bowie A.R., 2016. A preliminary model of iron fertilization by whales in the Southern Ocean: parameter sensitivity of primary production estimates. Ecological Modelling 320 (2016) 203–212, doi:10.1016/j.ecolmodel.2015.10.007.
- Samanta, M., M. J. Ellwood, and G. E. Mortimer (2016), A method for determining the isotopic composition of dissolved zinc in seawater by MC-ICP-MS with a 67Zn–68Zn double spike, Microchemical Journal, 126, 530-537, doi:http://dx.doi.org/10.1016/j.microc.2016.01.014.
- Schneider, L., Maher, W. A., Floyd, J., Potts, J., Batley, G. E., & Gruber, B. (2016). Transport and fate of metal contamination in estuaries: Using a model network to predict the contributions of physical and chemical factors. Chemosphere, 153, 227-236.
- Sinoir, M., Bowie, A.R., Mongin, M., Butler, E.C. V., and Hassler, C.S. (2016). Zinc requirement for two phytoplankton strains of the Tasman Sea. Marine and Freshwater Research , http://dx.doi.org/10.1071/MF15323
- Sinoir, M., M. J. Ellwood, E. C. V. Butler, A. R. Bowie, M. Mongin, and C. S. Hassler (in press) Zinc cycling in the Tasman Sea: Distribution, speciation and relation to phytoplankton community, Mar. Chem., doi:http://dx.doi.org/10.1016/j.marchem.2016.03.006.
- Winton, V. H. L., R. Edwards, B. Delmonte, A. Ellis, P. S. Andersson, A. Bowie, N. A. N. Bertler, P. Neff, and A. Tuohy, 2016, Multiple sources of soluble atmospheric iron to Antarctic waters, Global Biogeochemical Cycles, 30, 421–437, doi:10.1002/2015GB005265
- Winton, H., Bowie, A., Keywood, M., van der Merwe, P., and Edwards, R.: Suitability of high-volume aerosol samplers for ultra-trace aerosol iron measurements in pristine air masses: blanks, recoveries and bugs, Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2016-12, 2016.

Cruises

Three Australian GEOTRACES voyages have taken place in the reporting period:

- HEOBI: “Heard Earth Ocean Biosphere Interaction”, 8 January – 27 February 2016, RV Investigator voyage IN2016_V01, GEOTRACES Process Study. The project tested the hypothesis that hydrothermal activity driven by active submarine magmatism fertilises surface waters with iron thereby enhancing biological productivity around Heard and McDonald Islands, one of the world’s most active hotspot volcanic regions.
- K-Axis: “Assessment of habitats, productivity and food webs on the Kerguelen Axis in the Indian Sector of the Southern Ocean”, 8 January- 12 March 2016, *RSV Aurora Australis*

voyage au15_03, GEOTRACES Process Study. The project examined the principal drivers of ecosystem structure and processes around the southern Kerguelen plateau and included a trace element biogeochemistry component.

- SOTS+CAPRICORN+Eddy: "Linking eddy physics and biogeochemistry in the Antarctic Circumpolar Current south of Tasmania", 14 March – 16 April 2016, IN2016_02, GEOTRACES Process Study. The goal of this study was to understand how eddy circulation impacts elemental cycling, and how this scales up to the eddy field of the Southern Ocean. Process studies were conducted within two contrasting eddies, one cyclonic and one anti-cyclonic. A number of trace metal and nutrients profiles were collected and will analysed ashore for their isotopic composition.

New projects and/or funding

- Awarding of shiptime (GEOTRACES PI: Bowie) to support "Detecting Southern Ocean Change From Repeat Hydrography, Deep Argo And Trace Element Biogeochemistry" (Southern Ocean section from Tasmania to Antarctica) voyage in in January/February 2018 (45 days). The SR3 section was previously occupied during IPY-GEOTRACES in 2008, and we have the opportunity to expand the GEOTRACES measurements and spatial resolution on the 2018 voyage.
- Awarding of shiptime (GEOTRACES PIs: Boyd, Ellwood, Bowie) to support "Subantarctic Biogeochemistry of Carbon and Iron, Southern Ocean Time Series site" (Subantarctic Southern Ocean south of Tasmania voyage in March 2018 (20 days)
- Philip Boyd was awarded a prestigious Australian Research Council Laureate Fellowship, for the project: "Geoengineering the Southern Ocean? A transdisciplinary assessment"
- Science and Industry Fund (SIEF) John Stocker Postdoctoral Fellowship awarded to Taryn Noble and Zanna Chase for the project "The impact of changing ocean circulation on the Antarctic ice shelf". This project involves analysis of seawater and surface sediment Nd isotope composition in order to evaluate the potential of Nd to AABW in the Mertz glacier region. The project is also supported by the Antarctic Gateway Partnership, an initiative of the Australian Research Council.

PhD theses

- Fabien Queroue, 2015. "Trace metals distributions in the Southern Ocean: Kerguelen Plateau process study".
- Holly Winton, 2016. "Impact of biomass burning emissions and dust on soluble iron deposition to Australian waters, the Southern Ocean and Antarctica".

Meetings

Australian GEOTRACES scientists presented results at the following meetings:

- Goldschmidt 2015 (Prague), August 2015.
- Royal Society meeting (London), "Quantifying fluxes and processes in trace-metal cycling at ocean boundaries", December 2015.
- PACIFICHEM 2015 (Hawaii), December 2015.

- International Partnerships In Ice Core Sciences, Second Open Science Conference, (Hobart), March 2016

Outreach activities

- HEOBI blog: https://blog.csiro.au/investigator/
- K-axis blog: http://k-axis.voyage/
- Zanna Chase: Presentation on HEOBI voyage to students at Princes Street Primary School (March 11 and March 17).

Other activities

- Modifications were made to the new trace metal sampling container on R/V Investigator following sea trials in April 2015. The new container was thoroughly tested in early 2016 across two cruises, and performed well. Similarly the trace metal clean rosette and 6 new mark II McLane in situ pumps acquired as part of the ship's new equipment pool performed well in the cold waters and high seas around Heard Island (we didn't lose anything!). The ship's trace metal clean underway sampling system was also tested further in January 2016; results show this system may be suitable for uncontaminated collection of seawater at iron concentrations above 0.2 nmol/L.
- An atmospheric monitoring program for trace elements around Australia is being established at both land-based sites and on the *RV Investigator* (shiptime subject to approval). Contact: Andrew Bowie.
- Results of the joint Australian-New Zealand GEOTRACES GP13 section in the southwest Pacific are being written up.

Submitted by Zanna Chase (Zanna.Chase@utas.edu.au) and Andrew Bowie (Andrew.Bowie@utas.edu.au).

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN BELGIUM

June 1st, 2015 to April 30th, 2016

Meetings

- Lemaitre N., H. Planquette, F. Dehairs, L. Monin, L. André, S. Jacquet, F. Planchon, 2015. Mesopelagic carbon remineralization from particulate excess Ba along the GEOVIDE transect in the North Atlantic. Goldschmidt, 2015, Prague.
- Lemaitre N., F. Planchon, H. Planquette, F. Dehairs, L. Monin, L. André, M. Leermakers, D. Fonseca Batista, A. Roukaerts, M. Castrillejo, Y. Yang, C. Jeandel, V. Sanial, R. Sauzède, L. Foliot and D. Fonseca Batista, 2016. Carbon export along the GEOVIDE transect in the North Atlantic (GEOTRACES GA01), Ocean Sciences 2016, New Orleans.
- Li X., D. Fonseca, H. Ingber, N. Roevros, F. Dehairs and L. Chou (2015) Iron biogeochemistry under a changing climate: impact on the phytoplankton growth and the diazotrophic nitrogen fixation. Goldschmidt 2015 conference, 16-21 August 2015, Prague, Czech Republic. Oral presentation.
- Li X., D. Fonseca-Batista, H. Ingber, N. Roevros, F. Dehairs and L. Chou (2015) The impact of iron biogeochemistry on the phytoplankton growth and the diazotrophic nitrogen fixation under a changing climate. SOLAS Open Science Conference 2015, 07-11 Septembre 2015, Kiel, Germany. Poster presentation.
- Li X., D. Fonseca-Batista, Julie Brouwers, Nathalie Roevros, F. Dehairs and L. Chou (2016) The marine diatom and diazotroph under future climates: Role of Iron. EGU 2016 General Assembly, 17-22 April 2016, Vienna, Austria. Poster presentation.
- Dehairs F., N. Lemaitre, H. Planquette, L. Monin, L. André, S. Jacquet and F. Planchon, 2016. Mesopelagic carbon remineralization along the GEOVIDE transect in the North Atlantic (GEOTRACES GA01), Ocean Sciences 2016, New Orleans.
- Fonseca Batista D., F. Fripiat, F. Deman and F. Dehairs, 2016. Nitrate isotopic composition across a North-South transect in the Eastern Atlantic Ocean: Significance of nitrogen input through N2 fixation, Ocean Sciences 2016, New Orleans.

Cruises

- May 13-27, 2015: R/V Belgica 2015/14 cruise to the Bay of Biscaye and the Iberian Margin.
- August 3 -12, 2015: R/V Atlantic Explorer, Cruise AE1519: Test of underway measurement system for marine nitrogen fixation. Chief Scientist Nicolas Cassar (Duke University).
- October 27 – December 11, 2015: Antarctica, Davis station, Prydz Bay: Spring-summer temporal evolution of nutrient dynamics and primary production in fast ice (O'Gorman Rocks and Anchorage Island). Chief scientists Delphine Lannuzel and Klaus Meiners (ACE-CRC and AAD).

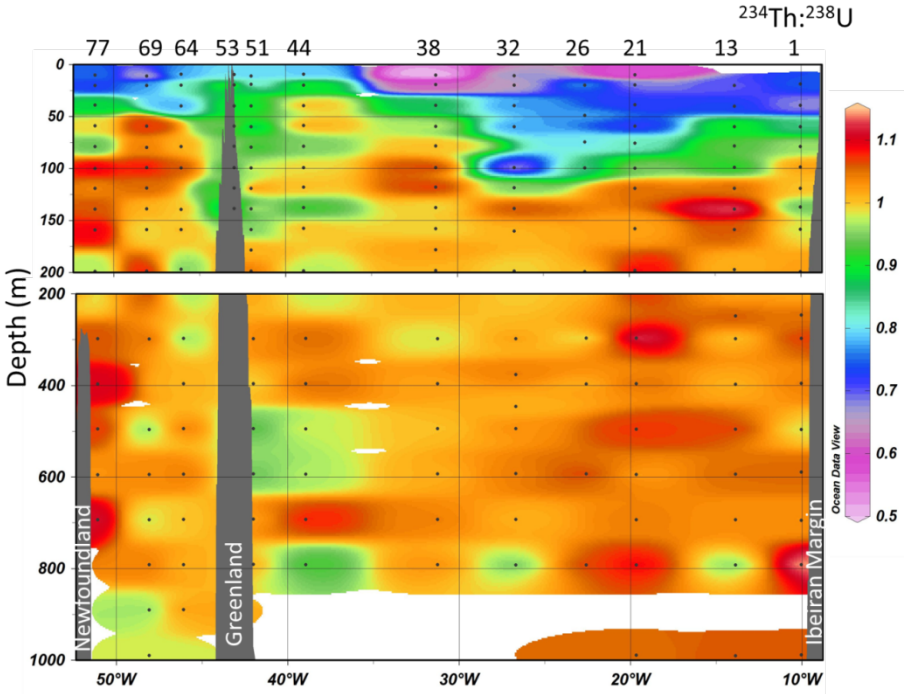
New results

- Southern Ocean sea ice nutrient inventories:

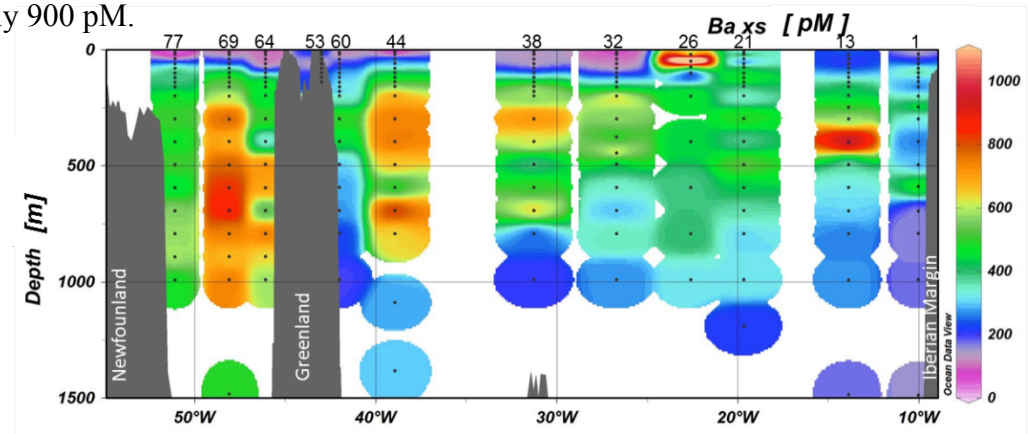
  In the framework of SCOR working group "Biogeochemical exchange processes at the sea ice interface" we compiled Antarctic sea ice nutrient data. Some ~13500 published data (from 1980 to 2015, i.e., nitrate, nitrite, ammonium, phosphate, and silicic acid) were retrieved and these will shed light on the nutrient dynamics in this extensive overlooked ecosystem (up to 8% of the Earth Surface).

- POC export and remineralization in the North Atlantic Ocean (GEOVIDE cruise; June - July 2014):

  Distribution of the 234Th/238U activity ratio along the GEOVIDE section (Lemaitre et al., unpublished). Ratios range from 0.50 at station 38 in surface waters to 1.15 at station 1, 790 m. The 234Th activity deficit in surface waters reflects 234Th export flux, while excess 234Th at depth reflects remineralization of particles.



Distribution of particulate biogenic barium (Ba_{xs}) along the GEOVIDE section (Lemaitre et al., unpublished). The distribution of Ba_{xs} is taken to reflect the intensity of remineralization of exported phytoplankton material. Generally, the maximum of Ba_{xs} content is located between 100 and 1000m in mesopelagic waters. Ba_{xs} concentrations are significantly larger to the west of station 44 and in particular in the Labrador Sea (stations 64, 69, 77), reaching nearly 900 pM.



- Nitrogen fixation activity in the North Atlantic

N_2 fixation rates obtained during field investigations in the eastern North Atlantic show higher photic zone integrated N_2 fixation rates along the Iberian Margin compared to the Bay of Biscay. Although the initial dissolved Fe concentration were relatively high in the Iberian Margin (2.5-20 nM), Fe addition significantly enhanced the original N_2 fixation rates.
We also observed very high N_2 fixation rates (up to 1000 μmol/m^2/d; i.e. similar in magnitude to values observed at the Iberian Margin) in the vicinity of the North American margin and shelf (40°N). Margin systems thus appear to sustain significantly higher diazotroph activities, compared to open ocean systems.

Relevant publications

- Dehairs F., F. Fripiat, A.-J. Cavagna, T.W. Trull, C. Fernandez, D. Davies, A. Roukaerts, D. Fonseca Batista, F. Planchon and M. Elskens, 2015. Nitrogen cycling in the Southern Ocean Kerguelen Plateau area: Evidence for significant surface nitrification from nitrate isotopic compositions, Biogeosciences, 12, 1459-148.
- Fripiat F., M. Elskens, T. Trull, S. Blain, A.-J. Cavagna, C. Fernandez, D. Fonseca-Batista, F. Planchon, P. Raimbault, A. Roukaerts, and F. Dehairs, 2015. Significant mixed layer nitrification in a natural iron-fertilized bloom of the Southern Ocean, Global Biogeochemical Cycles, 29, 1929-1943.
- Fripiat, F., D.M. Sigman, G. Massé, and J.-L. Tison, 2015. High turnover rates indicated by changes in the fixed N forms and their stable isotopes in Antarctic landfast sea ice. Journal of Geophysical Research: Oceans 120, doi:10.1002/2014JC010583.
- Jacquet S. H. M., F. Dehairs, D. Lefèvre, A.-J. Cavagna, F. Planchon, U. Christaki, L. Monin, L. André, I. Closset, and D. Cardinal, 2015. Early season mesopelagic carbon remineralization and transfer efficiency in the naturally iron-fertilized Kerguelen area, Biogeosciences, 12, 1713-1731.
- Jeandel C., M. Rutgers van der Loeff, P.J. Lam, M. Roy-Barman, R. Sherrell, S. Kretschmer, C. German and F. Dehairs, 2015. What did we learn on the oceanic particle dynamics in the GEOSECS-JGOFS era? Progress in Oceanography, 133, 6-16.
- Mawji E., R. Schlitzer, E. Masferrer Dodas, et al., 2015. The GEOTRACES Group (150 authors), The GEOTRACES Intermediate Data Product 2014, Marine Chemistry, 177, 1-8.
- Miller, L.A., F. Fripiat, B.G.T. Else, J.S. Bowman, K.A. Brown, R.E. Collins, M. Ewert, A. Fransson, M. Gosselin, D. Lannuzel, K.M. Meiners, C. Michel, J. Nishioka, D. Nomura, S. Papadimitriou, L.M. Russel, L.L. Sorensen, D.N. Thomas, J.-L. Tison, M.A. van Leeuwe, M. Vancoppenolle, E.W. Wolff and J. Zhou, 2015. Methods for biogeochemical studies of sea ice: The state of the art, caveats, and recommendations. Elementa: Science of the Anthropocene 3:000038, doi:10.12952/journal.elementa.000038.
- Planchon F., D. Ballas, A.-J. Cavagna, A.R. Bowie, D. Davies, T.W. Trull, E. Laurenceau, P. van der Merwe, and F. Dehairs, 2015. Carbon export in the naturally iron-fertilized Kerguelen area of the Southern Ocean based on the 234Th approach, Biogeosciences, 12, 3831-3848.
- Roukaerts A., A.-J. Cavagna, F. Fripiat, D. Lannuzel, K. Meiners and F. Dehairs, 2016. Sea-ice algal primary primary production and nitrogen uptake rates off East Antarctica, Deep-Sea Research II, in press.

- Riou V., D. Fonseca Batista, A. Roukaerts, I.C. Biegala, S.R. Prakya, C. M. Loureiro, M. Santos, A.E.M. Muniz-Piniella, M. Schmiing, M. Elskens, N. Brion, M.A. Martins and F. Dehairs, 2016. Importance of N2-fixation on the productivity at the North-Western Azores Current/Front system, and the abundance of diazotrophic unicellular cyanobacteria, PloS-ONE, (DOI: http://dx.doi. org/10.14284/40).
- Trull T.W., D. Davies, F. Dehairs, F. D'Ovidio, E. Laurenceau, M. Lasbleiz, F. Planchon, B. Queguiner and S. Blain, 2015. Chemometric perspectives on plankton community responses to natural iron fertilisation over and downstream of the Kerguelen Plateau in the Southern Ocean, Biogeosciences, 12, 1029-1056, doi:10.5194/bg-12-1029-2015.
- van der Merwe P., A. Bowie, F. Quéroué, L. Armand, S. Blain, F. Chever, D. Davies, F. Dehairs, F. Planchon, G. Sarthou, A.T. Townsend, and T.W. Trull, 2015. Sourcing the iron in the naturally fertilised bloom around the Kerguelen Plateau: particulate trace metal dynamics, Biogeosciences, 12, 739–755.

Submitted/ in review

- Charette M.A., P.J. Lam, M.C. Lohan, E.-Y. Kwon, V. Hatje, C. Jeandel, A.M. Shiller, G.A. Cutter, A. Thomas, P.W. Boyd, W.B. Homoky, A. Milne, H. Thomas, P.S. Andersson, D. Porcelli, T. Tanaka, W. Geibert, F. Dehairs, J. Garcia Orellana, Coastal ocean and shelf-sea biogeochemical cycling of trace elements and isotopes: lessons learned from GEOTRACES 2, submitted to Proceedings of the Royal Society of Sciences.
- Fonseca-Batista D., F. Dehairs, V. Riou, F. Fripiat, M. Elskens, F. Deman, N. Brion, M. Bode and H. Auel, Contribution of N2 fixation to biological productivity along a meridional section in the Eastern Atlantic Ocean, in review for Progress in Oceanography (special issue on AMT).
- Lemaitre N., H. Planquette, F. Dehairs, P. Van der Merwe, A.R. Bowie, T.W Trull, E.C. Laurenceau-Cornec, D. Davies, C. Bollinger, M. Le Goff, E. Grossteffan, and F. Planchon. Impact of the natural Fe-fertilization on the magnitude, stoichiometry and efficiency of PN, BSi and PFe export fluxes, to be submitted to Deep-Sea Research I.
- Rembauville M., I. Salter, F. Dehairs, J.-C. Miquel and S. Blain, Particulate matter and diatoms export fluxes at KERFIX, a fixed station in the HNLC Southern Ocean, submitted to Marine Ecology Progress Series.

Submitted by Frank Dehairs (fdehairs@vub.ac.be).

- Three activities related to GEOTRACES are organized for the Brazilian Conference on Oceanography (www.CBO2016.org), which will be held in Salvador November 5-9, 2016. Those activities are:
  - Oral/poster GEOTRACES session;
  - II GEOTRACES BRAZIL meeting. This meeting follows the actions initiated in 2015 with the aim to bring Brazilian scientists together to plan activities and promote collaborations to increase participation in the scope of the GEOTRACES program.
  - Ocean Data View (ODV) hands-on workshop. This 8 hours workshop will to teach basic ODV methods for the analysis of environmental data. The GEOTRACES Intermediate Data Product 2014 (IDP2014) and the Surface Ocean CO2 Atlas (SOCAT) will be used as example datasets.
- Submission of a proposal for a GEOTRACES invited speaker talk for the 46th World Chemistry Congress (IUPAC-2017) to be held in São Paulo, Brazil between July 9th to July 14th.
- The Scientific Committee on Oceanic Research (SCOR) awarded US$2500 towards sponsoring a three weeks visit by W. Burnett to Salvador, Brazil in order to teach a course for 25 students on uses of radioisotopes in environmental sciences. The use of Rn and the Ra quartet for studies concerning submarine groundwater discharge (SGD) was emphasized during the course. Rn measurements and Radium sampling throughout the Paraguaçu Estuary and throughout the Todos os Santos Bay were performed during the 3rd week of the visit to initiate a collaborative research project.
- Federal University of Rio Grande (FURG) - acquired a container, which has been remodeled to be a clean room for the *Atlantic Sul R/V*.
- Presentation on the GEOTRACES project during the High Level Meeting EU-Brazil Atlantic Research Cooperation held in Rio de Janeiro, November 2015. A Joint Declaration of Intent between the EU and the Ministry of Science, Technology and Innovation of Brazil was signed, creating a working group on Marine Research Cooperation to develop common expertise and scientific knowledge on Atlantic Ocean and its dynamic ecosystems. It was defined seven research priority topics for future studies including the land-ocean interactions and fluxes.

Projects/grants

- Since 2015 there has been very few funding opportunities announced by CNPq, FINEP and State agencies. The current opportunities are very specific in terms of research areas or activities that can be funded. As a result the purchase of the new clean sampling system for the *R/V Vital de Oliveira* is on hold. Besides, all research funding for exchanging students and researchers in international programs has been suspended.

Cruises

- One expedition was performed along the South coast of Brazil which included three transects parallel to shore. Fifteen profiles were performed up to 600 m depths. Key variables for this cruise were dissolved trace elements, C, N, δ13C and δ15N in sediments and suspended particulate material. INCT-MarCOI (CNPq 565062/2010-7).
- Two expeditions were postponed due to lack of funding. Many of the research grants awarded between the end of 2014 and 2016 have not yet been paid by CNPq and FINEP.
- A proposal for in-kind logistical support for fieldwork along the Brazilian PIRATA program annual expedition from 20º S to 15ºN has been submitted for the project "Vertical and horizontal processes on REE composition of seawater"

GEOTRACES-related articles

- Hatje, V. Chemistry of Our Oceans. (2015). Journal of the Brazilian Chemical Society, v. 26, p. 2170-2171.
- Hatje, V., Bruland, K.W.; Flegal, A.R. (2016). Increases in anthropogenic gadolinium anomalies and rare earth element concentrations in San Francisco Bay over a twenty-year record. Environmental Science & Technology. DOI: 10.1021/acs.est.5b04322, 2016.

Contributions to conferences

- GEOTRACES presentations and co-authorships by Brazilian Scientists at the following meetings: AGU Fall Meeting (San Francisco, USA, Dec 2015), OSM 2016 (New Orleans, USA, Feb 2016)

Submitted by Vanessa Hatje (vanessahatje@gmail.com).

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN CANADA

June 1st, 2015 to April 30th, 2016

Accomplishments

The main accomplishment this year was the successful completion of two cruises covering stations from the southern Labrador Sea to the western Beaufort Sea (see details in appendix 1). This was achieved despite a 2-week hiatus in our research program that resulted from the diversion of our ice breaker to open shipping lanes through the ice in eastern Hudson Bay.

Our situation garnered national and international attention, and was the subject of several news pieces on the CBC and Globe and Mail (eg. http://www.theglobeandmail.com/news/british-columbia/arctic-research-expedition-put-on-hold-after-vessel-diverted-to-break-ice/article25618672/).

Three of the GEOTRACES PIs wrote an Op-Ed on this topic: http://www.theglobeandmail.com/globe-debate/canadas-ocean-science-capacity-is-limited-with-resource-constraints/article25729123/.

Cruises

- GEOTRACES Arctic cruises: Labrador Sea, Baffin Bay and Canadian Arctic Archipelago; July 10-August 10, 2015 (Leg 2).
- GEOTRACES Arctic cruises: Beaufort Sea; September 4-October 1st, 2015 (Leg 3B).

Cruise BLOG:
blogs.ubc.ca/geotraces2015

Radio interview:
CBC Radio; "As it happens", July 22, 2015: *Ice Scientists*
http://www.cbc.ca/radio/popup/audio/player.html?autoPlay=true&clipIds=2672371897,2672329229

Outreach activities

We developed a highly successful program with the Vancouver Aquarium summer camps during 2015. PI Tortell worked closely with a number of UBC graduate students who spend several hours per week over the summer working with children (ages 8 - 14). Specifically, we designed a number of interactive, hands-on modules dealing with Ocean Acidification and Remote Sensing, with a particular focus on the Arctic. The modules included field-sampling at the beach next to the Aquarium, wet-chemistry work with pH buffers etc., computer-based analysis of ocean color imagery, and drone-based imaging of the Vancouver coastline. Our activities were highly successful, and plans are already under way to continue and expand this work for next summer. We also arranged for a live skype-call from the research vessel, with several scientists and Captain of the Amundsen spending about 30 minutes answering questions from children in the Aquarium gallery. The children and camp leaders seemed to be very excited by this opportunity.

Individual activities

Diana Varela; Biology Dept., University of Victoria, Victoria, BC

- Stable silicon isotope inter-calibration plans (UVic-Canada, UC Santa Barbara-USA, University of Brest-France): January - June, 2015

  A series of discussions with collaborators in both the United States and France regarding intercalibration of the stable silicon isotope measurements on our respective Arctic Geotraces cruises. Samples with be collected at a crossover station for intercalibration with our US colleagues, while we will be collecting samples to share with our French colleagues as their crossover station (that they have already visited) was deemed unsuitable for intercalibration.

Refereed journal publications

- Crawford, David W.; Wyatt, Shea N.; Wrohan, Ian A.; et al.2015. Low particulate carbon to nitrogen ratios in marine surface waters of the Arctic. Global Biogeochemical Cycles 29 (12): 2021-2033

Alfonso Mucci; Department of Earth and Planetary Sciences**,** McGill University, Montreal, QC

Refereed journal publications

- Varela, D. E., M. A. Brzezinski, C. P. Beucher, J. L. Jones, K. E. Giesbrecht, B. Lansard, *and* A. Mucci *(*2016*),* Heavy silicon isotopic composition of silicic acid and biogenic silica in Arctic waters over the Beaufort shelf and the Canada Basin. Global Biogeochem. Cycles*,* 29*, doi:* 10.1002/2015GB005277.

Presentations

- The Canadian Arctic GEOTRACES Program : Biogeochemical and tracer study of a rapidly changing Arctic Ocean. Meeting of the NSERC-CCAR Networks, May 3, 2015

Media interviews

- Opinion: Ocean acidification is an indisputable problem. The Gazette, June 22, 2015

  http://montrealgazette.com/news/world/opinion-ocean-acidification-is-an-indisputable-problem

Celine Gueguen; Chemistry Dept., Trent University, Peterborough, ON

- V. Mangal, C. Guéguen (2015) Examining concentrations and molecular weights of thiols in microorganism cultures and in Churchill River (Manitoba) using a fluorescent-labeling method coupled to asymmetrical flow field-flow fractionation. Anal Bioanal Chem (2015) 407:4305–4313

Andrew Ross; Fisheries and Oceans Canada, IOS, Sydney, BC

I continue to assist in collecting samples for analysis of iron and other trace metals on the annual August/September Line-P cruises in support of our Line-P Iron Program (which is recognized as a Process Study by GEOTRACES).

I've also been supervising Kyle Simpson on his development of a new Fe analysis system here at DFO-IOS.

Refereed journal publications

- Invited paper to the SCOR Working Group 139 Special Issue of the journal Frontiers in Marine Science (Marine Biogeochemistry section) on" Organic ligands - A key control on trace metal biogeochemistry in the ocean":
- Richard L. Nixon (*), Andrew R.S. Ross "Evaluation of immobilized metal-ion affinity chromatography and electrospray ionization mass spectrometry for the recovery and analysis of copper-binding ligands (chalcophores) in seawater" (in preparation, to submit by the May deadline)

Kristin Orians; Earth, Ocean & Atmospheric Sciences, UBC, Vancouver

PhD student Nari Sim participated in the Particulate Metals intercalibration, lead by Phoebe Lam

Refereed journal publications

- McAlister, J. and Orians, K. (2015) Dissolved Ga in the Beaufort Sea of the Western Arctic Ocean: A GEOTRACES cruise in the International Polar Year. Marine Chemistry 177: 101-109

Thesis

- McAlister, J. Biogeochemistry of dissolved gallium and lead isotopes in the northeast Pacific and western Arctic Oceans. Ph.D. Thesis, Oceanography, UBC (April 2015)

Jay Cullen; Earth & Ocean Sciences, University of Victoria, Victoria, BC

Refereed journal publications

- Janssen, D.J. and J.T. Cullen. (2015) Decoupling of zinc and silicic acid in the subarctic northeast Pacific interior. Marine Chemistry 177: 124-133
- Schallenberg, C., A.B. Davidson, K.G. Simpson, L.A. Miller and J.T. Cullen. (2015) Iron(II) variability in the northeast subarctic Pacific Ocean. Marine Chemistry 177: 33-44
- Quay, P., J.T. Cullen, P. Morton and W. Landing. (in press). Processes controlling the distributions of Cd and PO4 in the ocean. Global Biogeochemical Cycles

Maite Maldonado; Earth, Ocean & Atmospheric Sciences, UBC, Vancouver, BC

- Participated in the Particulate Metals intercalibration, lead by Phoebe Lam (in collaboration with K. Orians)
- Full Member of SCOR Working Group 145: Modelling Chemical Speciation in Seawater to Meet 21st Century Needs (MARCHEMSPEC)
- Hosted the GEOTRACES Data Management (July 13-14) & Scientific Steering Committee (July 15-17) meetings in EOAS, UBC, Vancouver, BC.
- Organized and lead an international BioGeotraces meeting in Woods Hole Oceanographic (Fall 2015)

Refereed journal publications

- Semeniuk, D.M., R.M. Bundy, A.M. Posacka, M. Robert, K.A. Barbeau, M.T. Maldonado. 2016. Using 67Cu to study the biogeochemical cycling of copper in the northeast subarctic Pacific Ocean. Frontiers in Marine Science (in press)
- Semeniuk, D.M., R.L. Taylor, R.M. Bundy, W.K. Johnson, J.T. Cullen, M. Robert, K.A. Barbeau, M.T. Maldonado. 2016. Iron-copper interactions in iron-limited phytoplankton in the northeast subarctic Pacific Ocean. Limnology and Oceanography 61, 279-297. doi: 10.1002/lno.1021
- Semeniuk, D.M., R.M. Bundy, C.D. Payne, K.A. Barbeau, M.T. Maldonado. 2015. Acquisition of organically complexed copper by marine phytoplankton and bacteria in the northeast subarctic Pacific Ocean. Marine Chemistry 173, 222-233. doi:10.1016/j.marchem.2015.01.005

Roger Francois; Earth, Ocean & Atmospheric Sciences, UBC, Vancouver, BC

Refereed journal publications

- Brown, K. A, L. A. Miller, C. J. Mundy, T. Papakyriakou, R. Francois, M. Gosselin, G. Carnat, K. Swystun, P. D. Tortell. 2015. Inorganic carbon system dynamics in landfast sea ice during the early-melt period. J. Geophysical Res. – Ocean 120 (5): 3542-3566
- Scheiderich, K, M. Amini, C. Holmden, and R. Francois. 2015. Global variability of Chromium isotopes in seawater demonstrated by Pacific, Atlantic, and Arctic Ocean samples. Earth and Planetary Science Letters 423: 87–97
- Jonkers. L, R. Zahn, A.Thomas, G. Henderson, W. Abouchami, R. Francois, P. Masque, I. R. Hall, and T. Bickert. (2015) Deep circulation changes in the central South Atlantic during the past 145 kyrs inferred from a combined sedimentary 231Pa/230Th, neodymium isotopes and benthic δ13C record. Earth and Planetary Science Letters 419, 14-21.
- Holmden, C., Amini, M. and Francois, R. (2015) Uranium isotope fractionation in Saanich Inlet: A modern analog study of a paleoredox tracer. Geochim. Cosmochim. Acta 153, 202-215.

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

Refereed journal publications

- Chandan, P.; Ghosh, S.; Bergquist, B.A. 2015. Mercury Isotope Fractionation during Aqueous Photoreduction of Monomethylmercury in the Presence of Dissolved Organic Matter. Environmental Science & Technology 49 (1): 259-267
- Rose, Carla H.; Ghosh, Sanghamitra; Blum, Joel D.; et al.2015. Effects of ultraviolet radiation on mercury isotope fractionation during photo-reduction for inorganic and organic mercury species. Chemical Geology 405: 102-111

Chris Holmden; Department of Geological Sciences at the University of Saskatchewan

Refereed journal publications

- Scheiderich, K. ; A. Marghaleray; C. Holmden, et al. 2015. Global variability of chromium isotopes in seawater demonstrated by Pacific, Atlantic, and Arctic Ocean samples . Earth and Planetary Science Letters 423: 87-97
- Holmden, C., Amini, M. and Francois, R. (2015) Uranium isotope fractionation in Saanich Inlet: A modern analog study of a paleoredox tracer. Geochim. Cosmochim. Acta 153, 202-215.

Philippe Tortell; Earth, Ocean & Atmospheric Sciences, UBC, Vancouver, BC

Refereed journal publications

- Capelle D.W., J.W.H. Dacey, and P.D. Tortell A high precision method for automated analysis of dissolved CH4 and N2O concentrations in natural waters. Submitted to Limonology and Oceanography Methods. ms# LOM-14-11-0112
- Asher E.C., J.W.H. Dacey, T. Jarnikova and P.D. Tortell. An automated ship-board method for sequential analysis of DMS, DMSP and DMSO in oceanic waters. Submitted to Limnology and Oceanography Methods 13 (9): 451-462

Presentations

ArcticNet meeting, Vancouver BC., Dec. 8 - 11, 2015:

- PD Tortell et al. Summertime net community production, CO2 uptake and phytoplankton photo-physiology in Canadian Arctic and Subarctic ocean waters
- L Fenwick et al. Distribution of CH4 and N2O concentrations in the Canadian Arctic during summer, 2015
- T Jarnikova et al. Surface water concentrations of dimethylsulfide (DMS), dimethylsulfoniopropionate (DMSP) and dimethylsulfoxide (DMSO) in the Canadian Arctic Archipelago during summer, 2015

- N Schuback et al. Coupling of photosynthetic electron transport and carbon fixation in Arctic marine phytoplankton assemblages
- C Hoppe et al. Response of Arctic phytoplankton assemblages to experimental pco2 and light manipulations.

Susan Allen; Earth, Ocean & Atmospheric Sciences, UBC, Vancouver, BC

Presentations

ArcticNet meeting, Vancouver BC., Dec. 8 - 11, 2015:

- Sha, Y., S. Allen, X. Hu and P. Myers. A modeling study of dissolved Barium and δ18O in the Arctic. Student Poster Presentation. Dec 2015. Arctic sciences Network meeting
- Yu, X., S. Allen, X. Hu and P. Myers. Intermediate and deep water circulation changes in the Arctic (2002-2013): Inferred from the distribution of 231Pa/230Th in the water column. Student Poster Presentation. Dec 2015.

Jack Cornett; Department of Earth Sciences, University of Otawa

Refereed journal publications

- Sookdeo, A., Cornett, J., Kieser, W.E (2015) Optimizing production of Pb beams for 205,210Pb analysis by Accelerator Mass Spectrometry. Nuclear Instruments and Methods in Physics Research, Section B: Beam Interactions with Materials and Atoms 361: 450–453
- MacDonald, C.M., Charles, C.R.J., Zhao, X.-L., Kieser, W.E., Cornett, R.J., Litherland, A.E. (2015). Determination of 135Cs by accelerator mass spectrometry. Nuclear Instruments and Methods in Physics Research, Section B: Beam Interactions with Materials and Atoms. 361: 554-558.
- Charles, C.R.J., Cornett, R.J., Zhao, X.-L., Litherland, A.E., Kieser, W.E. (2015). On-line I-/Te separation for the AMS analysis of 125I. Nuclear Instruments and Methods in Physics Research, Section B: Beam Interactions with Materials and Atoms. 361: 189-192.
- X.-L. Zhao, C. R. J. Charles, R.J. Cornett, W. E. Kieser, C. MacDonald, K. Zaki and N. St-Jean. (2015). An Exploratory Study of Recycled Sputtering and CsF2- current enhancement for AMS. Nuclear Instruments and Methods in Physics Research, Section B: Beam Interactions with Materials and Atoms 366: 96–103
- MacDonald, C.M. R.J. Cornett, C.R.J. Charles, X.-L. Zhao, and W.E. Kieser. (2015). Measurement of the Cs-135 Half Life with Accelerator Mass Spectrometry and Inductively Coupled Plasma Mass Spectrometry. Physics Reviews C 93, 014310

Invited Presentations

- R.J. Cornett. (2015). Measuring Radionuclides using Mass Spectrometry. Health Canada Seminar Series, Ottawa, Canada. Nov, 2015

- R.J. Cornett. (2015). Mass Spectrometry Techniques and Applications in Geoscience. OCGC Student Seminar, Ottawa, Canada Sept 2015
- R. J Cornett, W.E. Kieser and X.L. Zhao. (2015). Nouvelles techniques isotopiques pour la géoscience. University of Aix- Marseille, Aix en Provence, France, June 2015
- R. J. Cornett and A. Sookdeo* . (2015). MEASUREMENT OF PB-210. SpectrÀtom 2015, Halifax, Canada, June 2015
- R. J. Cornett, A. Sookdeo, and M. Khan . (2015). MEASUREMENT OF PB-210.BY MASS SPECTROSCOPY. SCL-CCFFR 2015, Ottawa, Canada, January, 2015
- R.J. Cornett. (2015). Applications of Accelerator Mass Spectrometry in Geoscience. ISWAN 2015, Ottawa, Canada February, 2015

Conference Presentations

- M. Khan, R.J. Cornett and X.L. Zhao. (2015). Measuring Lead Isotopes by AMS. University of Ottawa Undergraduate Research Colloquium, Ottawa, Canada, March 2015
- D. Sauvé, and R. J. Cornett . (2015). ISOTOPE MEASUREMENT BY AMS IN THE LABRADOR AND BEAUFORT SEAS. . SCL-CCFFR 2015, Ottawa, Canada, January 2015

Paul Myers; Earth and Atmospheric Sciences, University of Alberta, Edmonton, Alberta

Refereed journal publications

- Greenland Ice Sheet melt increases Baffin Bay heat content on the west Greenland shelf, 2015: L Castro de la Guardia, X Hu and PG Myers, Geophysical Research Letters, 42(12), 4922-4930

Invited conference presentation

- Freshwater Processes and Feedbacks in Baffin Bay and the Labrador Sea, May 2015, Paul G. Myers, Xianmin Hu, Amber Holdsworth, Laura Castro de la Guardia and Laura Gillard, Joint Canadian and American Geophysical Union Meeting, Montreal, QC.

Conference presentation

- Freshwater Processes in Baffin Bay and the Labrador Sea, March 2015, Laura Castro de la Guardia, Laura Gillard, Xianmin Hu and Paul G. Myers, Arctic SubArctic Ocean Fluxes Workshop, Bremerhavn, Germany
- Ocean Circulation and Marine Terminating Glaciers of the Greenland Ice Sheet and the Canadian Arctic Archipelago, June 2015, Laura C. Gillard, Xianmin Hu and Paul G. Myers, IUGG 2015, Prague, Czech Republic
- Positive Feedback between Baffin Bay Circulation and West Greenland Ice Sheet Melt, July 2015, Laura Castro de la Guardia, Xianmin Hu, Paul G. Myers, IUGG 2015, Prague, Czech Republic

- Numerical Modelling and Shelf-Basin Exchange in the Labrador Sea and Baffin Bay, November 2015, Paul G. Myers, Xianmin Hu, Clark Pennelly, Amber Holdsworth, Laura Gillard, Laura Castro de la Guardia, Ting On Chan and Juliana Marson, FAMOS Workshop, Woods Hole, Ma, USA
- Evolution of Baffin Bay water masses and transports in a climate change experiment including Greenland runoff, June 2015, Nathan Grivault, Xianmin Hu and Paul G. Myers, 49th CMOS Congress, June 2015, Whistler, B.C.
- Ocean Circulation and Marine Terminating Glaciers of the Greenland Ice Sheet and the Canadian Arctic Archipelago. Laura C. Gillard, Xianmin Hu, Paul G. Myers.CMOS Congress. May 31 – June 4, 2015

Invited University Seminar (Other – 1)
- Freshwater Processes and Feedbacks Between the Arctic and Sub-Polar North Atlantic Oceans, Paul Myers, CEOS, University of Manitoba, Winnipeg, Mb, February, 2015

Presentation on Geotraces at NSERC Event (other – 1)
- Canadian Arctic Geotraces Program, NSERC CCAR Research Day, May 2015, Montreal, Qc

Fei Wang; Department of Environment and Geography, University of Manitoba, Winnipeg, Manitoba

Refereed journal publications

- Wang F., Pucko M., and Stern G. 2015. Transport and transformation of contaminants in sea ice. In: Sea Ice, 3rd Ed. (Thomas D.N. Ed). Wiley-Blackwell. In press.

Conference presentations (invited)

- Wang F. 2015. Cryospheric chemistry: Chemical processes in frozen waters. 98th Canadian Chemistry Conference and Exhibition, Ottawa, Canada. June 13-17, 2015.

Conference presentations (not invited)

- Wang K., Munson K. and Wang F. 2015. Mercury in the Marine Water of the Canadian Arctic. ArcticNet Annual Scientific Meeting. Vancouver, BC, Canada. December 7-11, 2015.

(Social) Media

- Elliott A. Surprise visitors for the Canadian team. Blog at Researchgate.net. Posted on October 19, 2015.
- Xu W. Tough instruments on the CCGS Amundsen. Blog at Researchgate.net. Posted on September 22, 2015.

- Munson K. Update CCGS Amundsen: Bon voyage GEOTRACES! Blog at Researchgate.net. Posted on August 20, 2015.

Stephanie Waterman; Earth, Ocean & Atmospheric Sciences, UBC, Vancouver, BC

Outreach activities

- Scheifele, B. Arctic Currents. Guest lecture in the Vancouver Aquarium's Arctic Marine Life Course. 17 Nov 2015.

Conference presentations (not invited)

- Scheifele, B., S. Waterman and J. Carpenter. Glider deployments to measure microstructure on the Beaufort Sea Continental Shelf, Summer 2015. 49th CMOS Congress, Whistler, Canada. 31 May – 4 Jun 2015.
- Scheifele, B., S. Waterman, J. Carpenter and L. Merckelbach. Estimating Mixing Rates and Turbulence from Glider-based Microstructure Measurements in the Beaufort Sea. ArcticNet Annual Scientific Meeting, Vancouver, Canada. 7-11 Dec 2015.
- Chanona, M., S. Waterman and Y. Gratton. Spatial and temporal variability of small-scale energy and inferred internal-wave driven mixing in the Canadian Arctic. ArcticNet Annual Scientific Meeting, Vancouver, Canada. 7-11 Dec 2015.
- Thibault, J-L., S. Waterman and P. Meyers. Toward the role of diapycnal mixing on shelf-basin exchange in the Arctic Ocean in a Numerical Model. ArcticNet Annual Scientific Meeting, Vancouver, Canada. 7-11 Dec 2015.

Submitted by Maite Maldonado (mmaldonado@eos.ubc.ca).

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN CHINA-BEIJING

June 1st, 2015 to April 30th, 2016

Cruises

GEOTRACES GP06-CN (PN) cruise aboard the *R/V Dongfanghong* 2 was conducted between 19 October and 2 November 2015, with Prof. REN Jingling from Ocean University of China as chief scientist. Samples for trace metals and isotopes were collected at 8 clean stations, including 2 cross stations with Japanese KH-15-3 cruise (chief scientist: Prof. Jing Zhang from University of Toyama). Clean facilities were used for the sampling and sample preparations, including Kevlar cable/Electric winch, X-Niskin bottles, clean booth and clean bench. Trace elements (Fe, Al, Mn, Zn, Cu, Cd, REEs, Hg), radioactive isotopes (^{228}Ra & ^{226}Ra, ^{231}Pa, ^{230}Th, ^{232}Th, ^{234}U & ^{238}U, Δ^{14}C (DIC)), stable isotopes (d^{15}N (NO_3), d ^{13}C (DIC), d^{30}Si, d ^{18}O (H_2O), ^{137}Ba/^{134}Ba) and radiogenic isotopes (^{143}Nd/^{144}Nd, ^{87}Sr/^{86}Sr) will be analyzed mainly by laboratories in Ocean University of China in Qingdao, Xiamen University in Xiamen and East China Normal University in Shanghai.

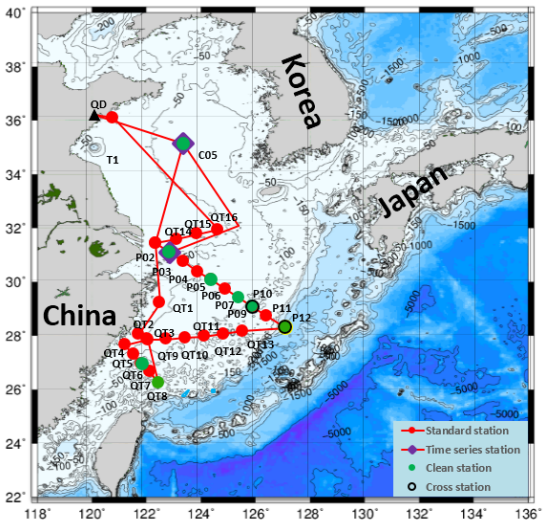


Figure 1. Water sampling locations in the East China Sea in 2015

R/V Tan Kah Kee (Jia Geng) of Xiamen University was launched in Guangzhou, southern China on 8 May, 2016. This ship (3,500 tonnes) will be particularly useful for enhancing China's capacity in GEOTRACES-related scientific activities by providing versatile chemically and biologically clean laboratories and sampling facilities.

Submitted by Liping Zhou (lpzhou@pku.edu.cn).

New scientific results

We have been studying the elemental and isotopic composition of the dissolved and particulate samples collected in Taiwan GEOTRACES cruises, carried out in July 2013 and March 2014 in the Western Philippine Sea. The following figure exhibits new data for trace metal distribution pattern in the suspended particles.

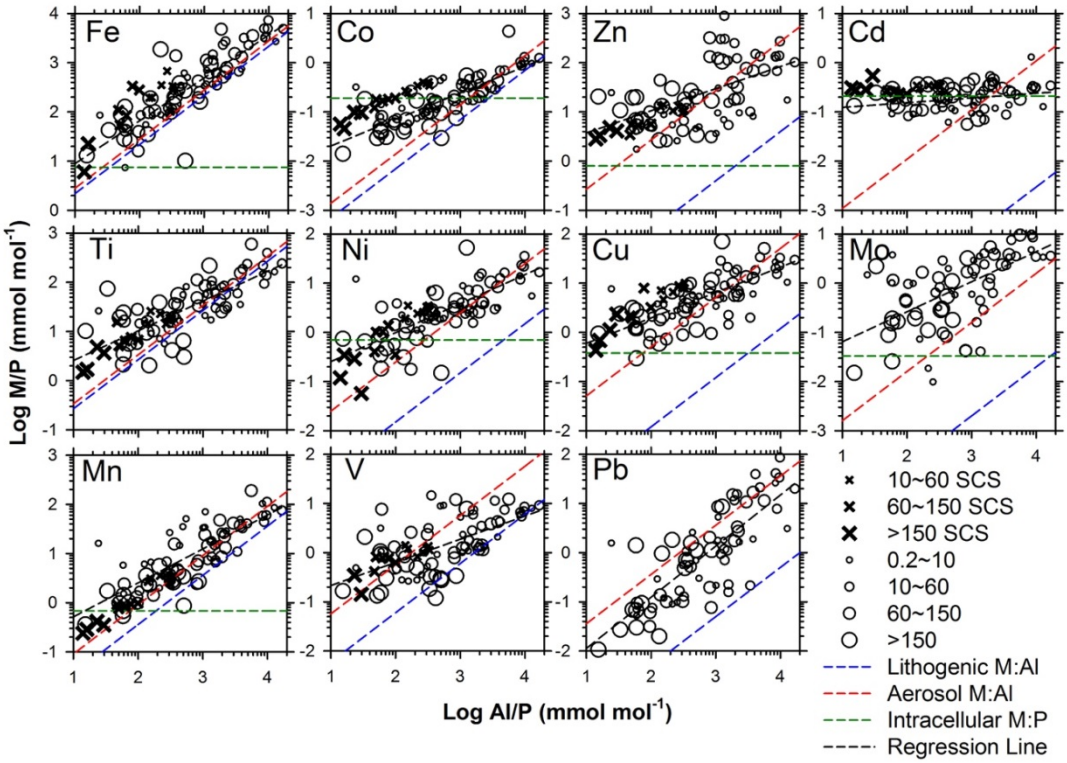


Figure 2. The distribution pattern of trace metals in size-fractionated suspended particles collected in the WPS, shown by log Metal/Al ratios vs log P/Al ratios. The red and blue dashed lines represent the log M/Al ratios of the in-situ aerosols collected in the WPS and of lithogenic materials, respectively. The green dashed lines represent the average metal quotas in marine plankton assemblages (Liao et al. submitted).

New Publications (2015/6-2016/5)

- Chuang, C.-Y., P.H. Santschi, L.-S. Wen, L.D. Guo, C. Xu, S. Zhuang, Y. Jiang, Y.-F. Ho, K.A. Schwehr, A. Quigg, C.-C. Hung, D. Schumann. 2015. Biopolymer- facilitated transport of 234Th, 233Pa, 210Pb, 210Po and 7Be, radionuclides in the ocean. Marine Chemistry, 173, 320-329.
- Chuang, C.-Y., P.H. Santschi, C. Xu, Y. Jiang, Y.-F. Ho, A. Quigg, L.D. Guo, P.G. Hatcher, M. Ayranov, D. Schumann. 2015. Molecular level characterization of diatom associated biopolymers that bind 234Th, 233Pa, 210Pb, and 7Be in seawater: a case study with Phaeodactylum tricornutum. Journal of Geophysical Research: Biogeosciences DOI: 10.1002/2015JG002970

- Lin, Y. C., J. P. Chen, T. Y. Ho, and I. C. Tsai (2015) Atmospheric iron deposition in the northwestern Pacific Ocean and its adjacent marginal seas: the importance of coal burning. Global Biogeochemical Cycles doi:10.1002/2013GB004795.
- Ren, H.J., A.S. Studer, S. Serno, D.M. Sigman, G.W. Winckler, R.F. Anderson, S. Oleynik, R. Gersonde, G.H. Haug. (2015) Glacial-to-interglacial changes in nitrate supply and consumption in the subarctic North Pacific from microfossil-bound N isotopes at two trophic levels. Paleoceanography DOI: 10.1002/2014PA002765.
- Yang, S.-C., D.-C. Lee, and T.-Y. Ho (2015) Cd isotopic composition in the suspended and sinking particles of the surface water of the South China Sea: the effects of biotic activities. Earth and Planetary Science Letters doi:10.1016/j.epsl.2015.07.025
- Yang, S.-C., D.-C. Lee, T.-Y. Ho, L.-S. Wen, and H.-H. Yang (2015) The isotopic composition of dissolved cadmium in the water column of the West Philippine Sea. Frontiers in Marine Science doi:10.3389/fmars.2014.00061.

New projects

- Dr. Tung-Yuan Ho has proposed 3-yr project to MOST (Ministry of Science and Technology) to carry out GEOTRACES research in the WPS and the Northwestern Pacific Ocean from 2016 to 2019. The title of the project is: Taiwan GEOTRACES II: Biogeochemical cycling and seasonal transformation of aerosol trace metals in the Western Philippine Sea. The scientific cruises are most likely to be carried out in 2018. The new RV will be equipped with trace metal clean sampling gears.

Other activities

- Dr. Chia-Ying Chuang is going to join Research Center for Environmental Changes at Academia Sinica this fall, 2016 as an assistant research fellow, whose Ph.D. research is closely associated with trace metal scavenging processes in the ocean. Two of her recent publications are included above. She has expressed her strong interests in doing GEOTRACES related research in Taiwan.
- TORI, Taiwan Ocean Research Institute, has been deploying moored sediment traps at two deep water depths (2000 and 3500 m) at our time series station in the northern South China Sea, SEATS, since 2014. Prof. Ching-Ling Wei and Tung-Yuan Ho have been measuring Th/U activities and trace metal fluxes by using the sinking particle samples.

Submitted by Tung-Yuan Ho (tyho@gate.sinica.edu.tw).

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN CROATIA

June 1st, 2015 to April 30th, 2016

The Croatian GEOTRACES activities were related to: 1) improvement of electrochemical methods, which in combination with ICPMS, are used for trace metals speciation (including interaction with organic matter and sulfur species), determination and quantification (mostly Zn,Cd,Pb,Cu, Fe,Ni,Co); 2) development of an automated system for determination of trace metals in natural waters (Voltammetric AutoAnalyser - Volt-AA) and solid (gold wire) micro sensors for on-site and in-situ metal analysis in seawater, 3) assessment of metal bioavailability in aquatic environment using passive samplers for metals (DGT) and cytosolic metal levels in tissues of aquatic organisms, 4) development of electroanalytical methods (chronoculometry) for determination of metal sulphide and elemental sulphur species, including nanoparticles, in natural waters, 5) characterization of marine aerosolos (PM2.5) regarding presence of organic matter, sulfur species and trace metals

Meetings

- Active participation in the COST Actions ES1205, ES1302 and TD1105, and SCOR WG 139 and 145.
- I. Pižeta as associated member, participated to the second meeting of SCOR WG145 „Modelling Chemical Speciation in Seawater to Meet 21st Century Needs“ (MARCHEMSPEC), 21. February 2016, New Orleans, USA and attended Ocean Sciences meeting, 21-26 February 2016, New Orleans, USA.

1. Characterization of Marine Aerosols at the highly Eutrophic Seawater Ecosystem Rogoznica Lake in Central Dalmatia, Adriatic Sea, A. Cvitešić, S. Frka, N. Bačić, N. Mikac, I. Ciglenečki, 5th International Workshop and Conference, Particulate Matter: Research and Management -WeBIOPATR2015, Belgrade, Serbia, October 2015.
2. Trace metals in water soluble fraction of marine aerosols I. Ciglenečki, A. Cvitešić, P. Orlović-Leko, S. Frka-Milosavljević, N. Bačić, N. Mikac, COST Action TD1105 - New Sensing Technologies for Air-Pollution Control and Environmental Sustainability -Fifth Scientific Meeting, organized by Bulgarian Academy of Sciences, Sofia, 16-18 December 2015.
3. Soluble fraction of metals in the bulk precipitation in an urban area (Zagreb, Croatia), P. Orlović-Leko, D. Omanović, K. Vidović, I. Ciglenečki, New Sensing Technologies for Air-Pollution Control and Environmental Sustainability -Fifth Scientific Meeting, organized by Bulgarian Academy of Sciences, Sofia, 16-18 December 2015.
4. Dissolved organic carbon in the northern Adriatic: long-term investigations – potential indicator of global changes, J.Dautović, V. Vojvodić, N. Tepić, B. Ćosović, I Ciglenečki, MISTRALS international conference 2015, October 2015, Marseilles France.

PhD thesis

- Ana-Marija Cindrić: "Distribution, speciation and fate of trace metals in the stratified Krka River estuary", June 2015, University of Zagreb, Faculty of Natural Science, Doctoral study of Oceanology.

Selected Publications

- Omanović, Dario; Garnier, Cédric; Kristoff Gibbon-Walsh; Pižeta Ivanka. Electroanalysis in environmental monitoring: tracking trace metals - a mini review. Electrochemistry Communications, 61 (2015) 78–83.
- Cindrić, Ana-Marija; Garnier, Cédric; Oursel, Benjamin; Pižeta, Ivanka; Omanović, Dario. Evidencing the natural and anthropogenic processes controlling trace metals dynamic in a highly stratified estuary: the Krka River estuary (Adriatic, Croatia). Marine pollution bulletin. 94 (2015) 199-216.
- Mlakar, Marina; Fiket, Željka; Geček, Sunčana; Cukrov, Neven; Cuculić, Vlado. Marine lake as in situ laboratory for studies of organic matter influence on speciation and distribution of trace metals. Continental shelf research. 103 (2015) 1-11.
- Ciglenečki, I., Svetličić, V., Nanoparticles and Marine Environment: An Overview, Nanotechnology to Aid Chemical and Biological Defense / Terri A. Camesano (ur.). Dordrecht, Netherlands: Springer, 2015. Str. 95-113.
- Ciglenečki, I., Janeković, I., Marguš M., Bura-Nakić, E. , Carić, M., Ljubešić, Z., Batistić, M., Dupčić, I., Hrustić, E., Garić, R., The impacts of the extreme weather events on the eutrophicated seawater ecosystem (Rogoznica Lake, Adriatic coast), Continental ShelfResearch108 (2015)144–155
- Marguš, M., Morales-Reyes, I., Bura-Nakić, E., Batina, N., Ciglenečki, I., The anoxic stress conditions explored at the nanoscale by Atomic Force Microscopy in highly eutrophic and sulfidic marine lake, Continental Shelf Research109(2015)24–34
- Plavšić, M., Strmečki, S., Carbohydrate polymers as constituents of exopolymer substances inseawater, their complexing properties towards copper ions, surfaceand catalytic activity determined by electrochemical methods, Carbohydrate Polymers 135 (2016) 48–56.

New equipment

- YSI EXO2 multiparameter probe with pH/ORP, Conductivity, Oxygen, Turbidity smart sensors

New projects supported by the Croatian Ministry of Science, Education and Sport and Croatian Science Foundation (CSF)

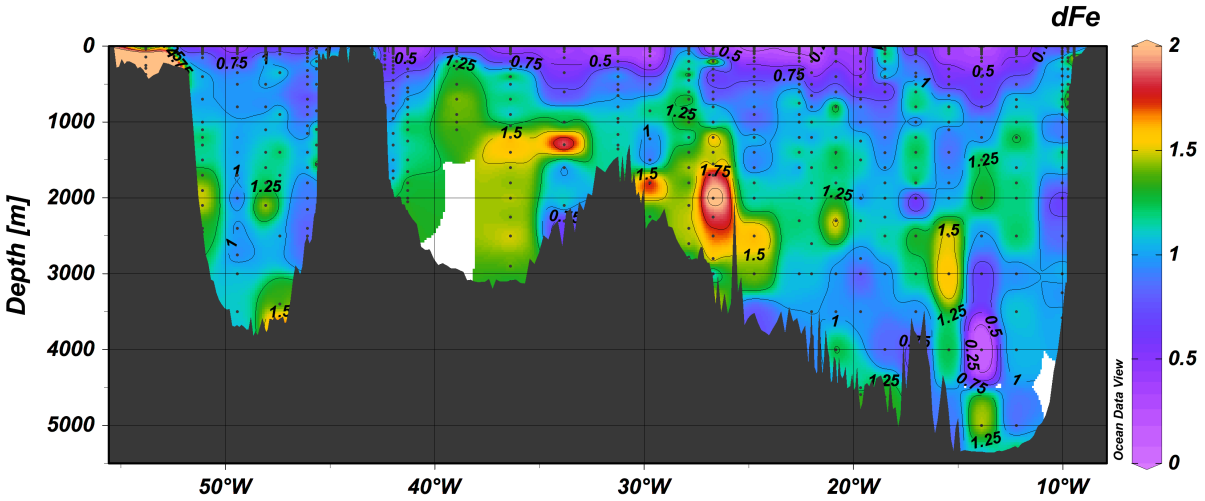
- 2014-2018 CSF project: "Appearance and interaction of biologically important organic molecules and micronutrient metals in marine ecosystem under environmental stress", AMBIOMERES
- 2014-2018 CSF project: „The Sulphur and Carbon dynamics in the Sea- and Fresh-water EnviRonment", SPHERE 1205

- 2014-2018 CSF project: „Transport and Chemodynamics of Trace Elements in Freshwater and Coastal Sedimentary Systems„
- NEWFELLPRO project 2014-2017 "Using lakes to develop isotopic tools for understanding ocean redox through Earth history"
- 2015-2019 CSF projekt: „New methodological approach to biogeochemical studies of trace metal speciation in coastal aquatic ecosystems" (MEBTRACE)
- 2015-2019 CSF project "Accumulation, Subcellular Mapping and Effects of Trace Metals in Aquatic Organisms" (AQUAMAPMET)
- 2015-2017: Monitoring program of coastal Adriatic Sea (Croatian side) (trace metals, organic matter)

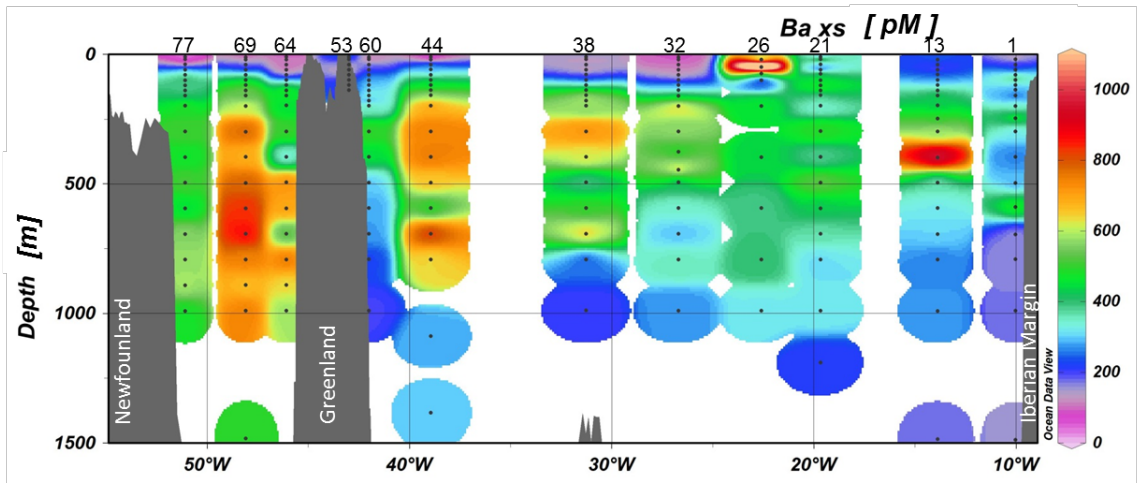
Submitted by Irena Ciglenecki Jusic (Irena.Ciglenecki-Jusic@irb.hr).

New Science highlights

- Distribution of dissolved Fe (dFe) along the GEOVIDE section (Tonnard et al., unpub.). Concentrations ranged from 0.1 nM to 10.1 nM, with the lowest values observed in the surface waters indicative of biological uptake and/or low atmospheric inputs. The highest values were found above the Greenland, Iberian and Canadian margins suggesting shelf inputs.

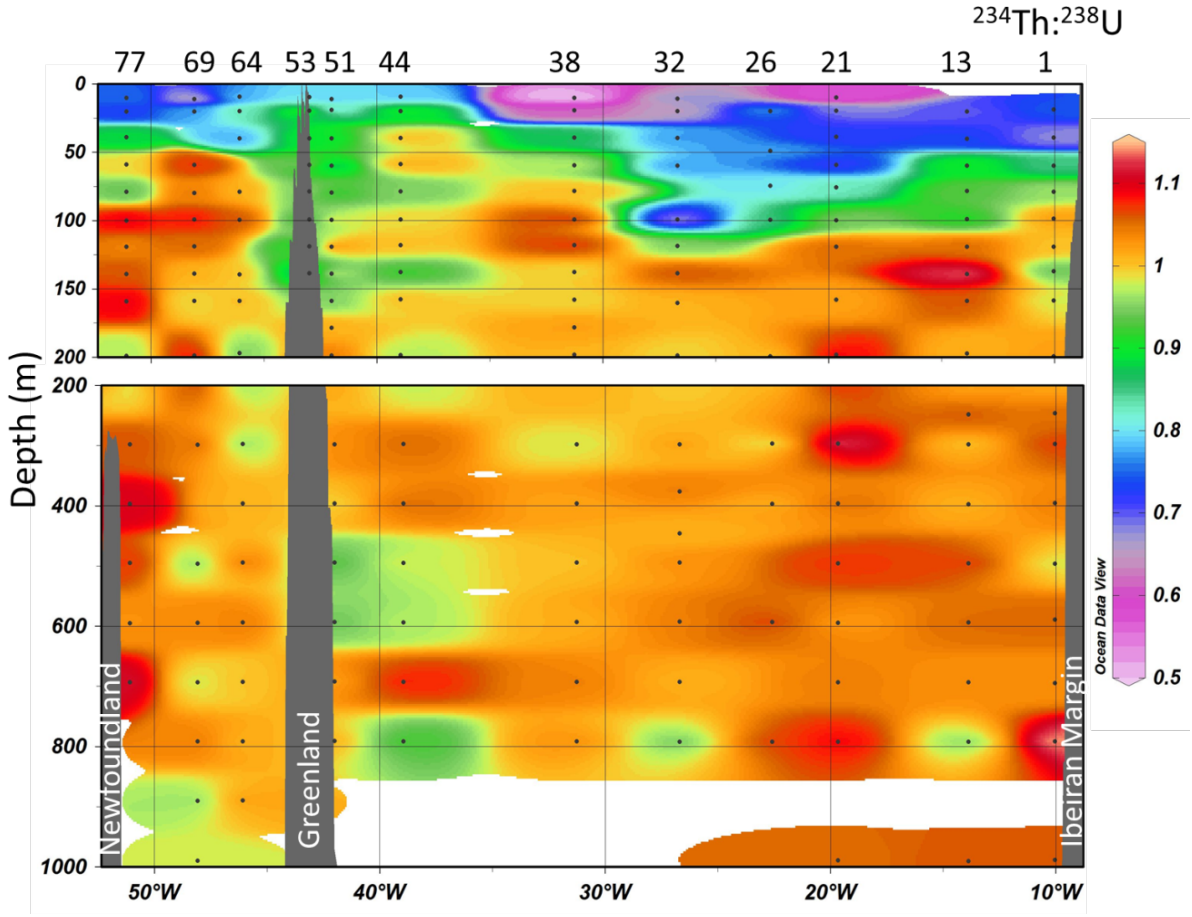


- Distribution of particulate biogenic barium (Baxs) along the GEOVIDE section (Lemaitre et al., unpublished). Concentrations range from 35 pM at station 77 in surface waters to 1888 pM at station 26 in surface waters. Generally, the maximum of Baxs content is located between 100 and 1000m. To the west of station 44 and in particular in the Labrador Sea, Baxs concentrations are significantly larger, reaching nearly 900 pM. These high values coincide with the formation of the Labrador Seawater.



- Distribution of the ratio 234Th/238U along the GEOVIDE section (Lemaitre et al., unpublished). Ratios range from 0.50 at station 38 in surface waters to 1.15 at station 1,

790 m. A larger deficit induces a greater 234Th export flux while a lager accumulation of 234Th relative to 238U highlights remineralization processes.



- POC export fluxes based on the 234Th approach, and carbon remineralization fluxes based on Baxs concentrations during the GEOVIDE cruise: Low POC export fluxes but high POC remineralization fluxes. As a result very little or no POC is transferred below 1000m

New peer-review publications (published or in press)

2015

- Bonnet, S., Rodier, M., Turk-Kubo, K.A., Germineaud, C., Menkes, C., Ganachaud, A., Cravatte, S., Raimbault, P., Campbell, E., Quéroué, F., Sarthou, G., Desnues, A., Maes, C., Eldin, G., 2015, Contrasted geographical distribution of N2 fixation rates and nifH phylotypes in the Coral and Solomon Seas (South-Western Pacific) during austral winter conditions, Global Biogeochem. Cy., 29, 1874–1892, doi:10.1002/2015GB005117
- Bowie A.R., van der Merwe, P., Quéroué, F., Trull, T., Fourquez, M., Planchon, F. Sarthou, G., Chever, F., Townsend, A.T., Obernosterer, I., Sallée, J.-B., Blain, S., 2015, Iron budgets for three distinct biogeochemical sites around the Kerguelen plateau (Southern Ocean) during the natural fertilization experiment KEOPS-2,. Biogeosciences, 12, 4421–4445, 2015
- Cavagna A. J., Fripiat F., Elskens M., Dehairs F., Mangion P., Chirurgien L., Closset I., Lasbleiz M., Flores–leiva L., Cardinal D., Leblanc K., Fernandez C., Lefevre D., Oriol L., Blain S., Queguiner B. (2015). Production regime and associated N cycling in the vicinity

of Kerguelen Island, Southern Ocean. Biogeosciences, 12(2), 6515-6528. http://doi.org/10.5194/bg-12-6515-2015

- Cuvier A., Panza F., Pourcelot L., Foissard B., Cagnat X., Prunier J., van Beek P., Souhaut M., 2015. Le Roux G., Accumulation and sources of U decay chain daughters around a minor closed uranium mine, Journal of Environmental Radioactivity 149, 110-120
- Dehairs, F., Fripiat, F., Cavagna, A.J., Trull, T.W., Fernandez, C., Davies, D., Roukaerts, A., Fonseca Batista, D., Planchon, F., Elskens, M., 2015. Nitrogen cycling in the Southern Ocean Kerguelen Plateau area: evidence for significant surface nitrification from nitrate isotopic compositions. Biogeosciences 12, 1459-1482.
- Fripiat F., Elskens M., Trull T. W., Blain S., Cavagna A. -J., Fernandez C., Fonseca-Batista D., Planchon F., Raimbault P., Roukaerts A., Dehairs F. (2015). Significant mixed layer nitrification in a natural iron-fertilized bloom of the Southern Ocean. Global Biogeochemical Cycles, 29(11), 1929-1943 http://doi.org/10.1002/2014GB005051
- Heimbürger, LE, JE Sonke, D Cossa, D Point, C Lagane, L Laffont, BT Galfond, M Nicolaus, B Rabe, M Rutgers van der Loeff (2015). Shallow methylmercury production in the marginal sea ice zone of the central Arctic Ocean Scientific Reports 5:10318. doi: 10.1038/srep10318
- Jacquet, S.H.M., Dehairs, F., Lefèvre, D., Cavagna, A.J., Planchon, F., Christaki, U., Monin, L., André, L., Closset, I., Cardinal, D., 2015. Early spring mesopelagic carbon remineralization and transfer efficiency in the naturally iron-fertilized Kerguelen area. Biogeosciences 12, 1713-1731.
- Koch-Larrouy A., Atmadipoera A., van Beek P., Madec G., Aucan J., Lyard F., Grelet J., Souhaut M., 2015. Estimate of tidal mixing in the Indonesian archipelago from multidisciplinary data, Deep-Sea Research I 106, 136–153
- Laurenceau-Cornec, E.C., Trull, T.W., Davies, D.M., Bray, S.G., Doran, J., Planchon, F., Carlotti, F., Jouandet, M.P., Cavagna, A.J., Waite, A.M., Blain, S., 2015. The relative importance of phytoplankton aggregates and zooplankton fecal pellets to carbon export: insights from free-drifting sediment trap deployments in naturally iron-fertilised waters near the Kerguelen Plateau. Biogeosciences 12, 1007-1027.
- Mawji, E., Schlitzer, R., Masferrer Dodas, E. et al., The GEOTRACES Intermediate Data Product 2014, Mar. Chem., doi :10.1016/j.marchem.2015.04.005.
- Planchon, F., Ballas, D., Cavagna, A.J., Bowie, A.R., Davies, D., Trull, T., Laurenceau-Cornec, E.C., Van Der Merwe, P., Dehairs, F., 2015. Carbon export in the naturally iron-fertilized Kerguelen area of the Southern Ocean based on the 234Th approach. Biogeosciences 12, 3831-3848.
- Quéroué F., G. Sarthou, H.F. Planquette, E. Bucciarelli, F. Chever, P. van der Merwe, D. Lannuzel, A.T. Townsend, M. Cheize, S. Blain, F. d'Ovidio and A.R Bowie., 2015. High variability in dissolved iron concentrations in the vicinity of the Kerguelen Islands (Southern Ocean), Biogeosciences 12, 3869–3883, www.biogeosciences.net/12/1/2015/, doi:10.5194/bg-12-3869-2015
- Rembauville M., Blain S., Armand L., Queguiner B., Salter I. (2015). Export fluxes in a naturally iron-fertilized area of the Southern Ocean - Part 2: Importance of diatom resting spores and faecal pellets for export. Biogeosciences, 12(11), 3171-3195. http://doi.org/10.5194/bg-12-3171-2015

- Rembauville M., Salter I., Leblond N., Gueneugues A., Blain S. (2015). Export fluxes in a naturally iron-fertilized area of the Southern Ocean - Part 1: Seasonal dynamics of particulate organic carbon export from a moored sediment trap. Biogeosciences, 12(11), 3153-3170. http://doi.org/10.5194/bg-12-3153-2015
- Rousseau T.C.C., Sonke J.E., Chmeleff J., van Beek P., Souhaut M., Boaventura G., Seyler P., Jeandel C., 2015. Rapid neodymium release to marine waters from lithogenic sediments in the Amazon estuary, Nature Communications DOI: 10.1038/ncomms8592
- Sanial V., van Beek P., Lansard B., Souhaut M., Kestenare E., d'Ovidio F., Blain S., 2015. Use of Ra isotopes to deduce rapid transfer of sediment-derived inputs off Kerguelen, Biogeosciences 12, 1415-1430, doi:10.5194/bg-12-1415-2015
- Trull, T.W., Davies, D.M., Dehairs, F., Cavagna, A.J., Lasbleiz, M., Laurenceau-Cornec, E.C., d'Ovidio, F., Planchon, F., Leblanc, K., Quéguiner, B., Blain, S., 2015. Chemometric perspectives on plankton community responses to natural iron fertilisation over and downstream of the Kerguelen Plateau in the Southern Ocean. Biogeosciences 12, 1029-1056.
- van der Merwe, P., A. R. Bowie, F. Quéroué, L. Armand, S. Blain, F. Chever, D. Davies, F. Dehairs, F. Planchon, G. Sarthou, A. T. Townsend, and T. Trull, Sourcing the iron in the naturally fertilised bloom around the Kerguelen plateau: particulate trace metal dynamics, 2014. Biogeosciences, 12, 1–17, 2015, www.biogeosciences.net/12/1/2015/, doi:10.5194/bg-12-1-2015.
- Zunino, Patricia, Pascale Lherminier, Herlé Mercier, Xose A. Padin , Aida F. Ríos and Fiz F. Pérez (2015): Dissolved Inorganic Carbon and anthropogenic CO2 budgets in the eastern Subpolar North Atlantic in the 2000s from in situ data. Geophys. Res. Lett. 42, doi:10.1002/2015GL066243

2016

- Conway T., John S. G., Lacan F. Intercomparison of dissolved iron isotope profiles from re-occupation of three GEOTRACES stations in the Atlantic Ocean. Accepted to Marine Chemistry.
- Pham M.K., van Beek P., Carvalho F.P., Chamizo E., Degering D., Engeler C., Gascó C., Gurriaran R., Hanley O., Harms A.V., Herrmann J., Hult M., Ikeuchi Y., Ilchmann C., Kanisch G., Kis-Benedek G., Kloster M., Laubenstein M., Llaurado M., Mas J.L., Nakano M., Nielsen S.P., Osvath I., Povinec P.P., Rieth U., Schikowski J., Smedley P.A., Suplinska M., Sýkora I., Tarjan S., Varga B., Vasileva E., Zalewska T., Zhou W., 2016. Certified reference materials for radionuclides in Bikini Atoll sediment (IAEA-410) and Pacific Ocean sediment (IAEA-412), Applied Radiation and Isotopes 109. doi: 10.1016/j.apradiso.2015.11.041.
- Rembauville, M., Meilland, J., Ziveri, P. Blain, S., Salter, I., 2016. Planktic foraminifer and coccolith contribution to carbonate export fluxes over the central Kerguelen Plateau. Deep Sea Research Part I, 111, 91-101, doi:10.1016/j.dsr.2016.02.017
- Soerensen, AL, DJ Jacob, AT Schartup, JA Fisher, I Lehnherr, VL StLouis, LE Heimbürger, JE Sonke, DP Krabbenhoft, EM Sunderland (2016). A Mass Budget for Mercury and Methylmercury in the Arctic Ocean. Global Biogeochemical Cycles 30 doi: 10.1002/2015GB005280

Other publications

- Guieu C. and V. Shevchenko, Dust in the Ocean, in : Encyclopedia of Marine Geosciences edited by Jan Harff, Martin Meschede, Sven Petersen and Jörn Thiede. DOI 10.1007/978-94-007-6644-0_56-3, Springer Science+Business Media Dordrecht, 2015.

Cruises

- In 2016, several coastal cruises along the French Mediterranean coastline in the framework of the MED-SGD project
- Participation to the Australian GEOTRACES cruise HEOBI (GIpr05), Jan.-Feb. 2016.
- Participation to the Germain TransArctic cruise FS Polarstern PS94 (GN04, TransArc II, chief scientist: U Schauer, GEOTRACES lead scientist: MR van der Loeff)

New projects and/or funding

- IDEX-Emergence IRONIC 2016-2018 86 000 €. Iron isotopes: an emerging field for exploring the oceanic biogeochemical cycles (PI: F. Lacan).
- MED-SGD (ANR Blanc; PI: P. van Beek; 2016-2019) : Submarine Groundwater Discharge: A hidden source of chemical compounds at the land-ocean interface
- RASEDIM (NEEDS-Environnement ; PI : P. van Beek ; 2015-2016) : Mobilité du RAdium à l'interface eau-SEdiment dans les milieux lacustres : Déséquilibres Isotopiques et Minéralogie de la barytine.
- PEACETIME ProcEss studies at the Air-sEa Interface after dust deposition in the MEditerranean sea, Coordination C. Guieu and K. Desboeufs).
- Labex EXPATE, EXploring the role of PArticles in Trace Element cycling in the central Arctic Ocean (PI. H. Planquette)
- Labex MOBIDIC, MOdelling the Biogeochemical Impact of seDImentary partiCulate iron (PI. T. Gorgues)
- Chantier Arctique Francais PARCS-AMER (PI PARCS K Law ; PIs AMER (Arctic Mercury) JE Sonke & LE Heimbürger)

PhD

- Sanial, V. (2015), Etude des échanges côte-large au moyen des isotopes du radium: cas de la fertilisation en fer au large des îles Crozet et Kerguelen (Océan Austral), Toulouse, France.

International conferences

2015

- Ayache M., C. Jeandel, JC Dutay and T. Arsouze Constraints on the neodymium (Nd) oceanic cycle in the Mediterranean Sea using a high resolution coupled model, EGU Vienne, 2015
- Cheize, M.; Planquette, H. F.; Fitzsimmons, J.; Sherrell, R. M.; Sarthou, G.; Bucciarelli, E.; Lambert, C.; Le Goff, M.; Viollier, E., 2015 Contribution of suspended marine particles

to the dissolved trace metals pool: an experimental study with sediments from contrasting environments, ASLO meeting, Granada, Spain, Feb. 2015 (Poster)

- Cossa D, Heimbürger LE, Sonke JE, Zhang Y, Lacan F, Lherminier P, Sarthou G. Mercury in the North Atlantic Ocean - results of the 2014 GEOTRACES GEOVIDE cruise (talk). 12th International Conference on Mercury as a Global Pollutant, Jeju, South Korea, June 2015. Talk.
- De Vleeschouwer F., Le Roux G., Sonke J., van Beek P., Souhaut M., Pourcelot L., Masson O., Guarriaran R., Hughes P.D.M., Piotrowska N., Tanimizu M., Hotes S., Klaminder J., Martinez-Cortizas A., Olid C. Japanese PEat records of ATmospheric deposition of artificial radionuclides (J-PEAT): Impacts of Fukushima accident and implications for radiochronology, INQUA meeting, Nagoya, Japan, 27 juillet-2 août 2015
- Gourain, A., Planquette, H., Cheize M., Menzel, J.-L., Boutorh J., Shelley R., Pereira Contreira L., Bucciarelli E., Sarthou G., Bassoullet, C., 2015, Size fractionated particulate iron along the GEOVIDE section (GEOTRACES section GA01), ASLO meeting, Granada, Spain, Feb. 2015. Poster.
- Heimbürger, LE, C Lagane, L Laffont, D Cossa, JE Sonke, Mercury measurements in the oceans - results of the 2013 and 2014 GEOTRACES intercalibration exercises, 12th International Conference on Mercury as a Global Pollutant, Jeju, South Korea, Invited talk
- Heimbürger, LE, D Cossa, A Schartup, C Lagane, L Laffont, JE Sonke, Methylmercury production in the oceans: links to physics, chemistry and biology, , 12th International Conference on Mercury as a Global Pollutant, Jeju, South Korea, Invited talk.
- Jeandel Catherine 25 years of Marine Geochemistry, Invited talk for the Goldschmidt 25th anniversary; Goldschmidt Conference, Prague, 16-21 Aug 2015
- Jeandel C. Solid river inputs and ocean margins as critical sources of elements to the oceans Invited Talk at the Royal Society Discussion Meeting, London, 7-8 december 2015
- Lacan F., Labatut M., Pradoux C., Radic A., Murray J.W., Poitrasson F., Johansen A. Iron isotopes along the Equator in the Western and Central Pacific Ocean. Goldschmidt Conference, Prague, Czech Republic, August 2015. Invited talk.
- Lemaitre, N., H. Planquette, F. Dehairs, L. Monin, L. André, S. Jacquet, F. Planchon. Mesopelagic carbon remineralization from particulate excess Ba along the GEOVIDE transect in the North Atlantic. 2015. Goldschmidt, Prague (Czech Republic). Talk.
- Masferrer Dodas, Catherine Jeandel, Reiner Schlitzer, Ed Boyle, Geotraces group* Highlights from the GEOTRACES International Programme Goldschmidt Conference, Prague, 16-21 Aug 2015, poster
- Menzel, J. L.; Schlosser, C.; Planquette, H.; Cheize, M.; Boutorh, J.; Shelley, R.; Contreira, L.; Gledhill, M.; Sarthou, G.; Achterberg, E. P.: High resolution dissolved aluminum (dAl) measurements along the GEOVIDE section (geotraces section GA01) and aerosol deposition rates to the north Atlantic, ASLO meeting, Granada, Spain, Feb. 2015 (Poster)
- Michael Susanna Marie, Joseph A Resing, Catherine Jeandel and Francois Lacan, Aluminum and Manganese Distributions in the Solomon Sea: Results from the 2012 PANDORA Cruise Poster AGU San Francisco, 2015
- Pham V., Jeandel C., leleu T., Grenier M., Rousseau T., Ganachaud G. and Eldin G. Rare Earth Elements in the Coral and Solomon Seas (Pandora-GEOTRACES) Goldschmidt Conference, Prague, 16-21 Aug 2015, poster

- Rosati, G., LE Heimbürger, JE Sonke, MJA Rijkenberg, L Gerringa, HJW de Baar, Developing a methylmercury dynamic model for the Black Sea, 12th International Conference on Mercury as a Global Pollutant, Jeju, South Korea
- Sarthou, G., Quéroué, F., Chever, F., van der Merwe, P., Lannuzel, D., Townsend, A.T., Bucciarelli, E., Planquette, H.F., Cheize, M., Blain, S., d'Ovidio, F. and Bowie, A.R., High variability of dissolved iron concentrations in the vicinity of the Kerguelen Island (Southern Ocean), 3rd International Symposium on the Effects of Climate Change on the World's Oceans, Santos, Brazil, March 23-27
- Sarthou, G, Lherminier, P. and the GEOVIDE team, 2015, GEOVIDE: An international GEOTRACES study in the North Atlantic and Labrador Sea, Goldschmidt Conference, Prague, August 16-21 (oral).
- Shelley, R. and Sarthou, G. 2015, Elemental composition of atmospheric deposition during the GEOVIDE campaign (Lisbon, Portugal-St John's, Canada; GEOTRACES GA01), Aquatic Sciences Meeting, Granada, Spain. 22-26 Feb. (Oral)
- Soerensen, AL, DJ Jacob, A Schartup, JA Fisher, I Lehnherr, Vl StLouis, LE Heimbürger, JE Sonke, An evaluation of internal production and external sources of methylmercury in the Arctic Ocean, 12th International Conference on Mercury as a Global Pollutant, Jeju, South Korea
- Tachikawa K., Arsouze T., Bayon G., Bory A., Colin C., Dutay J-C., Frank N., Gourlan A.T., Hillaire-Marcel C., Jeandel C., Lacan F., Meynadier L., Montagna P., Pucéat E., Roy-Barman M., Waelbroeck C. Comparison between seawater and archive Nd isotope compositions using multi-scatter plots: a new global data compilation. Goldschmidt Conference, Prague, Czech Republic, August 2015. Talk.
- Tonnard, G. Sarthou, H. Planquette, P. van der Merwe, J. Boutorh, M. Cheize, J.L. Menzel, L. Pereira Contreira, R. Shelley, A.R. Bowie, 2015, Dissolved iron along the GEOVIDE section (GEOTRACES section GA01), Goldschmidt Conference, Prague, August 16-21 (poster)
- van Beek P., Stieglitz T., Souhaut M., Study of SGD along the French Mediterranean coastline using airborne TIR images and in situ analyses, European Geosciences Union General Assembly 2015 Vienne, Autriche, 12-17 april 2015.
- Zhang Y, Heimbürger LE, Cossa D, Sonke JE, Lacan F, Lherminier P, Sarthou G. Mercury in the North Atlantic Ocean - direct comparison of model and observations along the 2014 GEOTRACES GEOVIDE cruise transect. 12th International Conference on Mercury as a Global Pollutant, Jeju, South Korea, June 2015. Poster.

2016

- Achterberg, E.P., Menzel Barraqueta, J.-L., Schlosser, C., Planquette, H., Cheize, M., Boutorh, J., Shelley, R., Sarthou, G. and Gledhill, M., High resolution dissolved and dissolvable aluminum measurements along the GEOVIDE section (GEOTRACES section GA01), 2016, Ocean Science Meeting, New Orleans, 21-26 Feb.
- Ayache, M., Dutay JC, Arsouze T., Revillon S. and Jeandel C. High resolution neodymium characterization along the Mediterranean Sea margins: implications for εNd modeling. EGU, Vienna, 2016
- Cheize, M., Planquette, H., Fitzsimmons, J., Sherrell, R.M., Pelleter, E., Lambert, C., Sarthou, G., Boutorh, J., Bucciarelli, E., Le Goff, M., Liorzou, C., Chéron, S. and

Gayet,N., 2016, Contribution of Resuspended Sediments to the Dissolved Trace Metal Pool (Fe, Mn): An Experimental Study, Ocean Science Meeting, New Orleans, 21-26 Feb.

- Heimbürger, L.E., Cossa, D., Rijkenberg, M.J.A., Sarthou, G., Rutgers van der Loeff, M., Sunderland, E.M., and Sonke, J., Mercury in the North Atlantic and Arctic Oceans - results of the 2014 GEOTRACES GEOVIDE & 2015 GEOTRACES TransArc II cruises, Ocean Science Meeting, New Orleans, 21-26 Feb
- Heimbürger, LE, JE Sonke, R Teisserenc, O Pokrovski, MJA Rijkenberg, M Rutgers van der Loeff, B Galfond, N Marusczak, C Lagane, Biogeochemical Studies in the Siberian Shelf Seas workshop, GEOMAR, Kiel, Germany, Invited talk: Arctic Mercury Puzzle(s) TRANSARCII science party, SVALBARD project, 2013 TARA OCEANS POLAR CIRCLE
- Heimbürger, LE, D Cossa, MJA Rijkenberg, G Sarthou, M Rutgers van der Loeff, EM Sunderland, JE Sonke, ISO-FOOD workshop on speciation of trace elements, Ljubljana, Slovenia Mercury in the North Atlantic and Arctic Oceans - results of the 2014 GEOTRACES GEOVIDE & 2015 GEOTRACES TransArc II cruises & some quality assurance
- Planquette H, Gourain A, Cheize M, Menzel Barraqueta J-L, Boutorh J, Shelley R, Pereira Contreira L, Lacan F, Lherminier P, Sarthou G. Particulate trace elements in the North Atlantic along the GEOVIDE section (GEOTRACES GA01). Ocean Sciences Meeting. February 2016. New Orleans (USA). Talk.
- Lemaitre, N., H. Planquette, F. Dehairs, L. Monin, L. André, S. Jacquet, F. Planchon. Mesopelagic carbon remineralization from particulate excess Ba along the GEOVIDE transect in the North Atlantic. 2016. Poster. Ocean Sciences Meeting, New Orleans (USA)
- Lemaitre, N., F. Planchon, H. Planquette, F. Dehairs, L. Monin, L. André, M. Leermarkers, D. Fonseca-Batista, A. Roukaerts, C. Mourgues, D. Verstraeten, M. Castrillejo, Y. Tang, C. Jeandel, V. Sanial, R. Sauzède, L. Foliot. Carbon export fluxes along the GEOVIDE transect in the North Atlantic (GEOTRACES GA01). 2016. Poster Ocean Sciences Meeting, New Orleans (USA)
- Lherminier, P., H. Mercier, N. Daniault, FF. Perez, A. Rios, P. Zunino, MI. García-Ibáñez, V. Racapé, M. Gehlen, L. Bopp (2016): OVIDE-A25, a Biennial Hydrographic Transect across the North Atlantic Subpolar Gyre since 2002: Overview of the Main Scientific Findings about the Variability of the Meridional Overturning Circulation and its Impact on the CO2 Physical Pump. Talk. AGU, Ocean Sciences, New Orleans, 21-26 Feb. 2016, session B53A.
- Michael S.M., Resing J.A., Jeandel C., Lacan F. Aluminum and Manganese Distributions in the Solomon Sea: Results from the 2012 PANDORA Cruise. Ocean Sciences Meeting, New Orleans, USA, February 2016. Poster.
- Racapé, V., M. Gehlen, P. Zunino, P. Lherminier, L. Bopp, H. Mercier: Transport and storage of anthropogenic C across the Greenland-Portugal OVIDE section: Observations vs NEMO-PISCES Talk. AGU, Ocean Sciences, New Orleans, 21-26 Feb. 2016
- Reverdin, G.P., Benetti, M., Yashayaev, Y., Olafsdottir, S., Holliday, N.P., Tynan, E., Lherminier, P., Treguer, P.J., and Sarthou, G., 2016, Freshwater Origin of the Upper Shelf and Slope Waters of Southern Labrador and Newfoundland, Ocean Science Meeting, New Orleans, 21-26 Feb

- Rosati, G., LE Heimbürger, D Melaku Canu, JE Sonke, MJA Rijkenberg, L Gerringa, HJW de Baar CIESM 2016, Kiel, Germany, Methylmercury in the Black Sea: new observations compared with a 1D numerical model
- Sarthou, G, Lherminier, P. and the GEOVIDE team, 2016, GEOVIDE: An international GEOTRACES study in the North Atlantic and Labrador Sea (GA01 GEOTRACES section), Ocean Science Meeting, New Orleans, 21-26 Feb
- Shelley, R., Roca-Martí, M., Castrillejo, M., Masqué, P., and Sarthou, G., 2016, Estimation of Trace Element Atmospheric Deposition Fluxes to the Atlantic Ocean (> 40°N) During Spring 2014 (GEOVIDE, GEOTRACES GA01), Ocean Science Meeting, New Orleans, 21-26 Feb
- Zunino, P., P. Lherminier, H. Mercier, A. F. Ríos, X. A. Padin and F. F. Pérez (2016): Budgets of Dissolved Inorganic Carbon in the Eastern Subpolar North Atlantic in the 2000s from In Situ Data Poster. AGU, Ocean Sciences, New Orleans, 21-26 Feb. 2016

National conferences

2016

- Heimbürger, LE D Cossa, MJA Rijkenberg, G Sarthou, M Rutgers van der Loeff, EM Sunderland, JE Sonke, Mercury in the North Atlantic and Arctic Oceans - results of the 2014 GEOTRACES GEOVIDE & 2015 GEOTRACES TransArc II cruises, Invited talk: OGS Trieste, Italy
- Heimbürger, LE D Cossa, MJA Rijkenberg, G Sarthou, M Rutgers van der Loeff, EM Sunderland, JE Sonk, Mercury in the North Atlantic and Arctic Oceans - results of the 2014 GEOTRACES GEOVIDE & 2015 GEOTRACES TransArc II cruises, Invited talk: Laboratoire d'Oceanographie de Villefranche s/Mer
- van Beek P., Souhaut M., Jean-Louis Reyss, 2016. Low-Background gamma spectromery at the underground laboratory of Ferrières, French Pyrénées, Invited talk, Journées NEEDS Environnement, 1-3 Février, Toulouse

Outreach activities

- Conferences in the framework of the Etoiles Brillent Pour Tous (www.ebpt.fr).
- Train du Climat:

  http://geotraces.org/outreach/geotraces-enewsletter/archive/view/listid-12-geotraces-newsletter/mailid-501-geotraces-outreach

Other activities (e.g., acquisition of new sampling systems, special sessions,…)

- Co-organization of the workshop “Biological and climatic impacts of ocean trace element chemistry”, The Royal Society, London, 7-8 December 2015.
- Co-organization of the workshop “Quantifying fluxes and processes in trace-metal cycling at ocean boundaries”, Kavli Royal Society Centre, Chicheley Hall, 9-10 December 2015.
- European Geosciences Union General Assembly 2015 Vienne, Autriche, 12-17 april 2015, session “HS8.2.9: Hydrogeology of coastal zones: processes, consequences and potentials” at the, Co-Conveners: Eric Zechner, G.H.P. Oude Essink , Thomas Graf , Perry de Louw , Ulf Mallast , P. van Beek , Christian Siebert

- Goldschmidt 2015, Prague; CZ, August 16-21 2015. Theme 2: Ocean Geochemistry. Present Conditions and Past Variation: Fluxes, reservoirs and processes. Theme Chairs: Géraldine Sarthou (LEMAR CNRS, Brest, France) and Andrew Bowie (University of Tasmania). 7 special sessions within this theme.
- Third international symposium on Effects of Climate Change on the World's Ocean, Santos, Brazil, 23-27 mars 2015. Session S3: "Changing ocean chemistry: From trace elements and isotopes to radiochemistry and organic chemicals of environmental concern". Session Chairs: Angelica Peña (Institute of Ocean Sciences, Sidney, Canada), Géraldine Sarthou (LEMAR, Brest, France).
- Ocean Science Meeting, New Orleans, USA, 21-27 February 2016. Trace Elements and Isotopes at the oceanic interfaces of the Atlantic Ocean. Session chairs: Géraldine Sarthou (LEMAR, Brest, France), Edward A Boyle (Massachusetts Institute of Technology, USA), Gideon Henderson (University of Oxford, UK), Micha Rijkenberg (NIOZ Royal Netherlands Institute for Sea Research, Texel, NL).
- Development of the LAFARA underground laboratory in the French Pyrénées in the framework of a FEDER project. This project will allow us to increase the capacity of analysis using low-background gamma spectrometry.
- SELECT (projet FEDER 2016-18- Région Languedoc- Roussillon-Midi-Pyrénées/ Europe): Sélection de matériaux « bas niveau » au laboratoire souterrain LAFARA pour la fabrication d'instruments et d'équipements de mesure nucléaire ultra-performants (PIs : P. van Beek/ M. Souhaut).
- GEOVIDE post-cruise meeting, Brest, 26-27 May 2015 (http://www.geovide.obs-vlfr.fr/post-cruise-meeting-25-26-may-2015/), 32 participants
- GEOVIDE 2016 meeting, Brest, 26-27 May 2016
- 12th International Conference on Mercury as a Global Pollutant, Jeju, Korea :

  LE Heimbürger is member of the Scientific Steering Committee
  Special session organizer and chair: Integrating marine observational studies and model development, AL Soerensen & LE Heimbürger (8 presentations + 5 posters)
  Workshop: trace clean sediment & water sampling, handling and analysis, Jim Hurley, LE Heimbürger, Seunghee Han, Brooks Rand Labs
  Workshop: Marine mercury measurements - open discussion on intercalibration issues, LE Heimbürger

- 2015 GEOTRACES intercalibration exercise for total methylmercury and total mercury in seawater, coordinated by LE Heimbürger
- In 2017, planned organization of a GEOTRACES summer school in Brest. This summer school will aim at teaching the skills and knowledge necessary for a good understanding of the biogeochemical cycles of trace metals. It will also allow doctoral students and early career researchers to see how their work fits within the international community of GEOTRACES. This event will gather numerous international students and world renowned scientists in Brest. IUEM has all the means necessary to consider a combination of practical conferences and workshops, especially through analytical tools of the PSO. Date is not fixed yet, but we are aiming for September 2017.

Submitted by Geraldine Sarthou (Geraldine.Sarthou@univ-brest.fr).

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN GERMANY

June 1st, 2015 to April 30th, 2016

Activities

- Walter Geibert (Alfred-Wegener Institute, Bremerhaven) initiated a 7Be interlaboratory comparison study for GEOTRACES in January 2016 that is nearing completion.
- Claudia Ehlert (ICBM, Oldenburg) participated in the GEOTRACES dissolved Si isotope intercalibration organized by M. Brzezinski (USA).
- The new trace metal clean rosette and winch of Geomar, Kiel, were used for trace metal sampling on the SE Atlantic GEOTRACES cruise (GA-08).
- Two new GEOTRACES reference samples for surface waters (SAG) and for deep waters near 2200 m (CAB) were collected in the SE Pacific. More than 500 0,5 liter samples were filtered, homogenized, acidified and bottled.

Cruises

- **GEOTRACES Arctic cruise PS94**, ARKXXIX/3 (*R/V Polarstern*, chief scientist U. Schauer, AWI). GEOTRACES PIs: M. Rutgers van der Loeff (AWI, Bremerhaven), K. Pahnke (ICBM, Oldenburg), Micha Rijkenberg (NIOZ, The Netherlands), M. Staubwasser (Univ. of Cologne),
- **GEOTRACES SE Atlantic cruise GA-08**, M121 (*R/V Meteor*, chief scientist: M. Frank). PIs: E. Achterberg (Geomar, Kiel), A. Koschinsky (Jacobs University, Bremen). A total of 51 full water column stations were complemented by continuous towed fish sampling for waters and by aerosol collection.
- **GEOTRACES Process Study**, Oligotrophic South Pacific Gyre (UltraPac), SO245 (*R/V Sonne*, chief scientist: Tim Ferdelman, MPI Bremen). GEOTRACES PIs: P. Croot (Galway), K. Pahnke (ICBM), M. Staubwasser (U. of Cologne).

New projects and/or funding

- Joint DFG proposal (E. Achterberg and A. Koschinsky) for the evaluation phase of the M121 cruise was approved and provides both working groups with a PhD position for 3 years. A third one will be applied for shortly.
- Three PhD studentships were approved as part of the successful GIO6 SONNE proposal.
- GEOTRACES Indian Ocean cruise (GIO6, R/V Sonne) was approved. Chief scientists: E. Achterberg/M. Frank (Geomar, Kiel), co-proponent: A. Koschinsky (Jacobs University, Bremen).
- A cruise proposal for R/V Meteor (A. Koschinsky, M. Frank, T. Dittmar) to study mixing processes in the Amazon estuary and its impact on trace metal fluxes into the Atlantic, was not approved but will be resubmitted in September 2016 (to be suggested as a GEOTRACES process study).

Other activities

- Melanie Behrens (ICBM, University of Oldenburg) won a student poster award at the AGU Fall Meeting 2015 for her presentation of Nd isotope and REE data from a GEOTRACES Process Study in the West Pacific.

Outreach activities

- Reiner Schlitzer, Presentation during GEOTRACES Townhall at Ocean Sciences Meeting, Feb 2016, in New Orleans

National and international service

- Germany is represented on the International GEOTRACES Standards and Intercalibration Committee by Walter Geibert (AWI), and on the SSC by Reiner Schlitzer (co-chair, AWI) and Katharina Pahnke (MPI/ICBM).

Meetings

- **Workshop on biogeochemical studies in Siberian Shelf Seas**

  GEOMAR Kiel 27-28 January 2016. Organized by H. Kassens, M. Rutgers van der Loeff, M. Frank, Andrei Novikhin, Sandra Gdaniec. Sponsored by IASC, TRANSDRIFT (System Laptev Sea) and GEOTRACES.

  Objectives:

  1) Bring together specialists working from widely different perspectives on geochemical studies in the Siberian Shelves Seas.

  2) Exploring possibilities of cooperation in future studies by exchange of data, samples, cruise participants.

  35 attendants, including 10 early career scientists, from 10 countries, represented: NABOS, SWERUS-ISSS08, GEOTRACES, TRANSDRIFT, Arctic-GRO, Shirshov Institute, Japan, RUSALCA, AWI-Lena estuary.

  Central in the discussions was the attempt to enhance cooperations between Russian and other scientists and to enhance the possibilities for trace metal analyses in Russian shelf seas. In this respect, two agreements were made:

  1. The Shirshov Institute participants announced that 2-3 foreign participants were welcome on their 2017 expedition to the Laptev/Kara/Barents Sea. And

  2. It was decided to set up possibilities for Russian students to get training in clean sampling techniques. Both cooperations were announced through the GEOTRACES mail server.

New publications (published or in press)

- Basak, C., Pahnke, K., Frank, M., Lamy, F., Gersonde, R., 2015. Neodymium isotopic characterization of Ross Sea Bottom Water and its advection through the southern South Pacific. Earth and Planetary Science Letters 419, 211-221. doi:10.1016/j.epsl.2015.03.011.

- Cao, Z., Frank, M., Dai, M., 2015. Dissolved silicon isotopic compositions in the East China Sea: Water mass mixing versus biological fractionation. Limnology and Oceanography 60: pp. 1619-1633.
- Hathorne, E., Stichel, T., Brück, B., and Frank, M., 2015. Rare earth element distribution in the Atlantic sector of the Southern Ocean: The balance between particle scavenging and vertical supply. Marine Chemistry 177: pp. 157-171.
- Osborne, A., Haley, B.A., Hathorne, E., Plancherel, Y., Frank, M., 2015. Rare Earth Element distribution in Caribbean seawater: Continental inputs versus lateral transport of distinct REE compositions in subsurface water masses. Marine Chemistry 177, 172-183.
- Poehle, S., Schmidt, K., Koschinsky, A., 2015, Determination of Ti, Zr, Nb, V, W and Mo in seawater by a new online-preconcentration method and subsequent ICP-MS analysis. Deep Sea Research Part I 98: 83–93.
- Snow J. T., Schlosser C., Woodward E.M.S., Mills M.M., Achterberg E. P., Mahaffey, C.A., Bibby T.S., Moore C.M., 2015. Environmental controls on the biogeography of diazotrophy and Trichodesmium in the Atlantic Ocean. Global Biogeochemical Cycles, Global Biogeochemical Cycles. doi:10.1002/2015GB005090.
- Stichel, T., Hartman, A.E., Duggan, B., Goldstein, S.L., Scher, H., Pahnke, K., 2015. Separating biogeochemical cycling of neodymium from water mass mixing in the Eastern North Atlantic. Earth and Planetary Science Letters 412, 245-260. doi:10.1016/j.epsl.2014.12.008.
- Xie, R.C., Galer, S.J.G., Abouchami, W., Rijkenberg, M.J.A., De Jong, J., de Baar, H.J.W., Andreae, M.O., 2015. The cadmium-phosphate relationship in the western South Atlantic – the importance of mode and intermediate waters on the global systematics. Marine Chemistry 177, 110-123. doi: http://dx.doi.org/10.1016/j.marchem.2015.06.011.

Conference abstracts

- Behrens, A., Pahnke, K., Schnetger, B., Brumsack, H.J., Trace element inputs to the upper West Pacific from Nd isotopes and rare earth elements, AGU Fall Meeting, San Francisco, 2015 (poster, won poster award).
- Cao, Z., Siebert C., Hathorne, E., Dai, M., Frank, M.. Do Dissolved Barium Isotopes in Seawater Trace Water Mass Mixing and Nutrient Cycling? 25th Goldschmidt Conference, Prague, Czech Republic, August 15-21, 2015 (talk).
- Geibert, W., Fluxes across the continental shelf. Royal Society Satellite Meeting "Quantifying fluxes and processes in trace-metal cycling at ocean boundaries" Chicheley Hall, UK, Dec. 2015 (keynote lecture).
- Filippova, A., Frank, M., Rickli, J., Hathorne, E., Yashayaev, I.. Water Mass Formation in the Labrador Sea Based on Coupled Hf-Nd Isotope and Rare Earth Element Distributions. 25th Goldschmidt Conference, Prague, Czech Republic, August 15-21, 2015 (talk).
- Koschinsky, A., Schmidt, K., Riedel, T., Poehle, S. and Schneider, A. (2016) The Amazon estuary as an interface for trace metal fluxes from the river into the Atlantic – a study along a salinity gradient in the mixing zone. Ocean Science Meeting, New Orleans, Feb. 2016 (poster).

- Kretschmer, S., Rutgers Van der Loeff, M.M., Masque, P., Geibert, W.: The distribution of 231Pa and 230Th between dissolved and particulate phases in the Western North Atlantic. 25th Goldschmidt Conference, Prague, Czech Republic, August 15-21, 2015 (talk).
- Schlitzer, R., Modelling the transport of trace elements: The mantle He example, GEOTRACES Royal Society Meeting, London, Dec. 2015 (invited talk).

Submitted by Katharina Pahnke (k.pahnke@icbm.de).

GEOTRACES Activity is continuing in India with new sampling in the Indian Ocean and measurement of trace elements and isotopes. Funding for GEOTRACES programme in India is continuing through the Ministry of Earth Sciences, Government of India. We are about to get two in situ pumps for sampling particulates. Our clean sampling system is working alright.

Sampling in the western Arabian Sea

As part of GEOTRACES Programme, a clean sampling enabled cruise was conducted in the western Arabian Sea (SK – 324, yellow dashed line) during September – November 2015. These region was difficult to sample due to piracy problem, however, we sample during this cruise. Samples for all the key trace elements were collected including Pa-Th. Dissolved Fe was measured onboard.

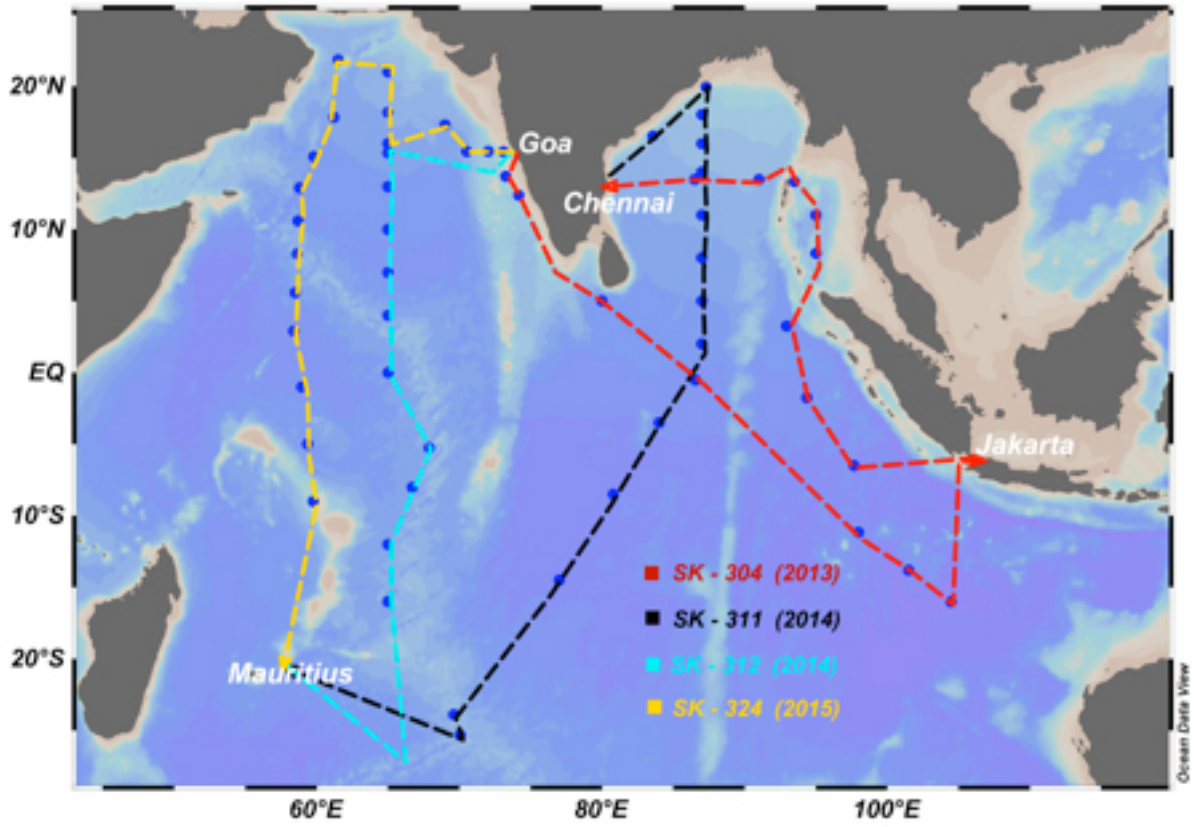


Figure 3. Various sections sampled for SOTRACES studies in the Indian Ocean. Western Arabian Sea (SK – 324) was sampled during September - November 2015.

REEs measurement in Indian Ocean

We have measured several profiles of dissolved REEs in the Arabian Sea and the Indian Ocean. More measurements are underway. Impact of oxygen minimum zone (OMZ) is visible on distribution of some of the REEs in the Arabian Sea.

REEs in the Estuaries

A systematic study of REEs distribution has been carried out in the eastern Indian estuaries. Results indicate massive release of REEs from the particulates in these estuaries. These could contribute significantly to the REEs budgets.

Submitted by Sunil Kumar Singh (sunil@prl.res.in).

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN IRELAND (ÉIRE)

June 1st, 2015 to April 30th, 2016

National and international service

- Ireland is represented on the International GEOTRACES Standards and Intercalibration committee by Prof. Peter Croot (also the national contact for GEOTRACES and IMBER).

New Results

- Titanium in the South Pacific: New data from a transect across the South Pacific during Sonne expedition SO245 indicates that Ti may be scavenged by iron from hydrothermal vents. Dissolved titanium across this transect was extremely low in surface waters indicating the lack of dust inputs in this region.
- Radium Quartet in the North East Atlantic: Measurements of the Radium quartet were undertaken during CE15011 in the North East Atlantic. Samples for ^{223}Ra, ^{224}Ra and ^{226}Ra were measured using a RADDEC and ^{228}Ra is being assessed by ^{224}Ra in-growth over time. Preliminary data indicate higher concentrations of ^{223}Ra and ^{224}Ra in the vicinity of the Irish continental shelf and particularly close to the Porcupine margin with lowest concentrations in the Rockall Trough. ^{227}Ac appears to be extremely low throughout this region based on measurements of the supported ^{223}Ra.

Cruises

- NUIG participated in the recent GEOTRACES process cruise SO245 onboard the *RV Sonne* from Antofagasta, Chile to Wellington, New Zealand (Dec 2015 – Jan 2016). Unfortunately, due to contamination problems with the pump CTD (previously used in the Baltic for clean Trace Metal work) no clean Fe samples were obtained (onboard analysis using FIA with luminol chemiluminescence with good performance for SAFe and GEOTRACES samples), however samples for other less contamination prone metals were taken. Shipboard measurements of Titanium from the normal CTD were made across the transect using an established voltammetric method.
- The radium quartet was measured in the North East Atlantic during Celtic Explorer expedition CE15011. This work forms part of an iCRAG (www.icrag-centre.org) project using radium isotopes to follow shelf exchange processes for CDOM and trace metals along the western continental shelf of Ireland. A further cruise is planned for October 2016 to carry out more inshore work.

Other activities

- Contribution to European Marine Board position paper on Deep-sea research: Prof Peter Croot was a co-author on the position paper that was launched in Sept 2015 in Aveiro, Portugal. More details can be found on the web at http://www.marineboard.eu/deep-sea-research, including links to the position paper and policy brief.

- COST Action TD1407: Network on technology-critical elements (NOTICE), Prof Peter Croot is a co-chair of WG1 which is involved in intercalibration efforts for TCEs (e.g. REE, Pt group etc).
- The Marine Institute (Oranmore) is developing expertise for determination of trace metals in marine, coastal and transitional waters (V, Cr*, Mn, Co, Ni*, Cu*, Zn*, As*, Ag*, Cd*, Pb*, U) quantification by Agilent ICP-MS 7700x, *= INAB accreditation, all other metals are fully validated and ready for accreditation in 2017, Hg by CVAFS (Gold trap) currently in validation process with accreditation expected in 2017 (for more details contact: andrew.morrissey@marine.ie).

New publications (involving GEOTRACES researchers in Ireland):

- Cobelo-García, A., Filella, M., Croot, P., Frazzoli, C., Du Laing, G., Ospina-Alvarez, N., Rauch, S., Salaun, P., Schäfer, J., Zimmermann, S., 2015. COST action TD1407: network on technology-critical elements (NOTICE)—from environmental processes to human health threats. Environmental Science and Pollution Research 22 (19), 15188-15194.
- Mawji, E., Schlitzer, R., Dodas, E.M., Abadie, C., Abouchami, W., Anderson, R.F., Baars, O., Bakker, K., Baskaran, M., Bates, N.R., Bluhm, K., Bowie, A., Bown, J., Boye, M., Boyle, E.A., Branellec, P., Bruland, K.W., Brzezinski, M.A., Bucciarelli, E., Buesseler, K., Butler, E., Cai, P., Cardinal, D., Casciotti, K., Chaves, J., Cheng, H., Chever, F., Church, T.M., Colman, A.S., Conway, T.M., Croot, P.L., Cutter, G.A., de Baar, H.J.W., de Souza, G.F., Dehairs, F., Deng, F., Dieu, H.T., Dulaquais, G., Echegoyen-Sanz, Y., Lawrence Edwards, R., Fahrbach, E., Fitzsimmons, J., Fleisher, M., Frank, M., Friedrich, J., Fripiat, F., Galer, S.J.G., Gamo, T., Solsona, E.G., Gerringa, L.J.A., Godoy, J.M., Gonzalez, S., Grossteffan, E., Hatta, M., Hayes, C.T., Heller, M.I., Henderson, G., Huang, K.-F., Jeandel, C., Jenkins, W.J., John, S., Kenna, T.C., Klunder, M., Kretschmer, S., Kumamoto, Y., Laan, P., Labatut, M., Lacan, F., Lam, P.J., Lannuzel, D., le Moigne, F., Lechtenfeld, O.J., Lohan, M.C., Lu, Y., Masqué, P., McClain, C.R., Measures, C., Middag, R., Moffett, J., Navidad, A., Nishioka, J., Noble, A., Obata, H., Ohnemus, D.C., Owens, S., Planchon, F., Pradoux, C., Puigcorbé, V., Quay, P., Radic, A., Rehkämper, M., Remenyi, T., Rijkenberg, M.J.A., Rintoul, S., Robinson, L.F., Roeske, T., Rosenberg, M., van der Loeff, M.R., Ryabenko, E., Saito, M.A., Roshan, S., Salt, L., Sarthou, G., Schauer, U., Scott, P., Sedwick, P.N., Sha, L., Shiller, A.M., Sigman, D.M., Smethie, W., Smith, G.J., Sohrin, Y., Speich, S., Stichel, T., Stutsman, J., Swift, J.H., Tagliabue, A., Thomas, A., Tsunogai, U., Twining, B.S., van Aken, H.M., van Heuven, S., van Ooijen, J., van Weerlee, E., Venchiarutti, C., Voelker, A.H.L., Wake, B., Warner, M.J., Woodward, E.M.S., Wu, J., Wyatt, N., Yoshikawa, H., Zheng, X.-Y., Xue, Z., Zieringer, M., Zimmer, L.A., 2015. The GEOTRACES Intermediate Data Product 2014. Marine Chemistry 177, Part 1, 1-8.
- McGrath, T., McGovern, E., Cave, R.R., Kivimäe, C., 2015. The Inorganic Carbon Chemistry in Coastal and Shelf Waters Around Ireland. Estuaries and Coasts 39 (1), 27-39.
- Rogers, A.D., Brierley, A., Croot, P., Cunha, M.R., Danovaro, R., Devey, C., Hoel, A.H., Ruhl, H.A., Sarradin, P.-M., Trevisanut, S., van den Hove, S., Vieira, H., Visbeck, M., 2015. Delving Deeper: Critical challenges for 21st century deep-sea research. . In: Larkin, K.E., Donaldson, K. and McDonough, N. (Ed.), Position Paper 22 of the European Marine Board, Ostend, Belgium. .

Submitted by Peter Croot (peter.croot@nuigalway.ie)

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN ISRAEL

June 1st, 2015 to April 30th, 2016

This report summarizes activities between June 2015 and April 2016 by scientists in Israel that are related to the GEOTRACES objectives.

Briefly, this report presents the related work of Adi Torfstein, Yeala Shaked, and Yishai Weinstein. I also provided a paragraph about the work of the Israeli National Monitoring Program, which includes a long and extensive time series of open ocean measurements in the Gulf of Eilat/Aqaba.

Dr. Adi Torfstein, Institute of Earth Sciences, Hebrew University of Jerusalem (HUJI), and Interuniversity Institute (IUI) for Marine Sciences of Eilat:

Research & funding

- My group operates a sediment trap mooring that has been deployed continuously in the center of the north Gulf of Aqaba/Eilat since January 2014. This mooring combines two types of traps and time resolutions:
  - KC-Denmark cylinder trap stations deployed at five depth points (water depth is 600 meters) that are sampled at a monthly resolution
  - McLane PARFLUX-II time series trap that collects the sinking particulates at a depth of 400 meters (water depth is 600 meters) on a ~daily resolution (between 24-48 hours) across the year
  - The mooring also hosts continuously a S4 current meter (InterOcean Systems, Inc.) that records current direction and velocity at a 10 minute resolution

  The collected samples are weighted, analyzed for their organic C and N content, d13C and d15N of the organic fraction, major and trace element concentrations of the bulk fraction, 230Th, 232Th, 234U, 238U. Planktonic assemblages are picked from different grain size fractions of the trap material

  Seawater profiles are sampled regularly and analyzed for their Nd content and isotopic composition.

  The Pb isotopic composition of Gulf of Eilat/Aqaba waters was measured at high temporal and spatial resolution during the summer of 2015, in collaboration with Adina Paytan (UCSC).
- The HUJI/IUI research group includes: a postdoc (Alison Hartman), a PhD student (Natalie Tchernichovsky), 2 MSc students (Ortal Sava, Merav Gilboa), an undergraduate research assistant (Ohad Steinberg), a lab technician (Barak Yarden). Israeli and international collaborators include: Dr. Ahuva Almogi-Labin (Geological Survey of Israel), Dr. Stephanie Kienast (Dalhousie University), Dr. Adina Paytan (UCSC), Prof. Jerry McManus (LDEO).
- Different aspects of the above project are funded by the Israel Science Foundation as well as collaborative work with Dr. S. Kienast at Dalhousie University funded by the Schulich Science Foundation.

Other sampling equipment and facilities at IUI:

- A clean lab (class 1000) includes two class 100 workstations, a Teflon coated acid purification system (Analab), two Teflon coated hotplates (Analab), a mq water system, a prepFAST-MC system.
- Eight Teflon coated GO-Flo bottles (12 Liters each), for trace element seawater sampling.
- One McLane WTS-Large Volume pump, 142 mm diameter, LV04.

Prof. Yeala Shaked, Institute of Earth Sciences, Hebrew University of Jerusalem, and Interuniversity Institute for Marine Sciences of Eilat:

Workshops and meetings

- We held a joint Vienna University & Hebrew University workshop in Israel titled "Atmospheric dust as nutrient source and pollutant in terrestrial and marine systems: Processes and mechanisms of nutrient acquisition and mineral weathering" (involving research groups of Prof. Stephan Kramer, Prof. Yeala Shaked and Prof. Yigal Erel).
- Yeala Shaked participated in a GEOTRACES meeting: Biological and climatic impacts of ocean trace element chemistry Dates: 7-8 December 2015 Location: Royal Society, London, UK.

Research & funding

- Funding is provided by the Israeli Science Foundation for the study of "Bioavailability of particulate Fe to planktonic cyanobacteria"
- We combine laboratory studies of cultured cyanobacteria and field studies with natural phytoplankton from Eilat.
- We strive to define and quantify the major components determining the ability of phytoplankton to acquire Fe from particles, focusing on the active role of cyanobacteria in "capturing" the particles, actively dissolving it etc.
- The research involves 2 PIs (Shaked, Nir Keren), 2 PhD students (Nivi Kessler, Chana Kranzler), a post-doc (Sunbhajit Basu), two research technicians (Murieller Dray, Rachel-Armoza-Zvoluni) and international collaborations (Satish Myneni, Princeton Synchrotron; Rhona Stuart, Livermore, Nano-Sims, Martha Gledhill, GeoMar, Orbitrap mass spectrometer.)

PhD's

- Chana Kranzeler (HUJI) submitted her PhD on "Iron acquisition mechanisms in a unicellular, planktonic cyanobacterium"
- The PhD of Hagar Lis (HUJI) was approved: "The bioavailability of iron to phytoplankton: rates and mechanisms of iron uptake"

Related publications in 2015

- Lis, H., Kranzler, C., Keren, N. and Y. Shaked. 2015. A comparative study of iron uptake rates and mechanisms amongst marine and fresh water cyanobacteria, Life, (special issue "cynaobacteria: Ecology, Physiology and Genetics"). http://www.mdpi.com/2075-1729/5/1/841.
- Chana Kranzler*, Nivi Kessler*, Nir Keren and Yeala Shaked (submitted to Environmental Microbiology) Biological dissolution of ferrihydrite by a unicellular, planktonic cyanobacterium: Insights into the bioavailability of particulate iron.

Additional activities at the InterUniversity Institute (IUI) for Marine Sciences of Eilat (location of Adi Torfstein and Yeala Shaked):

- A dust collection system has been sampling suspended aerosols on a weekly basis continuously since 2006 on the IUI pier. All samples between 2006-2010 have been measured for major and trace element concentrations on the water-dissolved, acid-leachable and silicate fractions.

  The National Monitoring Program (NMP) for the Gulf of Eilat/Aqaba operates out of the IUI (http://www.iui-eilat.ac.il/Research/NMPAbout.aspx). Activities include monthly cruises across the north Gulf of Eilat/Aqaba, during which physical, chemical and biological measurements are performed in depth profiles (at a water depth of 700 meters) together with spatial-surface coverage. The main-relevant parameters monitored are:

  Temperature, salinity, dissolved oxygen, pH, alkalinity, POC, NO2, NO3, Si(OH)4, PO4, Chl-a.

  The samples are collected with the IUI Research Vessel, which has a powder coated aluminium Rosette (SeaBird) with 12 niskin bottles (12 liters each), and a CTD (SeaBird electronics). These measurements have been performed continuously since the year 2000. Analyses are performed at the IUI labs.

Prof. Yishai Weinstein, Bar-Ilan University:

- In preparation of the deployment of a deep sea sampling station in late 2016 in the East Mediterranean, the following equipment has been purchased: three McLane PARFlux 78h-21 sediment traps and two McLane Large Volume Water Transfer System.

Submitted by Adi Torfstein (adi.torf@mail.huji.ac.il).

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN JAPAN

June 1st, 2015 to April 30th, 2016

General overview

- We have completed two GEOTRACES-related cruises in the East China Sea and the northwestern Philippine Sea (KS-15-6 cruise and KH-15-3 cruise).
- We had a national GEOTRACES symposium in March 28-29, 2016, for pursuing scientific discussion on recent Japanese GEOTRACES studies (23 papers were presented). We also had a business meeting as a GEOTRACES sub-committee meeting under the national SCOR committee (Science Council of Japan) on March 29, 2016. These symposium and meeting were held at the Atmosphere and Ocean Research Institute, the University of Tokyo.
- Six papers have been published as shown below, and eleven papers were presented during the Goldschmidt Conference 2015 and the Ocean Sciences Meeting 2016 as listed below. There were more presentations in Japanese at the Annual Meetings of Geochemical Society of Japan, the Oceanographic Society of Japan, Japan Geoscience Union etc.

New publications

- Gamo, T., Okamura, K., Hatanaka, H., Hasumoto, H., Komatsu, D., Chinen, M., Mori, M., Tanaka, J., Hirota, A., Tsunogai, U., Tamaki, K. (2015): Hydrothermal plumes in the Gulf of Aden, as characterized by light transmission, Mn, Fe, CH4 and d13C-CH4 anomalies. Deep-Sea Research II, 121, 62-70.
- Ishibashi, J., Tsunogai, U., Toki, T., Ebina, N., Gamo, T., Sano, Y., Masuda, H., Chiba, H. (2015): Chemical composition of hydrothermal fluids in the central and southern Mariana Trough backarac basin. Deep-Sea Research II., 121, 126-136.
- Kim, T-J., Obata, H., Kondo, Y., Ogawa, H., Gamo, T. (2015): Distribution and speciation of dissolved zinc in the western North Pacific and its adjacent seas. Marine Chemistry, 173, 330-341.
- Kim, T-J., Obata, H., and Gamo, T. (2015): Dissolved Zn and its speciation in the northeastern Indian Ocean and the Andaman Sea. Frontiers in Marine Science, 2, doi: 10.3389/fmars.2015.00060.
- Lee, J-M., Boyle, E. A., Gamo T., Obata, H., Norisuye, K., and Echegoyen, Y. (2015): Impact of anthropogenic Pb and ocean circulation on the recent distribution of Pb isotopes in the Indian Ocean. Geochimica et Cosmochimica Acta, 170, 126-144.
- Aoyama, M., Kajino, M., Tanaka, T.Y., Sekiyama, T.T., Tsumune, D., Tsubono, T., Hamajima, Y., Inomata, Y., and Gamo, T. (2016): 134Cs and 137Cs in the North Pacific Ocean derived from the March 2011 TEPCO Fukushima Dai-ichi Nuclear Power Plant accident, Japan: Part Two --- Estimation of 134Cs and 137Cs inventories in the North Pacific Ocean. Journal of Oceanography, 72, 67-76.

International Meetings

- Nakayama, N., Shirai, K., Sano, Y., Gamo, T., and Obata, H. Sulfides in oxic seawater over the submarine hydrothermal area of Kikai Caldera south of Kyushu Island, Japan. Goldschmidt Conference, Prague (CZ), August 16-21, 2015.
- Obata, H., Miwa, K., Kondo, Y., Gamo, T., Otosaka, S., and Suzuki, T. Iodine speciation and iodine-129 distribution in the Chukchi Sea and Bering Sea. Goldschmidt Conference, Prague (CZ), August 16-21, 2015.
- Norisuye, K., Hori, E., Nakagawa, M., Obata, H., Kondo, Y., and Gamo, T. Vertical distribution of lead and bismuth in the Japan Trench. Goldschmidt Conference, Prague (CZ), August 16-21, 2015.
- Takano S., Tanimizu, M., Hirata, T., Sohrin, Y., Little, S.H., and Archer, C. Determination of isotopic ratio of nickel, copper, and zinc in seawater using an ethylenediaminetriacetic acid chelating resin. Goldschmidt Conference, Prague (CZ), August 16-21, 2015.
- Zheng, L., Minami, T., Takano S., and Sohrin, Y. The distribution of bioactive trace elements (Al, Mn, Fe, Co, Ni, Cu, Zn, Cd, and Pb) over the Juan de Fuca Ridge. Goldschmidt Conference, Prague (CZ), August 16-21, 2015.
- Nishioka, J. and Takesue, N. A role of sea ice melt water on iron supply to surface water in the Chukchi Sea, the Arctic Ocean. Goldschmidt Conference, Prague (CZ), August 16-21, 2015.
- Kanna, N., Nishioka, J. and Toyota, T. Iron enrichment by sea ice melting in the surface water in the Okhotsk Sea. Goldschmidt Conference, Prague (CZ), August 16-21, 2015.
- Obata, H., Kim, T., Gamo, T. and Takeda, S. Dissolved zinc and its speciation in the coastal hydrothermal area of Japan. Ocean Sciences Meeting, CT34B-0189, New Orleans (USA), February 21-26, 2016.
- de Souza, G.F., Maden, C., Wetzel, F., Obata, H., and Vance, D. Silicon stable isotope constraints on the role of the subpolar North Pacific in the marine Si cycle. Ocean Sciences Meeting, B41A-03, New Orleans (USA), February 21-26, 2016.
- Suzuki-Mashio, A., Obata, H., Tazoe, H., and Gamo, T. Distributions and geochemical cycles of platinum in estuaries and rivers of Tokyo and Otuchi areas, Japan. Ocean Sciences Meeting, CT34B-0185, New Orleans (USA), February 21-26, 2016.
- Kim, T., Obata, H., and Gamo, T. Distribution of dissolved zinc in the western and central subarctic North Pacific. Ocean Sciences Meeting, CT31A-08, New Orleans (USA), February 21-26, 2016.

Cruises

- Two GEOTRACES-related cruises in the East China Sea and the Philippine Sea were conducted to take clean seawater samples for trace element analyses. KS-15-6 cruise by *R/V Shinsei Maru* (June 25 – July 6, 2015; PI: Hajime Obata) and KH-15-3 cruise by *R/V Hakuho-Maru* (Oct. 14 – Nov. 2, 2015; PI: Jing Zhang).

Submitted by Toshitaka Gamo (gamo@aori.u-tokyo.ac.jp).

Recent Trace Metal Analysis activities at Chemical Oceanography Laboratory, KISR, Kuwait

Kuwait is in the northwestern part of the Arabian Gulf and receives flow from Shatt Al-Arab River as the main fresh water input to the Gulf. Kuwait's waters can be described as eutrophic, euphotic, and highly saline waters.
In 2011, new trace metal laboratory has been established in Kuwait Institute for Scientific Research, by Dr. Turki Al-Said. Dissolved trace metals (Copper, Nickel, Cobalt and Zinc) in seawater samples are measured using electrochemical technique Adsorptive Cathodic Stripping Voltammetry (AdCSV) (797VA Computrace Instrument) and dissolved Iron is measured using Chemiluminoscence based Flow Injection Analyzer (FeLume-FIA).

New Scientific Results

- Recently, transactional survey was conducted for assessing the trace metals distribution in Kuwait water using acid clean polyethylene sampling devices during two seasons in June (summer) and November (winter), 2015. Figure 5 display the location of sampling conducted in Kuwait's seawater.

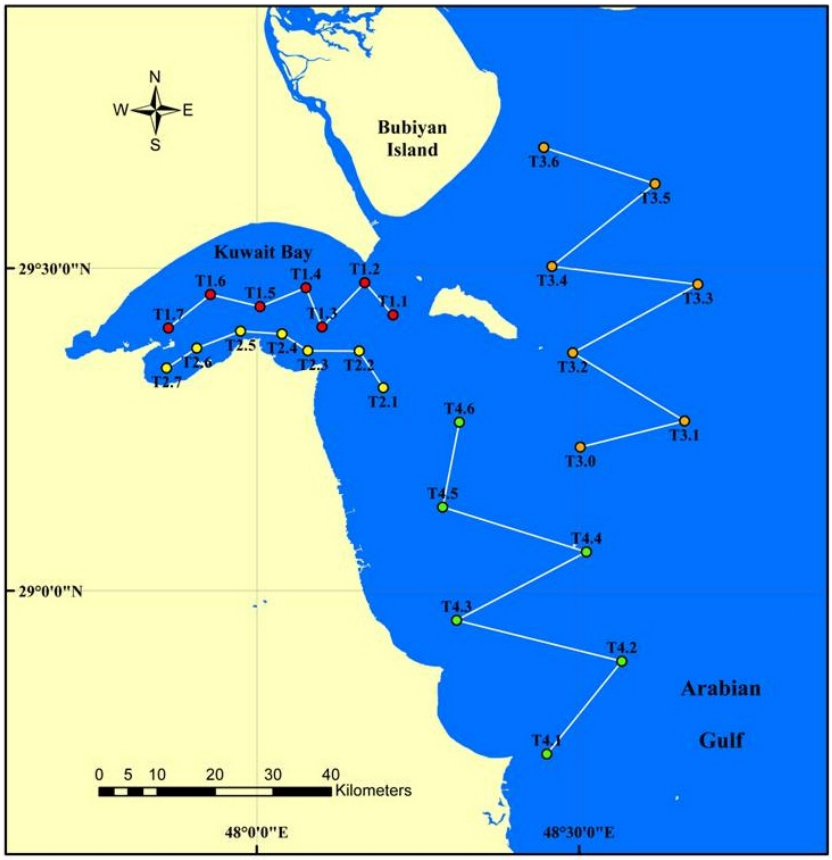


Figure 5. Location of sampling in Kuwait's waters

The average concentrations of Copper, Nickel, Cobalt, Zinc and Iron during the study in Kuwait's waters were 12.05nM (3.94 to 27.17nM), 17.67nM (7.80 to 34.80nM), 0.74nM

(0.51 to 1.34nM), 12.04 nM (5.14 to 33.17nM) and 4.54nM (0.44 to 28.16nM) respectively.

Although the dissolved trace metal values were within the range of published values in similar coastal regions, it was considerably lower than the earlier reports by Bu-Olayan et al. (2001) in Kuwait's water a decade ago. This shows the effectiveness of the clean technique used in this study.

The recent study is the first attempt towards describing trace metal in Kuwait waters using trace metal clean techniques. Future studies will confirm the importance of trace metal speciation to phytoplankton dynamics in Kuwait's waters.

Future Projects

- Effects of dust on biological activity, speciation studies on copper and Iron distribution in Kuwait waters.

Published Conference Paper

- Al-Said, T., T. Pokavanich, A. Al-Hashem, and R. Kedila (2016). Distribution of Bioactive Trace Metals (Fe, Co, Ni, Cu, and Zn) in the Semiarid Kuwait Bay: Role of Anthropogenic Sources. 2016 Ocean Sciences Meeting, February 21 - 26, New Orleans, LA 70130.

Reference

- Bu-Olayan, A.H., R. Al-Hassan, B.V. Thomas and M.N.V. Subrahmanyam. 2001. Impact of trace metals and nutrients levels on phytoplankton from the Kuwait Coast. Environ. Intern. 26:199–203.

Submitted by Turki Al-Said (trsaid@kisr.edu.kw).

Transect GA02: western Atlantic Ocean: The Dutch GEOTRACES cruises between 2010-2012 aimed to map the distribution of important trace elements and isotopes (PI: Hein de Baar) and to investigate the deep-sea microbiology (PI: Gerhard Herndl) in the West Atlantic Ocean. Gerhard Herndl is also involved in bioGEOTRACES together with Penny Chisholm (MIT) and Julie LaRoche (Dalhousie University). In 2015-2016 we focused with our west Atlantic work on the ongoing compilation and analysis of the data collected in the western Atlantic Ocean in 2010 – 2012. An estimated 22 articles have appeared.

Transect GA04N: Mediterranean Sea and the Black Sea: In 2012/2013 funding was granted by the Dutch Organization for Scientific Research (NWO) for GEOTRACES cruises in the Mediterranean Sea and the Black Sea (PI: Hein de Baar). The Dutch GEOTRACES cruises in the Mediterranean Sea (GA04N) was organized in concert with a cruise of the Spanish Mediterranean GEOTRACES program (GA04S). In 2015/16 our work in the Mediterranean and Black Seas focused on preparing the data for the IDP2017 and the presentation and writing up of the data. An estimated 3 articles have appeared and another 4 have been submitted.

Transect GN04: Arctic Ocean: In August-October 2015, a Dutch team (NIOZ and RUG) participated in the German organized GEOTRACES cruise (TransARC-II, PS94) on the RV Polarstern to the Arctic Ocean. On board we have measured DFe, Fe-binding ligands, CDOM, humics, bacteria, viruses, DIC, alkalinity, oxygen and the macronutrients nitrate, nitrite, phosphate, silicate and CTD data. Furthermore we took samples to measure a range of bio-essential and toxic metals.

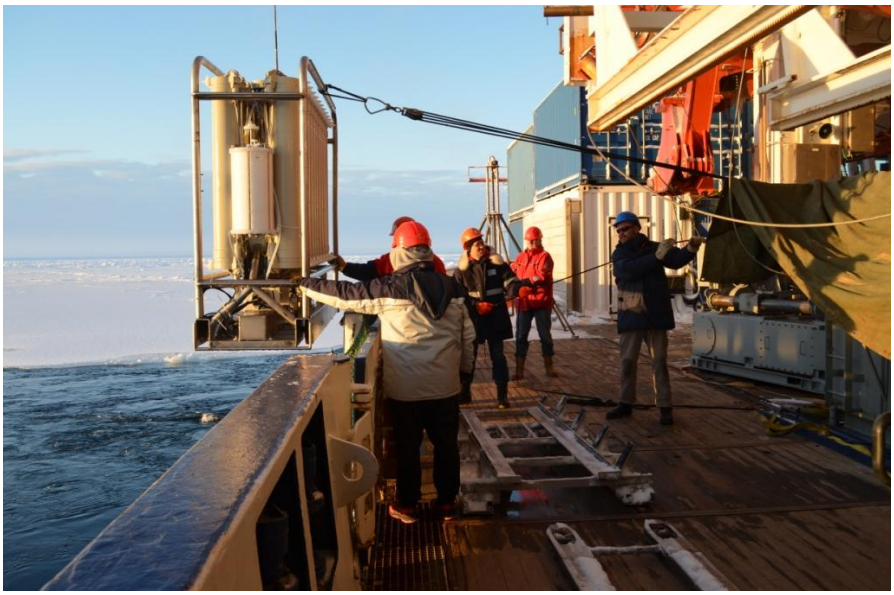


Figure 5. Return of the NIOZ ultraclean titanium CTD with PRISTINE samplers in on board RV Polarstern during cruise PS94 in the Arctic, 2015.

Transect GN05: Fram Strait / Arctic Ocean: In July-September 2016, a Dutch team (NIOZ/RUG) will participate in the German organized GEOTRACES cruise (GRIFF 2016, PS100) on the RV Polarstern to Fram Strait. On board measurement of DIC, Alkalinity and Oxygen will be performed and samples for DFe and Fe-binding ligands will be taken.

Process study: Response of the Iron Biogeochemical Cycle on Continental Shelves to Seawater Deoxygenation. In 2014, funding was granted by the Dutch Organization for Scientific Research (NWO) for GEOTRACES cruises in the Black Sea (September 2015) and Baltic Sea (planned for June 2016) (PI: Caroline Slomp). The research during both cruises will focus on quantifying the release of Fe and Mn and other metals from shelf sediments, elucidating the relevant mechanisms and assessing the transport pathways of the metals in the water column over the shelf and its transfer to the deep basin. Techniques include: lander deployments for in-situ determinations of sediment-water exchange fluxes, porewater analyses and the collection and analyses of dissolved and particulate constituents in the water column (with in-situ pumping and on deck filtration).

Meetings

- GEOTRACES SSC meeting: Micha Rijkenberg attended the GEOTRACES Scientific Steering Committee meeting on 15-17 July 2015 in Vancouver, Canada
- Workshop HYDROTHERMAL input during GN04 (cruise PS94, 2015) in the Arctic: Loes Gerringa and Micha Rijkenberg attended the workshop on 4-5 April 2016 in Bremerhaven, Germany

Cruises

- Transect GN04: was sailed from half August to half October 2015 on board of the *RV Polarstern*.
- Black Sea, Istanbul-Varna was sailed in September 2015 on board Pelagia.
- Baltic Sea, will be sailed in June 2016 on board Pelagia.
- Transect GN05 to FRAM Strait will be sailed in July-September 2016 on board of *RV Polarstern.*

New results

- Investigators are making good progress in the sample analysis and subsequent interpretation of the data collected in the western Atlantic Ocean. Many results of the western Atlantic transect have been presented at international conferences and appeared in journal publications.
- The first presentations and publications resulting from the MedBlack GEOTRACES cruises appeared.
- The Arctic dissolved Fe data measured during PS94 (transect GN04) show Fe limitation in the Nansen Basin.

Presentations

- Boye, M., Dulaquais, G., Planquette, H., Rijkenberg, M.J.A., 2016. Assessing the marine geological cycle of cobalt from its interactions with particles in the Black Sea Ocean Sciences Meeting. New Orleans, US, 21-26 Feb. 2016
- Bridgestock, L., Van de flierdt, T., Rehkämper, M., Baker, A., Achterberg, E., Rijkenberg, M., Lohan, M., de Baar, H., 2015. Detection of Pb from natural sources in the Tropical Atlantic, Goldschmidt. Prague, Czech Republic, 16-21 August
- Dijkstra, N., Kraal, P., Rijkenberg, M.J.A., Slomp, C.P., 2015. Coupled dynamics of iron, manganese and phosphorus in the water column of the Black Sea and implications for phosphorus burial Nutrient Cycling on the Modern and Ancient Earth conference. Leeds, School of Earth & Environment, University of Leeds, UK, 6-7 July
- Heimbürger, L.-E., Cossa, D., Rijkenberg, M.J.A., Sarthou, G., Rutgers van der Loeff, M., Sunderland, E.M., Sonke, J., 2016. Mercury in the North Atlantic and Arctic Oceans - results of the 2014 GEOTRACES GEOVIDE & 2015 GEOTRACES TransArc II cruises, Ocean Sciences Meeting. New Orleans, US, 21-26 Feb. 2016
- Margolin, A.R., Gerringa, L.J.A., Hansell, D.A., Rijkenberg, M.J.A., 2015. Net removal of dissolved organic carbon in the subsurface Black Sea, AGU Fall Meeting. San Francisco, 14-18 Dec. 2015.
- Middag, R., Rolison, J.M., Stirling, C.H., van Hulten, M.M.P., Rijkenberg, M.J.A., de Baar, H.J.W., 2015. Dissolved aluminium in the West-Atlantic Ocean and Mediterranean Sea, Goldschmidt Conference. Prague, Czech Republic, 16-21 August
- Rijkenberg, M.J.A., et al. 2016. Trace metals in the Atlantic and Arctic Oceans, Workshop: Biogeochemical studies in the Siberian Shelf Seas. Kiel, Germany, 27-28 Jan.
- Rijkenberg, M.J.A., Gerringa, L.J.A., Slagter, H.A., van Ooijen, J., Ober, S., Rutgers v.d. Loeff, M., 2015. Fe limitation in the Arctic Ocean, Symposium Polar Tipping Points. Den Haag, The Netherlands, 5 November
- Rolison, J.M., Stirling, C.H., George, E., Middag, R., Gault-Ringold, M., Rijkenberg, M.J.A., de Baar, H.J.W., 2015. Biogeochemical cycling of the uranium, iron and cadmium isotope systems during oceanic anoxia: A case study of the Black Sea, Goldschmidt Conference. Prague, Czech Republic, 16-21 August
- Rolison, J.M., Stirling, C.H., Middag, R., Rijkenberg, M.J.A., de Baar, H.J.W., 2015. Uranium Isotope Fractionation Factor During U(VI)-U(IV) Reduction In The Black Sea, AGU Fall Meeting. San Francisco, US, 14-18 Dec. 2015.
- Rosati, G., Heimbürger, L.E., Sonke, J.E., Rijkenberg, M.J.A., Gerringa, L.J.A., de Baar, H.J.W., 2015. Developing a methylmercury dynamic model for the Black Sea, 12th International Conference on Mercury as a Global Pollutant. Jeju, SOuth Korea, 14-19 June
- Séguret, M.J.M., Dijkstra, N., Andersen, A., Severmann, S., Rijkenberg, M., Laan, P., Slomp, C.P., 2016. Water column iron dynamics along a shelf-to-basin transect in the Black Sea, Nederlands Aardwetenschappelijk Congres. Veldhoven, NWO & KNGMG, 7-8 April, poster
- Tagliabue, A., Boyd, P., Rijkenberg, M.J.A., Williams, R.G., 2016. How do local and remote processes affect the distribution of iron in the Atlantic Ocean?, Ocean Sciences Meeting. New Orleans, US, 21-26 Feb. 2016

- van den Berg, C.M.G., Abualhaija, M.M., Rijkenberg, M.J.A., 2016. Iron binding ligands in the ocean are similar to humic substances, Ocean Sciences Meeting. New Orleans, US, 21-26 Feb. 2016
- Wu, Y., Goldstein, S.L., Pena, L., Hartman, A.E., Rijkenberg, M.J.A., de Baar, H.J.W., 2016. Potential Sources Affecting Seawater Nd Isotopes in the Southwest Atlantic Ocean, Ocean Sciences Meeting. New Orleans, US, 21-26 Feb. 2016

Publications

Published:

- Gerringa, L. J. A., Laan, P., van Dijken, G. L., van Haren, H., de Baar, H. J. W., Arrigo, K. R., Alderkamp, A.-C. (2015) Sources of iron in the Ross Sea polynya in early summer, Marine Chemistry, 177, 447–459
- Gerringa, L.J.A., Rijkenberg, M.J.A., Schoemann, V., Laan, P., de Baar, H.J.W. (2015) Organic speciation of dissolved iron in the West Atlantic Ocean. Mar. Chem., 177, 434–446.
- Lambelet, M., van de Flierdt, T., Crocket, K., Rehkämper, M., Kreissig, K., Coles, B., Rijkenberg, M.J.A., Gerringa, L.J.A., de Baar, H.J.W., Steinfeldt, R. (2015) Neodymium isotopic composition and concentration in western North Atlantic seawater: results from the GEOTRACES GA02 section. Geoch. Cosmochim. Acta., 177, 1-29
- Middag, R., van Hulten, M.M.P., van Aken, H.M., Rijkenberg, M.J.A., Gerringa, L.J.A., Laan, P., de Baar, H.J.W. (2015) Dissolved aluminium in the ocean conveyor of the West Atlantic Ocean: Effects of the biological cycle, scavenging, sediment resuspension and hydrography. Mar. Chem., 177, 69-86
- Middag, R., Séférian, R., Conway, T. M., John, S. G., Bruland, K.W., de Baar, H.J.W (2015) Intercomparison of Dissolved Trace Elements at the Bermuda Atlantic Time Series Station, Marine Chemistry, 177, 476-489
- Rijkenberg, M.J.A., de Baar, H.J.W., Bakker, K., Gerringa, L.J.A., Keijzer, E., Laan, M., Laan, P., Middag, R., Ober, S., van Ooijen, J., Ossebaar, S., van Weerlee, E.M., Smit, M.G. (2015) "PRISTINE", a new high volume sampler for ultraclean sampling of trace metals and isotopes. Mar. Chem., 177, 501–509
- Rolison, J.M., Middag, R., Stirling, C.H., Rijkenberg, M.J.A., de Baar, H.J.W. (2015) Zonal distribution of dissolved aluminium in the Mediterranean Sea. Mar. Chem., 177, 87-100.
- Sintes, E., De Corte, D., Haberleitner, E., Herndl, G.J., 2016. Geographic distribution of archaeal ammonia oxidizing ecotypes in the Atlantic Ocean. Frontiers in Microbiology 7, 10.3389/fmicb.2016.00077
- van de Poll, W.H., Boute, P.G., Rozema, P.D., Buma, A.G.J., Kulk, G., Rijkenberg, M.J.A. (2015) Sea surface temperature control of taxon specific phytoplankton production along an oligotrophic gradient in the Mediterranean Sea. Mar. Chem., 177, 536-544.
- Xie, R.C., Galer, S.J.G., Abouchami, W., Rijkenberg, M.J.A., de Jong, J., de Baar, H.J.W., Andreae, M.O. (2015) The cadmium-phosphate relationship in the western South Atlantic

– the importance of mode and intermediate waters on the global systematics. Mar. Chem., 177, 110-123

Submitted:

- Abualhaija, M.M., van den Berg, C.M.G., Rijkenberg, M.J.A., submitted. Probable identity of the main iron-binding substances in the Atlantic ocean. Mar. Chem.
- Bridgestock, L., van de Flierdt, T., Rehkämper, M., Paul, M., Middag, R., Milne, A., Lohan, M., Baker, A., Chance, R., Khondoker, R., Strekopytov, S., Humphreys-Williams, E., Achterberg, E., Rijkenberg, M.J.A., Gerringa, L.J.A., de Baar, H.J.W., Bruland, K., submitted. Return of naturally sourced Pb to Atlantic surface waters. Nature Communications.
- Ditt, R.F., Rijkenberg, M.J.A., Lindsay, R., Orellana, M.V., submitted. RuBisCO: a specific tracer for organic matter dynamics in the deep South Atlantic. Limnol. Oceanog.
- Gabriel Dulaquais, Hélène Planquette, Stephane l'helguen, Micha J. A. Rijkenberg and Marie Boye, submitted. Biogeochemical cycle of cobalt in the Mediterranean Sea: behind its scavenged profile. Biogeosciences
- Gerringa, L.J.A., Rijkenberg, M.J.A., Bown, J., Margolin, A.R., Laan, P., de Baar, H.J.W., submitted. Fe-binding dissolved organic ligands in the oxic and suboxic waters of the Black Sea. Frontiers.
- Margolin, A.R., Gerringa, L.J.A., Hansell, D.A., Rijkenberg, M.J.A., submitted. Net removal of dissolved organic carbon in the subsurface Black Sea. Mar. Chem.
- Rolison, J.R., Stirling, C.H., Middag, R., Rijkenberg, M.J.A., submitted. Uranium stable isotope fractionation in the Black Sea: Modern calibration of the 238U/235U paleo-redox proxy. Geoch. Cosmochim. Acta.
- Vance, D., Little, S.H., Archer, C., Cameron, V., Andersen, M., Rijkenberg, M.J.A., Lyons, T.W., submitted. The oceanic budgets of nickel and zinc isotopes: the importance of sulphidic environments as illustrated by the Black Sea. Philosophical Transactions of the Royal Society A.

Submitted by Micha Rijkenberg (micha.rijkenberg@nioz.nl).

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN NEW ZEALAND

June 1st, 2015 to April 30th, 2016

New Scientific Results

- Rebecca Zitoun (PhD student supervised by Res Assoc Prof Sylvia Sander and Dr Rob Middag) participated on the German led FS Meteor 121 cruise from November 21-December 27, 2015 to study the biogeochemistry of trace elements in the southeast Atlantic Ocean. Rebecca supported the sampling team and will analyse samples for Cu-binding ligands.
- **GEOTRACES GA04N Black Sea and Mediterranean Sea Expedition.** The GEOTRACES (GA04N) expedition to the Mediterranean and Black Seas in 2013 provided an opportunity to examine the biogeochemical cycling of a suite of trace elements under low- and zero-oxygen conditions. Using multiple-collector inductively coupled plasma mass spectrometry (MC-ICPMS) combined with double spiking techniques, we have measured the isotopic composition of U, Fe and Cd for the entire water column and underlying sediments of the Black Sea across oxic-suboxic-anoxic-euxinic transitions. These new data help elucidate the mechanisms driving the uptake and removal of redox-sensitive metals from the dissolved phase and their export to the solid phase across a gradation of changing redox settings from oxic to anoxic and ultimately euxinic. These results form the basis of the PhD research programme of recently completed graduate student John Rolison, and were presented at the 2015 Goldschmidt Conference in the Czech Republic.

  We are currently obtaining Fe and Cd isotope datasets for water samples collected during the Mediterranean legs of the GA04N expedition. The chemical preparation and isotopic analysis of surface samples is being led by Dr Nadya Teutsch from the Geological Survey of Israel, who is undertaking sabbatical research at the University of Otago. This will be followed by Zn isotope analysis of surface waters, and a combined Cd, Zn and Fe isotope investigation of water samples collected from depth profiles in the Mediterranean Sea.
- **GEOTRACES GP13 South Pacific Ocean Expedition.** Using techniques in double-spiking and MC-ICPMS, we have obtained measurements of Cd isotopic composition and Cd concentration for water column samples collected from a suite of 8 depth profiles and additional surface locations along the GEOTRACES GP13 zonal section. This cruise transect extends for 5,500 km from offshore Australia to the remote interior of the subtropical Pacific Ocean, an understudied region of the world's oceans, where Cd concentrations in the upper water column are at ultra-trace levels, and some of the lowest detected globally. These results form the basis of the PhD research of graduate student Ejin George, who is expected to submit his thesis in late 2016, and will be presented at the 2016 Goldschmidt Conference in Japan. The Cd isotope and Cd concentration datasets for the GP13 expedition have been submitted to the 2017 International Data Product.
- **Method Development.** A chemical preparation method has been devised for extracting and purifying Cd, Zn and Fe from large volume (up to 10 L) seawater samples for the purpose of double-spike Cd, Zn and Fe isotopic analysis.

Publications with NZ author or co-author

- Ellwood MJ, Hutchins DA, Lohan MC, Milne A, Nasemann P, Nodder SD, Sander SG, Strzepek R, Wilhelm SW, Boyd PW (2015) Iron stable isotopes track pelagic iron cycling during a subtropical phytoplankton bloom. Proceedings of the National Academy of Sciences 112 (1):E15-E20. doi:10.1073/pnas.1421576112
- Middag, R., Seferian, R., Conway, T. M., John, S. G., Bruland, K. W. & de Baar, H.J.W., 2015 Intercomparison of Dissolved Trace Elements at the Bermuda Atlantic Time Series Station. Marine Chemistry 177(3): 476-489.
- Middag, R., van Hulten, M.M.P., van Aken, H.M., Rijkenberg, M.J.A., Gerringa, L., Laan, P. and de Baar, H.J.W., 2015. Dissolved aluminium in the Ocean Conveyor of the West Atlantic Ocean: effects of the biological cycle, scavenging, sediment resuspension and hydrography. Marine Chemistry (1): 69-86.
- Rolison, J., C.H. Stirling, R. Middag and M. Rijkenberg (in review). Uranium stable isotope fractionation in the Black Sea: Modern calibration of the 238U/235U paleoredox proxy. Geochim. Cosmochim. Acta.
- Rolison, J., R. Middag, C.H. Stirling, M. Rijkenberg and H. de Baar (2015). Zonal distribution of dissolved aluminium in the Mediterranean Sea. Marine Chemistry 177, 87-100.

Presentations with NZ author or co-author

- Kleint, C., Hawkes, J.A., Sander, S.G., Koschinsky, A. Dissolved Fe and Fe binding ligand concentrations at the hydrothermal vent fields in the Coriolis Troughs, New Hebrides Island Arc. Oral presentation at the 2016 Ocean Sciences Meeting – New Orleans, 24-02-2016, USA.
- Middag, R., Alderkamp, A.-C., Arrigo, K., Limiting iron concentrations early in the season off the West Antarctic Peninsula. Oral presentation at the 2015 Antarctic Science Conference – Christchurch, 30-07-2015, NZ.
- Middag, R., Alderkamp, A.-C., Arrigo, K., van Hale, R. Limiting iron concentrations early in the season off the West Antarctic Peninsula. Poster presentation at the 2016 Ocean Sciences Meeting – New Orleans, 25-02-2016, USA.
- Middag, R., Rolison, J.M., Stirling, C.H., Van Hulten, M.M.P., Rijkenberg, M.J.A., Gerringa, L.J.A., de Baar, H.J.W. Aluminium in the West-Atlantic Ocean and Mediterranean Sea. Oral presentation at the 2015 Goldschmidt meeting – Prague, 18-08-2015, Czech Republic.
- Rolison, J.M., Stirling, C.H., George, E., Middag, R., Gault-Ringold, M., Rijkenberg, M.J.A., de Baar, H.J.W. Biogeochemical Cycling of Uranium, Iron and Cadmium Isotope Systems during Oceanic Anoxia: A case study of the Black Sea. Oral presentation at the 2015 Goldschmidt meeting – Prague, 17-08-2015, Czech Republic.
- Sander, S.G., Buck, K.N., Lohan, M.C., Turner, D.R., Clegg, S.L. Metal Speciation Analysis and Modeling – How do we Best Estimate the Bioavailable Form? Oral presentation at the 2016 Ocean Sciences Meeting – New Orleans, 24-02-2016, USA.
- Van Hulten, M.M.P., Dutay, J.-C., Roy-Barman M, Tagliabue, A., Sterl, A., Middar, R., de Baar, H.J.W. Manganese in an Ocean General Circulation Model. Oral presentation at the 2015 Goldschmidt meeting – Prague, 17-08-2015, Czech Republic.

PhD Thesis

- John Rolison – University of Otago (supervisors: Claudine Stirling and Rob Middag). Title: 'The biogeochemical cycling of zinc and iron in the Mediterranean and Black Seas'. PhD completed: April 2016.

Funding

- Dr Middag was awarded funding under the Marsden Fast-Start scheme for a project entitled 'The ice is melting: How do trace metals in the ocean influence the Antarctic marine ecosystem and global climate?'. This project is based on samples from the GEOTRACES process study Phantastic II in the Southern Ocean, west of the Antarctic Peninsula.

Other

- Dr Middag has been appointed Associate Editor for Marine Chemistry.

Submitted by Rob Middag (rob.middag@otago.ac.nz).

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN NORWAY

June 1st, 2015 to April 30th, 2016

Publications

- Kuria Ndungu, Cheryl M. Zurbrick, Sharon Stammerjohn, Silke Severmann, Robert M. Sherrell and A. Russell Flegal (2016). Lead sources to the Amundsen Sea, West Antarctica. ACS` editor`s choice, open access *and cover article on the June 21, 2016 vol. 50, issue No. 12 of Environmental Science & Technology: DOI: 10.1021/acs.est.5b05151*.

On going projects

- Iron and microbial ecosystem related mesocosm experiments continue in Ny Aalesund, part of the ongoing EU-funded Ocean-Certain project (http://oceancertain.eu/what-is-ocean-certain/) led by Murat Ardelan from the Norwegian University of Science and Technology (NTNU). Andrew King from the Norwegian Institute for Water Research-NIVA is also involved in the project as well as partners from eight European countries in additional to Chile and Australia.

New CTD rosette

- The Norwegian Institute for Water Research-NIVA acquired a 12-position CTD rosette from General Oceanics. The rosette came with six 5L-Niskin-X Bottles and will initially be used for sampling coastal water. We hope to make the necessary modifications in the near future to adapt it for TM sampling.

Meetings

- Kuria Ndungu attended the 2015 AGU fall meeting in San Francisco and presented a paper (Dissolved Silver in Marine Waters: Reviewing Three Decades of Advances in Analytical Techniques and Understanding its Biogeochemical Cycling). The AGU session: Trace Metal Cycling in the Environment: Forty Years of Advancements III was convened by Priya Ganguli (WHOI & UC Santa Cruz); Frank Black (Westminster College); Sergio A Sanudo-Wilhelmy (University of Southern California) and Edward Boyle (MIT) in honor of Russell Flegal (UC Santa Cruz).

Submitted by Kuria Ndungu (Kuria.ndungu@niva.no)

- Institute of Oceanology in the previous year concentrated mostly on the development of LC-ICPMS method to measure metals in seawater. The system was set-up, and sample preparation method was developed, using a variety of glass cleaning procedures, different purity of acids, and acids redistillation. Low blank values were achieved and then the test was performed with two estuarine water reference materials – NASS-6 and SLEW3. Results are presented in table 1 and 2

Table 1 Accuracy (given as recovery) and precision (given as standard deviation) of estuarine water reference material SLEW 3

Metal	Metal concentrations (mg/kg ± st.dev.)		Recovery (%)
	Certified	Our values (n=5)	
Cd	0.048 ± 0.004	0.043 ± 0.001	90.6
Ni	1.23 ± 0,07	1.36 ± 0,02	110.3
Mn	1,61 ± 0,22	1,89 ± 0,02	117.6
Pb	0,0090 ± 0,0014	0,0097 ± 0,0003	107.8
Co	0,042 ± 0,010	0,052 ± 0.001	123.3
Cu	1,55 ± 0,12	1,77 ± 0.02	113.9

Table 2 Accuracy (given as recovery) and precision (given as standard deviation) of estuarine water reference material NASS-6

Metal	Metal concentrations (mg/kg ± st.dev.)		Recovery (%)
	Certified	Our values (n=5)	
Cd	0.0311 ± 0.0019	0.045 ± 0.0019	144.7
Ni	0.301 ± 0.025	0.290 ± 0.025	96.3
Mn	0.530 ± 0,050	0.620 ± 0,038	117.0
Pb	0,006 ± 0,002	0,011 ± 0,002	
Co	0.015	0,017 ± 0.0007	113.3
Cu	0.248 ± 0.025	0.348 ± 0.003	140.3

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New results

- Distribution of atmospheric Black Carbon (BC) in the marine boundary layer was estimated in the North Atlantic, as well in the Baltic, North, Norwegian, Barents, White, Kara and Laptev Seas based on samples collected in the 62 and 63 research cruises of the RV "Akademik Mstislav Keldysh" since July 23 to October 6, 2015. During some parts of the cruises, air masses arrived from the background areas of high latitudes, and the measured BC concentrations were low. During other parts of the cruise, air masses arrived from industrially developed areas with strong BC sources, and this led to substantially enhanced measured BC concentrations. Model-supported analyses are currently performed to use the measurement data for constraining the emission strength in these areas (V.P. Shevchenko).
- The first data were obtained on the vertical chlorin flux in the water column and its accumulation in the upper layer of sediments of the Caspian Sea. Seasonal variability of the chlorine concentration in sedimentary matter was evaluated. During the last 60 years, the content of the phytoplankton-synthesized (autochthonous) organic matter, the marker of which is the chlorophyll a concentration, generally decreased. Incomplete organic matter mineralization in the water column promotes accumulation of the labile form of the autochthonous organic matter near the sea bottom and is an additional source of energy for biogeochemical processes in the interface water–bottom sediment layer. The results of study of the chlorine concentration may be applied in reconstructions of paleoproductivity of the Caspian Sea waters. Chlorophyll a and its derivatives are markers of the phytoplankton origin organic matter in the water column and bottom sediments and reliable quantitative indicators of the conditions and processes of biogenic sedimentation [Kravchishina et al., 2016].
- The trace metals (Al, Fe, Mn, Mo, Cu, Co, Cd, Pb, Ni, Cr, As) behavior in the processes of early diagenesis in high resolution (1-2 cm) core of the Barents Sea bottom sediments was examined on the base of the trace metal speciation. Along the core length (44 cm) Al is almost totally presented by lithogenous geochemically inert form, meanwhile portion of Fe, Cr and Ni in this form varies from 61 to 87% from total content. Mn and Mo were the most labile metals (till 90% from total content) in the upper 0-6 cm layer, while down the core they were progressively altered. The adsorbed, organically-bound and lithogenous forms of Co, Cd, Cu, Pb, and As contribute approximately equal portions in accumulation of these metals in the Barents Sea bottom sediments [Demina et al. 2016].
- The monitoring investigations to control the heavy metal concentrations in water and in suspended particulate matter (SPM) of small rivers on the Caucasus coast of the Russian Federation and in the coastal waters of the Black Sea have been carried out over 5 years (2009-2014) in frameworks of the program " Small Rivers of the Black Sea". Special attention was paid to areas nearby the capital of the recent Winter Olimpic Games in Sochi (February-March 2014). The results have shown that no significant changes in the water due to large scale preparations and fulfillment of the Olimpic Games were detected.
- Very interesting results were obtained in studying of several elements' behavior in the river/sea mixing zone of the Mzymta River. Due to small sizes and short residence time of

river water in this zone, the riverine sedimentary material crosses it without any changes of its chemical composition [Gordeev et al., 2015].

- Isotopic composition of S ($\delta^{34}S\text{-}SO_4$) in water was studied in the H_2S oxidation zone of central part of the Black Sea at the horizons 110 and 120 m, i.e. just below the border of disappearance of hydrogen sulfide. Samples of water prepared in different chemical ways were identical in term of $\delta^{34}S(SO_4)$ within the reproducibility of the method (< 0.2‰) and do not show the lightening of the isotopic composition of sulfur, unlike the earlier data [A.V. Dubinin, E.O. Dubinina]

Cruises

Shirshov Institute of Oceanology RAS has completed 3 cruises connected with the International GEOTRACES Program:

- Cruise of *R/V Akademik Ioffe* in the North Atlantic (22 June - 4 July 2015) was performed to research the modern sedimentation system, including employment of 3 deep-sea automatic observatories with sediment traps, samples of SPM and bottom sediments were collected to study the high-resolution reconstruction of the climate change over the Holocene.
- Cruise of *R/V Akademik Mstislav Keldysh* in the North Atlantic (21 July -20 August 2015) was carried out. Unique material was sampled to study the modern sedimentation processes and the high-resolution reconstruction of the climate change in boundary areas the North Atlantic - Arctic: straits between Greenland, Iceland, Faroe Islands and Shetland Islands, the Norway and Barents Seas. For these purposes, based on hydrophysical sounding SPM samples were collected, as well as 8 sediment cores (to 512 cm length), 3 sediments cores (to 40 cm length) by the Neimisto tube with undisturbed contact zone between near-bottom water and bottom sedoments.
- Cruise of *R/V Akademik Mstislav Keldysh* in the Kara Sea and Sea of Laptev (24 August - 10 October 2015) was held. New data on the SPM concentrations, vertical fluxes of sinking particles and aerosols, as well as diagenetic processes in the bottom sediments of the Kara and Laptev Seas processes were obtained to better understanding of modern sedimentation in the Arctic Ocean. Joint study of the system "dispersed sedimentary matter (aerosols, SPM, sedimentary matter collected by sediment traps) - uppermost bottom sediment - underlying sedimentary cover" is a new stage in investigation of the sedimentation in the Arctic Ocean.

All the samples obtained are in the processes of chemical treatment and ICP-MS, AAS analysis, including trace metals, as well as under mineralogical investigations (SEM, X-Ray difraction, optical microscopy).

New projects and/or funding

Russian Science Foundation - 2 projects till 2017:

- № 14-50-00095 "World Ocean in XXI Century: climate, ecosystems, mineral and biological resources and disasters", an issue "Geospheres' interaction and mineral resources in the World Ocean" under the direction of academician Alexander Lisitzyn.
- № 14-27-00114 "Sedimentology and biogeochemistry of the seas of Russian European part (dispersed sedimentary matter, bottom sediments, diagenesis)" under the direction of academician Alexander Lisitzyn.

Meetings

- Demina L.L. 26 IUGG General Assembly, Prague, June 27 – July 1, 2015: Co-conviner of Symposium P-02 "Physics and Biogeochemistry of Semi-Enclosed and Shelf Seas", Poster presentation: Demina L. L., Budko D. F., Novigatsky A.N., Filippov A.S. “Occurence Forms of Some Heavy Metals in the Surface Sediments of the White Sea".
- Simposium P-11. Oral presentation: Elena Masferrer Dodas, Ed Boyle, Reiner Schlitzer, Catherine Jeandel, Ludmila L. Demina "GEOTRACES highlights in the Indian Ocean and plans for the future.
- Shevchenko V.P., Kopeikin V.M., Evangeliou N., Novigatsky A.N., Pankratova N.V., Starodymova D.P., Stohl A., Thompson R. The distribution of atmospheric black carbon in the marine boundary layer over the North Atlantic and the Russian Arctic Seas in July – October 2015 // European Geosciences Union (EGU) General Assembly, Vienna, April 17–22, 2016 / Poster.
- Kravchishina M.D. Workshop “Biogeochemical Studies in the Siberian Shelf Seas”, GEOMAR, Kiel, Germany, 27–28 January 2016.

Outreach activities

- The research results of the GEOTRACES Program were many times cited in : "Trace Metal Biogeochemistry and Ecology of Deep-Sea Hydrothermal Vent Systems" (eds. Demina L.L. and Galkin S.V.). Handbook of Environmental Chemistry. SPRINGER-Nature. 2016 (in press).

Other activities (e.g., acquisition of new sampling systems)

- New samplers of bottom sediments (Multi-corers, Sediment traps, eco-soundings).
- Teflon - covered heating platform, Teflon sub-boiling system to obtain clean acids, Laminar Box to prepare filters and analytical solutions.

New publications

- L.L. Demina, A.Yu. Lein, S.V. Galkin, and A.P. Lisitzyn. Features of trace metal distribution in the components of the ecosystem of the Lost City hydrothermal vent field (Mid-Atlantic Ridge). Doklady Earth Sciences. 2015. Vol 465, part 2. pp. 1312-1316. DOI: 10.7868/S0869565215360189
- Gordeev V.V., Makkaveev E.P., Kochenkova A.I. Heavy metals in water and suspended matter in mouths of small rivers and in coastal zone of the Russian part of the Caucasus coast of the Black Sea.// Water: chemistry and ecology, 2015, V.19, N11, P.7 -21.
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- Kravchishina M.D., Lein A.Yu., Sukhanova I.N., Artem’ev V.A., Novigatsky A.N. Genesis and Spatial Distribution of Suspended Particulate Matter Concentrations in the Kara Sea during Maximum Reduction of the Arctic Ice Cap // Oceanology. 2015. T. 55. № 4. 623–643.

- Kravchishina M.D., Lisitzin A.P., Lein A.Yu., Lukashin V.N., Novigatsky A.N., Klyuvitkin A.A. First Results on Determination of Chlorophill A and Its Derivatives in the System of Trapped Sedimentary Material–Fluffy Layer–Bottom Sediment of the Caspian Sea // Doklady Earth Sciences. 2016. T. 467. Part 1. C. 284–288.
- Kravchishina M.D., Lein A.Yu., Pautova L.A., Klyuvitkin A.A., Politova N.V., Novigatsky A.N., Silkin V.A. Vertical distribution of suspended particulate matter in the Caspian Sea in the beginning of summer // Oceanology. 2016. In press.
- Shevchenko V.P., Starodymova D.P., Vinogradova A.A. et al. Elemental and organic carbon in atmospheric aerosols over the northwestern coast of Kandalaksha Bay of the White Sea // Doklady Earth Sciences. 2015b. V. 461. Part 1. P. 242–246.
- Guieu C., Shevchenko V.P. Dust in the Ocean // Encyclopedia of Marine Geosciences. Dordrecht: Springer Science+Business Media, 2015. DOI 10.1007/978-94-007-6644-0_56-3.
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- Shevchenko V.P., Vorob'ev S.N., Kirpotin S.N., Kritskov I.V., Manasypov R.M., Pokrovsky O.S. and Politova N.V. Investigations of insoluble particles in the snow cover of Western Siberia from Tomsk to the Ob estuary. Optika Atmosfery i Okeana. 2015. V. 28(6), 499–504 (in Russian).

Some publications (in press)

- Demina L.L. Trace metals in water of deep-sea hydrothermal biotopes. Chapter 3. In: "Trace Metal Biogeochemistry and Ecology of Deep-Sea Hydrothermal Vent Systems" (eds. Demina L.L. and Galkin S.V.). Handbook of Environmental Chemistry. SPRINGER-Nature. 2016 (in press).
- Demina L.L., Galkin S.V. Factors controlling the trace metal distribution in hydrothermal vent organisms. Chapter 6. In: "Trace Metal Biogeochemistry and Ecology of Deep-Sea Hydrothermal Vent Systems" (eds. Demina L.L. and Galkin S.V.). Handbook of Environmental Chemistry. SPRINGER- Nature. 2016 (in press).
- Demina L.L., Bud'ko D.F., Lisitzyn A.P. Geochemical fractionation of some trace metals in the high-resolution sedimentary core of the Barents Sea (Doklady Earth Science, 2016, submitted)
- Dubinin A.V., Dubinina E.O., Kossova S.A., Berezhnaya E.D. Ventilation of anaerobic zone in the Black Sea from δ34S-SO4 isotopic data (Doklady Earth Science, 2105, accepted)
- Berezhnaya E.D., Dubinin A.V. Elements of Platinum group and gold in the Fe-Mn nodules reference material NOD-A-1. Geochemistry International (accepted).
- Rimskaya-Korsakova M.N., Berezhnaya E.D., Dubinin A.V. Determination of Mo, W and V in the Atlantic Ocean by concentration method with 8-oxychinolin extraction followed by ICP-MS analysis (Oceanology, 2016, in press).

• Dubinin A.V., Uspenskaya T.Yu., Rimskaya-Korsakova M.N., Demidova T.P. Rare elements and isotopic composition of Nd and Sr в manganese micro-nodules of the Brazil depression of the south Atlantic Ocean. Lithology and mineral resources. 2015(in press).

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New scientific results

To better understand the presence and abundance of Hg species in the remote ocean regions, waters of South Atlantic Ocean along 40°S parallel were investigated during UK-GEOTRACES cruise GA10. Total mercury (THg), methylated mercury (MeHg), and dissolved gaseous mercury (DGM) concentrations were determined. The concentrations were very low in the range of pg/L (femtomolar). All Hg species had higher concentration in western than in eastern basin. THg did not appear to be a useful geotracer. Elevated methylated Hg species were commonly associated with low-oxygen water masses and occasionally with peaks of chlorophyll a, both involved with carbon (re)cycling. The overall highest MeHg concentrations were observed in the mixed layer (500 m) and in the vicinity of the Gough Island. Conversely, DGM concentrations showed distinct layering and differed between the water masses in a nutrient-like manner. DGM was lowest at surface, indicating degassing to the atmosphere, and was highest in the Upper Circumpolar Deep Water, where the oxygen concentration was lowest. DGM increased also in Antarctic Bottom Water. At one station, dimethylmercury was determined and showed increase in region with lowest oxygen saturation. Altogether, our data indicate that the South Atlantic Ocean could be a source of Hg to the atmosphere and that its biogeochemical transformations depend primarily upon carbon cycling and are thereby additionally prone to global ocean change.

For the first time, Hg isotope composition of seawater in the Canadian Arctic Archipelago is reported. Hg was pre-concentrated from large volumes of seawater sampling using anion exchange resins onboard the research vessel immediately after collection. Elution of Hg was performed in laboratory followed by isotope composition determination by multi-collector inductively coupled plasma mass spectrometry (MC-ICP-MS). For comparison, seawater from two stations was shipped to the laboratory and processed within it. Results showed negative mass-dependent fractionation in the range from -2.85 to -1.10‰ for δ202Hg, as well as slightly positive mass-independent fractionation of odd Hg isotopes. Positive mass-independent fractionation of 200Hg was also observed. Samples that were pre-concentrated in the laboratory showed different Hg isotope signatures and this is most probably due to the abiotic reduction of Hg in the dark by organic matter during storage and shipment after sampling. This emphasizes the need for immediate onboard pre-concentration.

We examine the large-scale distribution patterns of the nano- and microphytoplankton collected from 145 oceanic stations, at 3 m depth, the 20% light level and the depth of the subsurface chlorophyll maximum, during the Malaspina-2010 Expedition (December 2010-July 2011), which covered 15 biogeographical provinces across the Atlantic, Indian and Pacific oceans, between 35°N and 40°S. In general, the water column was stratified, the surface layers were nutrient-poor and the nano- and microplankton (hereafter phytoplankton, for simplicity, although it included also heterotrophic protists) community was dominated by dinoflagellates, other flagellates and coccolithophores, while the contribution of diatoms was only important in zones with shallow nutriclines such as the equatorial upwelling regions. The main trends of variability identified consisted of: 1) A contrast between the community composition of the upper and the lower parts of the euphotic zone, expressed respectively by positive or negative scores of the first principal component, which was positively correlated with taxa such as the dinoflagellates Oxytoxum minutum and Scrippsiella spp., and the

coccolithophores Discosphaera tubifera and Syracosphaera pulchra (HOL and HET), and negatively correlated with taxa like Ophiaster hydroideus (coccolithophore) and several diatoms, 2) a general abundance gradient between phytoplankton-rich regions with high abundances of dinoflagellate, coccolithophore and ciliate taxa, and phytoplankton-poor regions (second principal component), 3) differences in dominant phytoplankton and ciliate taxa among the Atlantic, the Indian and the Pacific oceans (third principal component) and 4) the occurrence of a diatom-dominated assemblage (the fourth principal component assemblage), including several pennate taxa, Planktoniella sol, Hemiaulus hauckii and Pseudo-nitzschia spp., in the divergence regions. Our findings indicate that consistent assemblages of co-occurring phytoplankton taxa can be identified and that their distribution is best explained by a combination in different degrees of both environmental and historical influences.

The possibility of tracing routes of dense waters toward and within the ocean abyss by the use of an extended set of observed physical and biochemical parameters was explored. To this purpose, we employ mercury, isotopic oxygen, biopolymeric carbon and its constituents, together with indicators of microbial activity and bacterial diversity found in bottom waters of the Eastern Mediterranean. In this basin, which has been considered as a miniature global ocean, two competing sources of bottom water (one in the Adriatic and one in the Aegean seas) contribute to the ventilation of the local abyss. Moreover, as the near-bottom development of exogenous bacterial communities transported by convectively-generated water masses in the abyss can provide a persistent trace of episodic events, intermittent flows like those generating abyssal waters in the Eastern Mediterranean basin may become detectable beyond the availability of concomitant measurements.

Our research performed in the Gulf of Trieste confirmed that, on an annual scale, the Gulf acts as a sink of CO2 that is strongly controlled by the seasonal variability of the water temperature, biological processes, wind speed and riverine inputs. The results also indicated that the buffer capacity of the Gulf of Trieste is relatively high, meaning that its waters are not particularly exposed to acidification processes.

Large volumes of seawater were sampled monthly from December 2011 to October 2012 in the southeastern part of the Gulf of Trieste (northern Adriatic Sea) in order to study the seasonal changes of colloidal organic matter (COM) concentrations, its origin and composition. The lipid fraction increased up to 2-fold and the polysaccharide fraction remained nearly constant while protein fraction decreased, reflected in a higher C/N (28) molar ratio. Also, higher concentrations of humics were observed in late spring – early summer probably due to local freshwater discharges in spring. An increase of lipid fraction and nearly constant polysaccharide content in late spring - early summer, in parallel with agglomeration of high molecular weight (>200 kDa) macromolecules, indicates the possible formation of macroaggregates, which has been periodically occurred in the northern Adriatic Sea in the past.

Sequential nutrient regeneration and organic matter (OM) degradation were studied in surface coastal sediments of the Gulf of Trieste (northern Adriatic Sea). Nutrient budgets at the sediment-water interface of this sandy coastal sediment showed intensive anoxic recycling of inorganic N, but low P and Si cycling in all redox phases.

Deposition of riverine suspended solids affects operations in ports located in the proximity of river mouths. The Rižana River is the main source of riverine solids in the shallow Bay of Koper (Gulf of Trieste, northern Adriatic Sea). The mean discharge increases rapidly in relation to high precipitation, typical of spring and autumn. During such events, the runoff leads to torrential river flow with high concentration of suspended solids which are

consequently deposited in the port zone. The regression model was found to be a useful tool to estimate TSS and SOM concentrations from turbidity data in rivers and the coastal sea, thus providing an evaluation of riverine TSS and SOM input and deposition into the small bay, which in turn affects local port activities. Less than 50 % of the introduced TSS settles within the second port basin during mean river flow conditions.

The potential link between the microbial dynamics and the environmental parameters was investigated in a semi-enclosed and highly dynamic coastal system (Gulf of Trieste, northern Adriatic Sea, NE Mediterranean Sea). Our comprehensive 2-year time-series study showed that despite the shallowness of this area, there was a significant difference between the surface and the bottom bacterial community structure. The bottom bacterial community was more diverse than the surface one and influenced by sediment re-suspension. The surface seawater temperature had a profound effect on bacterial productivity, while the bacterial community structure was more affected by freshwater-borne nutrients and phytoplankton blooms. Phytoplankton blooms caused an increase of Gammaproteobacteria (Alteromonadaceae, SAR86 and Vibrionaceae) and shift in dominance from SAR11 to Rhodobacteraceae taxon at the surface. Our results propose the importance of the water mass movements as drivers of freshwater-borne nutrients and of allochthonous microbial taxa. This study emphasizes the prediction power based on association networks analyses that are fed with long-term measurements of microbial and environmental parameters. These interaction maps offer valuable insights into the response of marine ecosystem to climate- and anthropogenic-driven stressors.

Between January 30th and February 4th we collected the first turbulence observations in the Gulf of Trieste under different wind forcing and water column structure. The vertical profiles of the turbulence kinetic energy dissipation rates showed that the presence near the sea floor of different water masses, inflowing from the open sea, can prevent the complete mixing of the water column. This dumping effect is enhanced when these masses present higher suspended sediment concentrations. Coupled and uncoupled circulations in the northern Adriatic are predominantly wind-driven and show no significant mesoscale differences.

Based on the stable isotope compositions of carbon and oxygen for shells and soft tissues, invasive serpulids (Ficopomatus enigmaticus) in the Krka estuary (Croatia) were proven to be excellent environmental indicators of salinity and sources of particulate and dissolved nutrients, and can be therefore be used as proxies for water circulation in a permanently stratified microtidal estuary.

New publications (published or in press)

- BRATKIČ, Arne, VAHČIČ, Mitja, KOTNIK, Jože, OBU, Kristina, BEGU, Ermira, MALCOLM, E., WOODWARD, S., HORVAT, Milena. Mercury presence and speciation in the South Atlantic Ocean along the 40°S transect. Global biogeochemical cycles, ISSN 1944-9224, [in press] 2015, 10 str., doi: 10.1002/2015GB005275.
- RUBINO, Angelo, BENSI Manuel, HAINBUCHER Dagmar, ZANCHETTIN Davide, MAPELLI Francesca, OGRINC Nives, MARCHETTO Davide, BORIN Sara, CARDIN Vanessa, FAJON Vesna, HORVAT Milena, TARICCO Carla, BALDI Franco. Biogeochemical, isotopic and bacterial distributions trace oceanic abyssal circulation. PloS ONE, ISSN 1932-6203, 2016, vol. 11, 0145299-1-0145299-12. doi: 10.1371/journal.pone.0145299
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- SOCZKA-MANDAC, Rok, FAGANELI, Jadran. Deposition of riverine suspended solids into a shallow bay (Bay of Koper, Gulf of Trieste, nothern Adriatic Sea). Journal of soils and sediments, ISSN 1439-0108, 2015, vol. 15, issue 12, str. 2433-2442, doi: 10.1007/s11368-015-1146-y.
- KORON, Neža, OGRINC, Nives, METZGER, Eduard, RIEDEL, Bettina, FAGANELI, Jadran. The impact of induced redox transitions on nutrient diagenesis in coastal marine sediments (Gulf of Trieste, northern Adriatic Sea). Journal of soils and sediments, ISSN 1439-0108, 2015, vol. 15, no. 12, str. 2443-2452, doi: 10.1007/s11368-015-1215-2.
- TAHERI, Mehrshad, GREGO, Mateja, RIEDEL, Bettina, VINCX, Magda, VANAVERBEKE, Jan. Patterns in nematode community during and after experimentally induced anoxia in the northern Adriatic Sea. Marine environmental research, ISSN 0141-1136, 2015, vol. 110, 110-123, doi: 10.1016/j.marenvres.2015.08.004.
- GOLLASCH, Stephan, DAVID, Matej, FRANCÉ, Janja, MOZETIČ, Patricija. Quantifying indicatively living phytoplankton cells in ballast water samples - recommendations for Port State Control. Marine pollution bulletin, ISSN 0025-326X, 2015, 1-8, doi: 10.1016/j.marpolbul.2015.09.037.

New projects and/or funding

- In November the IAEA BoG approved, the TC interregional project INT7019 “Supporting a Global Ocean Acidification Observing Network towards Increased Involvement of Developing States”, where Slovenia is taking an active part. The objective of this project is to build ocean acidification observing capacity and connect countries and regions with an interest in ocean acidification to identify the most sensitive areas and inform policy measures at domestic and inter-regional level.

PhD theses

- KLUN, Katja. Composition and complexation of colloidal organic matter in coastal sea (Gulf of Trieste): doctoral dissertation. University of Ljubljana: 2016. XIII f., pp. 103 (supervisor: J. Faganeli)

Meetings

- 22nd International Symposium on Environmental Biogeochemistry (ISEB) was held in Piran, September 28 – October 2, 2015 (www.iseb22.ijs.si). The ISEB has always strived to bring together scientists from a range of disciplines with interests and this Symposium "Dynamics of Biogeochemical System: Processes and Modeling" explored issues relating to biogeochemistry in various fields including soil science, microbial ecology and marine, lacustrine and atmospheric research. The sessions have been organized around ten themes which integrate the following topics:

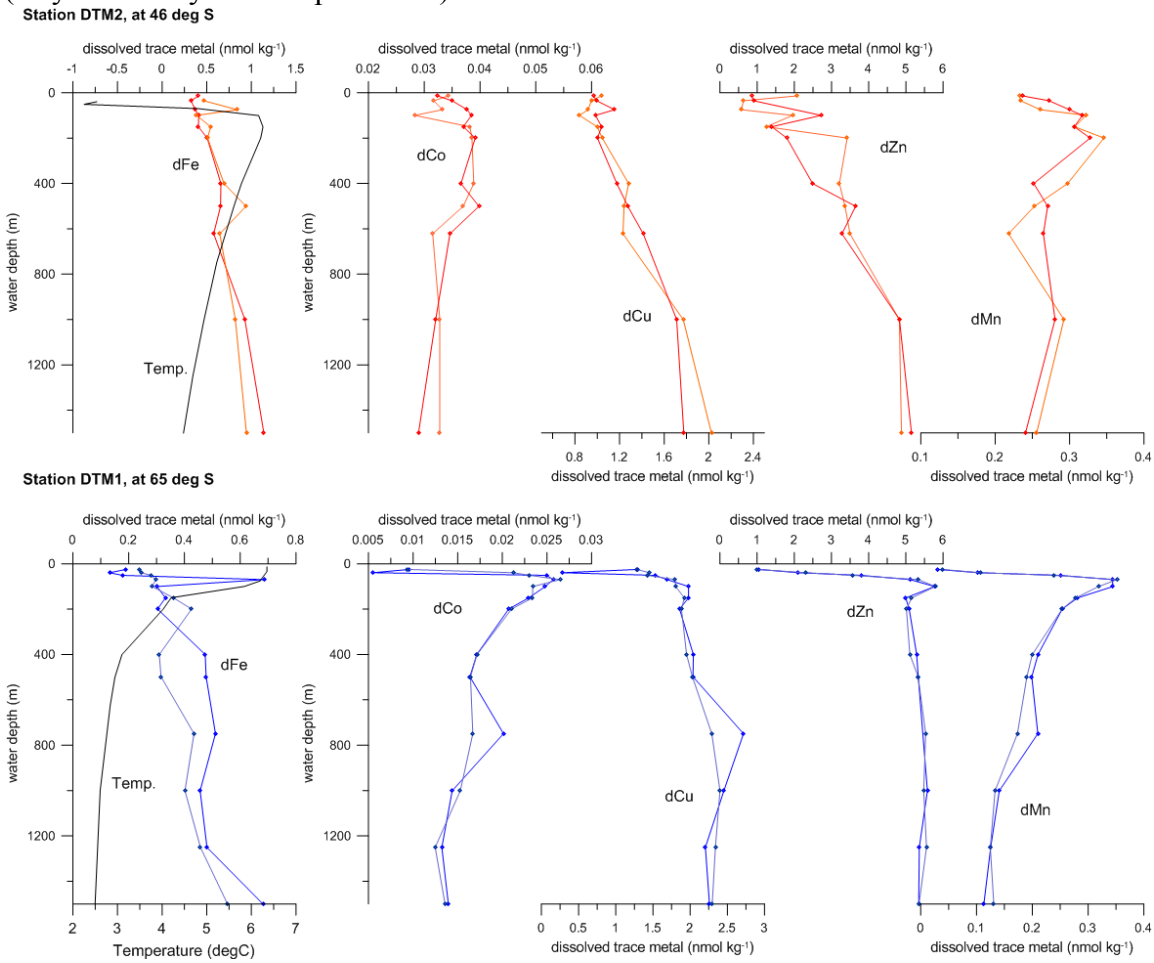
  1 The marine and coastal environment
  2 Surface and groundwater systems
  3 Soils
  4 Climate change
  5 Microbial biogeochemistry
  6 Nanoparticles and colloids
  7 Isotopes in biogeochemical processes
  8 Biogeochemistry of pollutants
  9 Archeological biogeochemistry.

  The program included two Special sessions GMOS and GEOTRACES (The marine and coastal environments) and GLOBAQUA (Surface and groundwater systems). In addition, the SOIL session was devoted to the International Year of Soils (IYS), the main purpose of which is to raise global awareness of the importance of soils for food security, agriculture as well as in mitigating climate change, alleviating poverty, and sustainable development. The program included six invited speakers, 52 oral and 54 poster presentations. Prof. G. Henderson (University of Oxford, Oxford, UK) was the invitated speaker in the GEOTRACES session. The symposium also continues its tradition of strong international representation, with authors of accepted abstracts from 23 countries from around the world.

Submitted by Nives Ogrinc (nives.ogrinc@ijs.si).

New results

Vertical profiles for Cu, Cd, Co, Fe, Mn and Zn were produced for the Southern Atlantic (Roychoudhury et al. unpublished)



New publications

- Von der Heyden, B. and Roychoudhury A. N. (2015) A review of colloidal iron partitioning and distribution in the open ocean, Marine Chemistry, V177(1), pp. 9-19, doi:10.1016/j.marchem.2015.05.010
- Von der Heyden, B. and Roychoudhury A. N. (2015) Application, Chemical Interaction and Fate of Iron Minerals in Polluted Sediment and Soils. Current Pollution Reports, V 1, pp. 265-279, doi: 10.1007/s40726-015-0020-2
- von der Heyden, B.; Roychoudhury, A. N., Tyliszczak. T.; Myneni, S. C. (Submitted) Iron L3-edge spectroscopic evaluation of iron oxide and oxy-hydroxide coordination. American mineralogist

- Das, S., Roychoudhury, A. N., Routh, J., Veldhuis, M. J. W., Ismail, H. E. (Submitted) Connection of pigment biomarkers and dissolved trace elements to primary production in southern Benguela Upwelling zone (St. Helena Bay). Journal of Marine Systems.

Meetings

- S. Fietz, R. Cloete, J. Loock, R. Philibert, A.N. Roychoudhury, N. van Horsten, T. Mtshali, S. Thomalla (2016) Response of Southern Ocean Phytoplankton to iron and light limitation 34th SCAR Biennial Meeting, Kuala Lumpur, Malaysia, August 22 – 26, 2016
- R. Cloete, J. Loock, T. Mtshali, S. Fietz, A.N. Roychoudhury (2016) The distribution and controls of bioactive trace elements (Cu and Zn) in the Atlantic Sector of the Southern Ocean. 34th SCAR Biennial Meeting, Kuala Lumpur, Malaysia, August 22 – 26, 2016
- J. Loock, R. Cloete, T. Mtshali, S. Fietz, A.N. Roychoudhury (2016) The seasonal distribution and controls of bioactive trace elements cadmium and cobalt in the southern ocean, Atlantic sector. 34th SCAR Biennial Meeting, Kuala Lumpur, Malaysia, August 22 – 26, 2016
- S. Fietz, R. Cloete, J. Loock, R. Philibert, A.N. Roychoudhury, N. van Horsten, T. Mtshali, S. Thomalla (2016) Response of Southern Ocean Phytoplankton Communities to Trace Metal and Light Availability. Ocean Sciences Meeting, New Orleans, USA February 21 – 26, 2016

Cruises

- SANAE 55 (Southern Ocean physics and biogeochemistry) cruise was undertaken along the BONUS-GOODHOPE line in the Southern Ocean to support the following projects (Dec 2014 – Feb2015):
    1. Seasonal Cycle of Carbon in Southern Ocean – SNA2011112600001
    2. Fe and light limitation in Southern Ocean phytoplankton – SNA2011120600005
    3. Bioactive trace elements in Southern Ocean – SNA2011110100001
    4. Stratification dynamics in the Southern Ocean mixed layer: a high resolution approach – YREF 0000005441
    5. Southern Ocean Phytoplankton Adaption to mimicked future changes in light and iron availability - Molecular bases and modelling – SANCOOP 234229
    6. Bio-optics - SNA2011120800004

  During this cruise, samples for GEOTRACES process study SOSCEx were also collected. As per SOSCEx III objectives, multiple occupations of the same two stations were carried out in the winter early, mid and late summer that aim to resolve the seasonal evolution of the Fe profile/ferricline in the SAZ.

New funding

- Fietz, S and Roychoudhury AN (2016) Southern Ocean Ecosystem response to dust input, NRF Competitive Rated Researcher Grant R 1,277,000
- Roychoudhury AN (2015) ICP-MS mass spectrometer for ultra-trace metal analysis. National Equipment Program, NRF, R 2,699,000

- Roychoudhury AN (2015-2017) Speciation and interaction of iron nanoparticles in Southern Ocean, SANAP, R 1,353,500
- Roychoudhury AN (2014 – 2016) Iron nanoparticles in environment, NRF Competitive Rated Researcher Grant, R 1,427,220
- Fietz, S and Roychoudhury, AN (2014- 2016) Southern Ocean Phytoplankton adaption to mimicked future changes in light and iron availability – molecular bases and modeling, South Africa – Norway bilateral grant, R 2,421,712 + NOK 1,453,027

Other activities *(e.g., acquisition of new sampling systems)*

A pico-Fast® system acquired last year for pre-concentration of sea-water samples for trace elemental analysis using ICP-MS is functioning successfully. SAFe standard and other internal standards have been analyzed repeatedly and data for Co, Cu, Zn, Cd, Mn and Fe has been sent for comparison of consensus values.

Report submitted by AN Roychoudhury (roy@sun.ac.za).

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN SPAIN

June 1st, 2015 to April 30th, 2016

National collaborators

P. Masqué, E. Garcia-Solsona, V. Rodellas, J. Garcia-Orellana (Barcelona-UAB)

A. Tovar-Sanchez (Cádiz-CSIC)

A. Cobelo, R. Prego (Vigo-CSIC)

J. Santos (IEO-Murcia)

J. Magdalena Santana-Casiano, Melchor González-Dávila (Canarias-ULPGC)

L. Lagrera (UIB)

- Samples for artificial (i.e. 236U, Pu isotopes, 137Cs, 90Sr, 129I) and natural (i.e. 7Be, 210Po and 210Pb) radionuclides from French GEOVIDE cruise (May- 2014) to undertake an integrated oceanographic transect in the North Atlantic Ocean and Labrador Sea (GEOTRACES GA01 section) are in process.
- Participation in the German cruise PS94 (GEOTRACES GN04) on August 2015 to undertake an integrated oceanographic transect in the Arctic Ocean collecting samples and collaborating with other groups to measure artificial (i.e. 236U, Pu isotopes, 129I) and natural (i.e. 234Th, 210Po and 210Pb) radionuclides. Samples are in process.
- Participation in the Eddies cruise (GEOTRACES GPpr11) on board RV Investigator collecting samples for Th-234 in order to evaluate exportation and remineralization of C.

GEOTRACES-related projects

- PROJECT TITLE: NUevos REtos en la investigación de cañones submarinos: Indicadores del Estado ambiental y Variabilidad espacio- temporal – El papel de los temporales (NUREIEV). IP: Miquel Canals (U. of Barcelona). Funded by Ministerio de Economía y Competitividad, CTM2013-44598-R.
- PROJECT TITLE: MEzcla y DISpersión en el TRAnsporte de Energia y Solutos (MeDistraes). IP: Jesus Carrera y Maaten W Saaltink. Funded by Ministerio de Economía y Competitividad. CGL2013-48869-C2-2-R, 2014-2016.
- PROJECT TITLE: Effect of the ocean acidification and warming in the biogeochemical cycle of Fe in the Norh Atlantic. IP: J. Magdalena Santana-Casiano, M. González-Dávila (ULPGC). Funded by Ministerio de Economía y Competitividad. CTM2014-53342-P.
- PROJECT TITLE: Aportes de metales traza a la zona costera durante diferentes períodos oceanográficos. Influencia del fitoplancton sobre la concentración de metales traza (MEFIO). IP - Coordinator: C. García Soto (IEO). Funded by Ministerio de Economía y Competitividad. CTM2011-28792-C02-02.
- PROJECT TITLE: Estudio del contenido de metales traza en el golfo de Cádiz: influencia de los ríos Guadiamar, Tinto, Odiel y Guadalquivir. IP: A. Tovar Sánchez (ICMAN). Funded by Ministerio de Economía y Competitividad. CTM2014-59244-C3-3-R.

- PROJECT TITLE: COST Action: Network On Technology-Critical Elements: From Environmental Processes To Human Health Threats. IP: A. Cobelo García (IIM). Funded by European Union (H2020).

GEOTRACES-related articles

- Casacuberta, N., Masqué, P., Henderson, G., Rutgers van-der-Loeff., M., Bauch, D., Vockenhuber, C., Daraoui, A., Walther, C., Synal, H.-A., and Christl, M. (2016). First data of 236U in the Arctic Ocean and implications of using 236U/238U and 129I/236U as a new dual tracer. Earth and Planetary Science Letters, 440, 127-134.
- A. López, M. Rico, J. M. Santana-Casiano, A. G. González and M. González-Dávila. 2015. Phenolic profile of Dunaliella tertiolecta growing under high levels of copper and iron. Environ. Sci. Pollution Res. 22: 14820-14828.
- A. G. González, N. Pérez-Almeida, J. M. Santana-Casiano, F. J. Millero and M. González-Dávila 2016. Redox interaction of Fe and Cu in seawater. Mar. Chem. 179:12-22.
- G. Samperio, J. M. Santana-Casiano and M. González-Dávila. 2016. Effect of ocean warming and acidification on the Fe(II) oxidation rate in oligotrophic and eutrophic natural waters. Biogeochemistry. DOI 10.1007/s10533-016-0192-x.
- Almécija, C., Sharma, M., Cobelo-García, A., Santos-Echeandía, J., Caetano, M. 2015. Osmium and platinum decoupling in the environment: evidences in intertidal sediments (Tagus Estuary, SW Europe). Environmental Science and Technology, 49: 6545–6553. Doi: 10.1021/acs.est.5b00591.
- Cervantes-Duarte, R., Prego, R., Gaxiola-Castro, G., López-López, S., Aguirre-Bahena, F., Murillo-Murillo, I. 2015. Half-yearly patterns of upwelling and primary production in the euphotic zone of the shelf off southern Baja California. Estuarine, Coastal and Shelf Science, 157: 51-58. doi: 10.1016/j.ecss.2015.02.008.
- Cobelo-García, A., Filella, M., Croot, P., Frazzoli, C., Du Laing, G., Ospina-Alvarez, N., Rauch, S., Salaun, P., Shäfer, J., Zimmermann, S. 2015. COST Action TD1407: network on technology critical elements (NOTICE) – from environmental processes to human health threats. Environmental Science and Pollution Research, 22: 15188-15194. doi: 10.1007/s11356-015-5221-0.
- Neira, P., Cobelo-García, A., Besada, V., Santos-Echeandía, J., Bellas, J. 2015. Evidence of increased anthropogenic emissions of platinum: time-series analysis of mussels (1991-2011) of an urban beach. Science of the Total Environment, 514: 366-370. doi: 10.1016/j.scitotenv.2015.02.016 .
- Trezzi G, Garcia-Orellana J, Santos-Echeandía J, Rodellas V, Garcia-Solsona E, García-Fernández G, Masque P. 2016. The influence of a metal-enriched mining waste deposit on submarine groundwater discharge to the coastal sea. Marine Chemistry 178, 35-45.
- Bokuniewicz H, Cochran JK, Garcia-Orellana J, Rodellas V, Daniel JWR, Heilbrun C. 2015. Intertidal Percolation through Beach Sands as a Source of 224,223Ra to Long Island Sound, New York and Connecticut, U.S.A. Journal of Marine Research 73, 127 – 140.
- Trezzi G., Garcia-Orellana J, Rodellas V, Santos-Echeandía J, Tovar-Sanchez J, Garcia-Solsona E, Masque P. Relevance of submarine groundwater discharge as a source of dissolved trace metals to the North Western Mediterranean Sea. Marine Chemistry, Submitted.

- Álvarez-Vázquez, M.A., Prego, R., Caetano, M., 2015. Fluvial transport patterns of dissolved trace metals to the Ria of Cedeira. En: Panorámica Interdisciplinar sobre el Agua (P. Membiela, N. Casado & M.I. Cebreiros, Eds.), pp. 53-57. Educación Editora, ISBN: 978-84-15524-23-6. Digital CSIC: http://hdl.handle.net/10261/110021.

Contributions to conferences

- Shelley, R., Roca-Martí, M., Castrillejo, M., Masque, P. and Santhou, G. (2016). CT11A-07: Estimation of Trace Element Atmospheric Deposition Fluxes to the Atlantic Ocean (> 40°N) During Spring 2014 (GEOVIDE, GEOTRACES GA01). AGU-ASLO 2016 Ocean Sciences Meeting. 21-26 February 2016, New Orleans (USA).
- Christl, M., Casacuberta, N., Henderson, G.M., Rutgers van der Loeff, M., Vockenhuber, C., - Bauch, D. and Walther, C. (2016). T14B-0129: Artificial Radionuclides (236U and 129I) in the Arctic and North Atlantic Ocean. AGU-ASLO 2016 Ocean Sciences Meeting. 21-26 February 2016, New Orleans (USA).
- Tang, Y., Stewart, G., Masque., P., Church, T.M., Castrillejo, M. and Choi, H.Y. (2016). T24A-0143: The Relationship Between Particulate Composition and 210Po and 210Pb Content along Three GEOTRACES Transects. AGU-ASLO 2016 Ocean Sciences Meeting. 21-26 February 2016, New Orleans (USA).
- The emissions of the submarine volcano of El Hierro Island and the effect on the physico-chemical properties of seawater. J. M. Santana-Casiano, M. González-Dávila, E. Fraile-Nuez. VIII SIMPOSIO SOBRE EL MARGEN IBÉRICO ATLÁNTICO (MIA15), 21 - 23 September 2015, Málaga.
- Persistence of Fe(II) in seawater due to the effect of organic exudates from D. Tertiolecta. Aridane G. Gonzalez, J. Magdalena Santana-Casiano, M. Gonzalez-Davila, M. Rico, A. Lopez, N. Perez-Almeida, M. Suares de Tangil, A. Martel. Ocean Sciences Meeting, 21-26 February 2016, New Orleans.
- C. Almécija, A. Cobelo-García, M. Sharma, J. Santos-Echeandía, M. Caetano. Contrasting geochemical behaviour and sources of osmium and platinum in the environment as revealed from intertidal sediments. Oral. 13th International Estuarine Biogeochemistry Symposium (13th IEBS). Burdeos (Francia). 7-10 Junio 2015.
- M. Abdou, J. Schäfer, A. Cobelo-García, P. Neira, J. Petit, D. Auger, G. Blanc, J.-F. Chiffoleau. Long-term records of platinum contamination and sources in sediments and oysters from a fluvial-estuarine system (Gironde estuary, SW France). Poster. 13th International Estuarine Biogeochemistry Symposium (13th IEBS). Burdeos (Francia). 7-10 Junio 2015.
- M.A. Álvarez-Vázquez, M. Caetano, Mª.C. Pedrosa-García, S. Calvo, E. de Uña-Álvarez, B. Quintana, C. Vale, R. Prego. Natural and human enrichment of trace elements in estuarine sediments during the Anthropocene in the northwestern Iberian rias. Oral. ECSA 55 Unbounded boundaries and shifting baselines: Estuaries and coastal seas in a rapidly changing world. London (U.K.). 6-9 September 2015.
- R. Prego, M.A. Álvarez-Vázquez, M.D. Doval, J. Santos-Echeandía, E. de Uña-Álvarez, A. Cobelo-García and C. García-Soto. Land-Sea exchange of nutrient salts and organic matter in a small ria: anthropogenic disturbance of river contributions and ria budget implications. Poster. ECSA 55 Unbounded boundaries and shifting baselines: Estuaries and coastal seas in a rapidly changing world. London (U.K.). 6-9 September 2015.

- A. Cobelo-García, C. Almécija-Pereda, J. Santos-Echeandía, J. Schäfer, P. Neira,, M. Abdou. The environmental geochemistry of platinum: recent advances for an emerging inorganic contaminant. Conferencia plenaria (invitado). 10th International Conference – Processes in Isotopes and Molecules. Cluj-Napoca (Rumania). 23-25 Septiembre 2015.
- V. Rodellas, J. Garcia-Orellana, P. Masqué, M. Feldman, Y. Weinstein. Evaluating Submarine Groundwater Discharge as a source of nutrients to the Mediterranean Sea using 228Ra. Goldschmidt 2015, Prague 16-21 August 2015.
- M. Castrillejo, N. Casacuberta, M. Christl, J. Garcia-Orellana, P. Masqué, C. Vockenhuber, H. A. Synal.. First transect of 236U and 129I in the Mediterranean Sea. Goldschmidt 2015, Prague 16-21 August 2015.
- J. Scholten, J. Garcia-Orellana, P. Masque, C. Rocha, M. Schlüter, T. Stieglitz, P. van Beek. Submarine groundwater discharge in Europe and effects on coastal zones. Euromarine Foresight Symposium "Future Coast – Europe. Berlin-Brandenburg Academy of Sciences and Humanities (BBAW), from the 5th to the 7th of October 2015.

PhD defenses

- Giada Trezzi. Assessing the significance of submarine groundwater discharge as sourceof trace metals and Sr to the Mediterranean Sea. Advidors: Jordi Garcia-Orellana and Pere Masqué. Universitat Autònoma de Barcelona. 29/07/2016.
- Clara Almécija-Pereda. Geochemical behaviour and sources of platinium group elements in anthropogenically-impacted sediments. Advisors: Antonio Cobelo Garcia and Juan Santos Echeandía. Universidade de Vigo 29/5/2015.

Other cruises

- VULCANA1015. Vulcanología Canaria Submarina. Organized by Instituto Español de Oceanografía. From October 13th to 23th, 2015 in the area of the submarine volcano of El Hierro. Chemical parameters measured: pH, total alkalinity, total dissolved inorganic carbon, Fe(II) and O2.
- POS494. Submarine volcano of El Hierro. Organized by GEOMAR, Kiel. From February 7th to 15th, 2016. Chemical parameters measured: Fe(II) and pH.
- VULCANA0316. Vulcanología Canaria Submarina. Organized by Instituto Español de Oceanografía. From March 7th to 17th, 2016 in the area of the submarine volcano of El Hierro. Chemical parameters measured: pH, total alkalinity, total dissolved inorganic carbon, Fe(II) and O2.

Submitted by Jordi Garcia-Orellana (Jordi.Garcia@uab.cat).

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN SWEDEN

June 1st, 2015 to April 30th, 2016

Fieldwork (Per Andersson)

- "Particle transport derived from isotope tracers and its impact on ocean biogeochemistry: a GEOTRACES project in the Arctic Ocean". A joint French-Swedish Research Council (VR) funded project to study particle transport by U-series nuclides. Sandra Gdaniec (PhD student) participated on R/V Polarstern cruise ARK XXIX/3 (PS94), 17 August to 15 October, 2015 in the Arctic Ocean. The field work was partly funded by the Swedish Research Council and the Swedish Polar Research Secretariat http://polar.se/en/expedition/transarc-ii/

Intercalibration

- Per Andersson participated in the GEOTRACES Si isotope intercalibration led by Mark Brzezinski UC Santa Barbara, USA. Results reported and participate in writing a report (manuscript in prep.).

Publications

- Rosén, P.-O., Andersson P.S., Alling V., Mörth C.-M., Björk G., Semiletov I., and Porcelli D. (2015). Ice export from the Laptev and East Siberian Sea derived from δ18O values. doi:10.1002/2015JC010866. Journal of Geophysical Research. Oceans, 120, 5997-6007.
- Valk O., Gdaniec S., Rutgers van der Loeff M., Puigcorbe Lacueva V., and Paffrath R. (2016) 230Th and 231Pa: tracers for deep water circulation and particle fluxes in the Arctic Ocean. Abstract presented at Ocean Science Meeting New Orleans, Louisiana 21-26 February *2016.*

Meetings

- Per Andersson and David Turner: Biological and climatic impacts of ocean trace element chemistry. Royal Society, London 7 to 8 December, 2015.
- Per Andersson and David Turner: Quantifying fluxes and processes in trace metal cycling at ocean boundaries. Royal Society meeting at Chicheley Hall, Buckinghamshire, UK. 9 to 10 December, 2015. Contributions to the group reports "Coastal ocean and shelf-sea biogeochemical cycling of trace elements and isotopes: lessons learned from GEOTRACES" (Per Andersson); and "Hydrothermal Impacts on Trace Element and Isotope Ocean Biogeochemistry" (David Turner)
- Per Andersson: Biogeochemical studies in the Siberian Shelf Seas Workshop 27 to 28 January, 2016 in Kiel, Germany. Workshop funded by the International Arctic Science Committee (IASC). Presentation "Biogeochemical observations along the Eurasian-Arctic continental shelf, results from the ISSS-08 and the Lena River".

Outreach activities

- Sandra Gdaniecs participation on R/V *Polarstern* 2015 will be part of an exhibition at the Swedish Museum of Natural History showing different types of research expeditions both modern and in the past. The GEOTRACES expedition will be an example of a modern expedition to the Polar Sea. The exhibition is planned to be opened in June 2016.

Relevant SCOR Working Groups

- WG145 MARCHEMSPEC (chair David Turner): The WG met in New Orleans on 21 February, hosted a Town Hall at Ocean Sciences 2016 (22 February) and together with WG139 convened a session "Trace Metal Speciation in Seawater: Measurements, Modelling, and Impact on Marine Biogeochemistry".

New funding proposals

- Per Andersson has applied for funding of field work in the Lena River and tributaries during 2017-2020. The main objective is to study a large basin dominated by permafrost and the impact of changing temperatures on the delivery of TEI to the Arctic Ocean.
- David Turner has applied for funding for the development of chemical models for the binding of trace metals by natural organic matter in seawater. Collaboration is planned with Martha Gledhill (Kiel) and Alessandro Tagliabue (Liverpool).

Submitted by David Turner (davidt@chem.gu.se).

New results

- One process cruises GApr04 Leg 3- Shows clear seasonal cycle of Fe, where Fe is limiting during summer months, a surprising result in a shelf system. Clear signal of remineralisation was Fe observed and this was offset from nitrate.
- Pb isotopes have revealed that significant proportions of up to 30 – 50% of natural Pb, derived from mineral dust, are observed in Atlantic surface waters, reflecting the success of the global effort to reduce anthropogenic Pb emissions (Bridgestock et al. submitted).
- Modelling- Alessandro Tagliabue and co-workers produced a critical intercomparison of 13 global ocean biogeochemistry models to investigate how these models simulate dissolved iron distributions using data from IDP2014 (Tagliabue et al., 2016).

New publications

- Aumont, O., Ethé, C., Tagliabue, A., Bopp, L. & Gehlen, M. (2015) PISCES-v2: an ocean biogeochemical model for carbon and ecosystem studies, Geoscientific Model Development, 8, 2465-2513, doi: 10.5194/gmd-8-2465-2015.
- Bratkič. A., Vahčič, M., Kotnik, J., Vazne, K.O., Begu, E., Woodward, E.M.S. & Horvat, M. (2016). Mercury presence and speciation in the South Atlantic Ocean along the 40°S transect: Global Biogeochem. Cycles, 30, 105–119.
- Casacuberta, N., Masqué, P., Henderson, G., Rutgers van-der-Loeff, M., Bauch, D., Vockenhuber, C., Daraoui, A., Walther, C., Synal, H.A. and Christl, M. (2016) First 236U data from the Arctic Ocean and use of 236U/238U and 129I/236U as a new dual tracer. Earth Planet. Sci. Lett. 440, 127-134.
- Chance, R., Jickells, T. & Baker, A.R. (2015). Atmospheric trace metal concentrations, solubility and deposition fluxes in remote marine ari over the south-east Atlantic. Mar. Chem. 177: 45-66
- Floor, G.H., Clough, R., Lohan, M.C, Ussher, S.J. & Worsfold, P.J. (2015). Combined uncertainty estimation for the determination of the dissolved iron amount content in seawater using flow injection with chemiluminescence detection. Limonol. Oceanogr. Methods, doi:10.1002/lom3.10057
- Lambert, F., Tagliabue, A., Shaffer, G., Lamy, F., Winckler, G., Farias, L., Gallardo, L., De Pol-Holz, R. (2015). Dust fluxes and iron fertilization in Holocene and Last Glacial Maximum climates, Geophysical Research Letters, doi: 10.1002/2015GL064250.
- Lambelet, M., van de Flierdt, T., Crocket, K., Rehkämper, M., Kreissig, K., Coles, B., Rijkenberg, M.J.A., Gerringa, L.J.A., de Baar, H.J.W., & Steinfeldt, R. (2016). Neodymium isotopic composition and concentration in the western North Atlantic Ocean: Results from the GEOTRACES GA02 section. Geochim. Cosmochim. Acta 177, 1-29.
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Cruises

- GA08: Pa and Th samples for Gideon Henderson
- GPpr04: Process Study: The supply of iron from shelf sediments to the ocean
- GPpr04 leg 2- DY033 11/7/2015-03/8/2015

New projects and/or funding

- Lohan, M.C & Tagliabue, A. NERC Standard Grant 'The impact of mid-ocean ridges on the ocean's iron cycle'
- Mahaffey, C. Tagliabue, A. & Lohan, M.C. NERC Standard Grant 'ZIPLOc Zinc, iron, phosphorus co-limitation in the Ocean'.
- Plancherel, Y. NERC Independent Research fellowship 'The large-scale oceanic distribution of trace elements: disentangling performed contributions, regenerative processes, subsurface controls and sinks'.

PhD theses

- Roulin Khondoker, 2015. Anthropogenic vs natural sources of aerosols over the South Atlantic Ocean, Imperial College London, 216 pages
- Luke James Bridgestock, 2015. Tracing the cycling of Pb and Cd from natural and anthropogenic sources through the troposphere and ocean. Imperial College London, 182 pages.
- Torben Struve, 2016. Deciphering glacial-interglacial Southern Ocean dynamics with deep-sea corals. Imperial College London, 196 pages.

Meetings

- Presentations at Royal Society Meeting 'Quantifying fluxes and processes in trace-metal cycling at ocean boundaries'.

  This meeting was organised by UK GEOTRACES and funding secured from Royal Society and GEOTRACES.

  UK Presentations:

  1. Homoky, W. Discerning the mechanisms and measuring the rates of trace metal release from ocean sediments.
  2. Henderson, G. U-series rate-meters for ocean processes
  3. Little, S. Isotope tracing of boundary fluxes
  4. Jickells, T. Atmospheric transport to the oceans of trace elements and micronutrients.
  5. Van der Flierdt, T. Radiogenic isotope tracers of present and past ocean circulation

- Presentations at Goldschmidt 2015
  - Bridgestock, L., van de Flierdt, T., Rehkämper, M. Baker, A. Achterberg, E. Rijkenberg, M. Lohan, M. de Baar, H. Detection of Pb from natural sources in the Tropical Atlantic
  - Lamblet, M., van de Flierdt, T., Butler, E.C.V., Bowie, S.R., Rintoul, S.R., Watson, R.J., Remenyi, T., Lannuzel, D. The Nd isotopic composition and concentrations in the Australian sector of the Southern Ocean-insights from GIPY6 GEOTRACES cruise along 140oE.
  - Little, S., Vance, D. & Milne, A. Particulate metal stable isotopes in the South Atlantic.

- Ganeshram, R.S. & Tuerena, R.E. Nitrogen cycling in the Atlantic: Insights from Nitrate δ15NNO3 & δ18ONO3 measurements across the UK-GEOTRACES 40oS transect
- Henderson, G., Deng, F., Hsieh, Y-T. & Placheral, Y. Quantifying oceanic trace elments with U-Series isotopes
- Homoky, W.B., Conway, T.M., John, S., Heish, Y.T., Woodward, E.M.S., Hendseron, G.M. & Mills, R.A. The iron isotope signature of shallow pore waters spanning the depth of the South Atlantic Ocean.
- Lohan, M.C., Milne, A., Schlosser, C., Achterberg, E., Chance, R., Baker, A. Particulate iron, an important source of dissolved Fe.
- Murphy, K., Rehkämper, M. van de Flierdt, T. Abraham, K. Barling, J., Halliday, A.N., Hein, J. Nielsen, S. & Reinhard C.T. Cadmium isotope composition of Cenozoic seawater from ferromanganese crusts.
- Stichel, T., Kretschmer, S. Lambelet, M. van de Flierdt, T., Rutgers van der Loeff, M., Rijkenberg, M.J.A. Gerringa, L.J. & deBaar H.J.W. The interplay between particulate and dissolved neodymium in the Western North Atlantic

- Presentations at Ocean Science 2016
  - Annett, A., Birchill, A., Lakr, J.K., Homoky, W.B., Lohan, M.C., Statham, P.J. & Thomas, A. Using radium isotopic fingerprinting to quantify iron release and distribution from different Celtic Sea shelf sediment types.
  - Birchill, A., Milne, A., Ussher, S., Annett, A., Giebert, W., Statham, P.J. The Celtic Sea Shelf system acts as persistent source of iron to the North Atlantic.
  - Daniels, C., Lohan, M.C, Poulton, A. & Moore, C.M.M. Iron uptake in a shelf sea: seasonality and stoichiometry.
  - Klar, J., Homoky, W.B., Chever, F., Lichtschlag, A., Graves, C.A., Annett, A. & Statham, P.J. Seasonal variability in sediment porewater Fe and potential for water column release in the Celtic Sea.
  - Lohan, M.C. Birchill, A., Milne, A., Ussher, S. & Worsfold, P.W. Seasonal cycling of dissolved and colloidal iron in the Celtic Sea.
  - Mahaffey, C., Reynolds, Davis, C. & Lohan, M.C. Nutrient and trace metal controls on alkaline phosphatase in the Subtropical Ocean: Insights from bioassay and gene expression
  - Milne, A., Palmer, M. & Lohan, M.C. Key sources and distributions patterns of particulate material in the S. Atlantic data from UK GEOTRACES.
  - Plancherel, Y., Henderson, G.M., Deng, F., Khatiwala, S. and Hsieh, Y.-T. Evaluating the ability of the Thorium-232 and Thorium-2310 isotopic couple to quantify lithogenic fluxes to the Ocean.
  - Sander, S.G., Buck, K.N., Lohan, M.C. Turner, D.R. & Clegg, S.L. Metal speciation analysis and modelling-How do we best estimate the bioavailable form.
  - Stichel, T., Lough, A.J.M., Homoky, W.B., Connelly, D., Klar, J.K & Conway, T.M. Iron isotopes in bottom waters from the Bransfield Strait: Implications for deep water Fe supply.

    - Tagliabue, A., Boyd, P., Rijkenberg, M., Williams, R. How do local and remote processes affect the distribution of iron in the Atlantic Ocean?
    - Ye, Y., Tagliabue, A., Volker, C. Prognostic modelling of iron-binding ligands in a global biogeochemical models and its effect on iron distribution.
    - Woodward, E.M.S. Seasonal trends of nutrients over the 18 month Shelf Sea Biogeochemistry Programme
    - Tutorial: Tagliabue, A. What controls the distribution of dissolved iron in the ocean?

- Presentations at EGU 2016
    - Carney, L., Plancherel, Y., Khatiwala, S. and Henderson G.M. (17th-22nd April, 2016). A model-based evaluation of sedimentary reconstructions of 10Be production rates.
- Maeve Lohan attended a Standards and Intercalibration meeting in April 2016
- Alessandro Tagliabue attended a SCOR WG 145 'Chemical Speciation in Modelling seawater to meet 21st Century needs (MARCHEMSPEC)'

Outreach activities

- Will Homoky was a NERC 'Anniversary Ambassador' on board the *RSS Discovery* outreach event in London (Oct 2015) and spoke to members of public about GEOTRACES research
- Public Evening lecture series 'Isotopes in the Earth Sciences', Cardiff University (February 2016). T. van de Flierdt delivered a presentation on 'Ocean Currents, Ice Sheets and Climate: A story unravelled by radiogenic isotopes'.

Other activities (e.g. acquisition of new sampling systems)

- New Polar Ship (due in 2019) and will include a trace metal clean sampling laboratory, conducting Kevlar winch and trace metal clean CTD.
- Myriam Lambelet won the postdoctoral medal from the Geochemistry Group of the Geological Society for her paper on 'Neodymium isotopic composition and concentration in the western North Atlantic Ocean: Results from the GEOTRACES GA02 section'. She delivered a keynote talk on the paper at the annual Geochemistry Group Research in Progress meeting (Leeds, March 2016).

National and International service

- The UK continues to host the GEOTRACES Data Assembly Centre at the British Oceanographic Data Centre in National Oceanography Centre Southampton.
- The UK is represented on the International GEOTRACES SSC and on the International Standards and Intercalibration Committee by Maeve Lohan.
- Alessandro Tagliabue is the co-chair of the Data Management Committee.

Submitted by Maeve Lohan (M.Lohan@soton.ac.uk).

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN THE UNITED STATES

June 1st, 2015 to April 30th, 2016

Principal activities of the U.S. GEOTRACES program include:

1) Preparing manuscripts manuscripts from Pacific section (GP16),
2) Analyzing samples from the Arctic (GN01), and
3) Preparing to host a synthesis workshop.

Activities

North Atlantic Papers from Atlantic section GA03 continue to be published (see Publications below). New data sets have been submitted for IDP2017.

Eastern Tropical Pacific Approximately 65 investigators (scientists, post docs and students) participated in a data workshop for the Eastern Tropical South Pacific section (GP16) covered by U.S. GEOTRACES. The workshop was held 8-13 November 2015 at the University of Southern California – Wrigley Institute for Environmental Studies facility on Catalina Island. The workshop allowed investigators the opportunity to scrutinize each data set, comparing similarities and dissimilarities among the various tracers, with a view toward identifying information provided by each tracer about the principal processes (e.g., dust deposition) and environmental conditions (e.g., oxygen minimum zone, hydrothermal plume) that regulate the distributions of trace elements and their isotopes along the section. A more complete report on the workshop is included as an Appendix 2 to this report.

A number of oral and poster presentations of GP16 data were made at the 2016 Ocean Sciences meeting in New Orleans (21 – 26 February). Presentations from GP16 were distributed throughout all of the GEOTRACES-related sessions at the meeting, rather than in a single session devoted to the GP16 section.

Arctic Ocean US investigators participated in an international GEOTRACES study of the Arctic Ocean during the summer of 2015, sailing aboard the U.S. Coast Guard Cutter Healy (HLY1502, 9 August to 12 October, sailing out of and returning to Dutch Harbor, Alaska; Chief Scientist: David Kadko, Co-Chief Scientist: Bill Landing, Logistics Coordinator: Greg Cutter). The expedition included a northbound track through the Makarov Basin, reaching the North Pole on 7 September, followed by a southbound track through the Canada Basin (Figure 6).

Relatively thin ice allowed investigators to cover the entire cruise track, which was by no means certain before the ship sailed. Indeed, this expedition was the first occasion that a U.S. surface ship has reached the North Pole without an escort by another icebreaker, an indication of the changes in the Arctic ice as a consequence of recent global warming.

While on station at the North Pole the U.S. team was visited by the Polarstern, carrying the German GEOTRACES program from the opposite side of the Arctic Ocean under the leadership of Michiel Rutgers van der Loeff of the Alfred Wegener Institute in Bremerhaven.

GN01 was carried out in partnership with the CLIVAR Repeat Hydrography program under the leadership of Jim Swift of the Scripps Institution of Oceanography. By sharing their

combined hydrographic data, sampling was carried out at a much greater spatial resolution than would have been possible if GEOTRACES had completed the expedition by itself. The expertise of the Repeat Hydrography team will be invaluable in providing a hydrographic framework to interpret the GEOTRACES trace element and isotope results.

Sampling of sea ice was also carried out on GN01. However, due to the relatively fragile ice conditions and related concerns about the safety of investigators working on the ice, only six of the ten planned ice stations were completed.

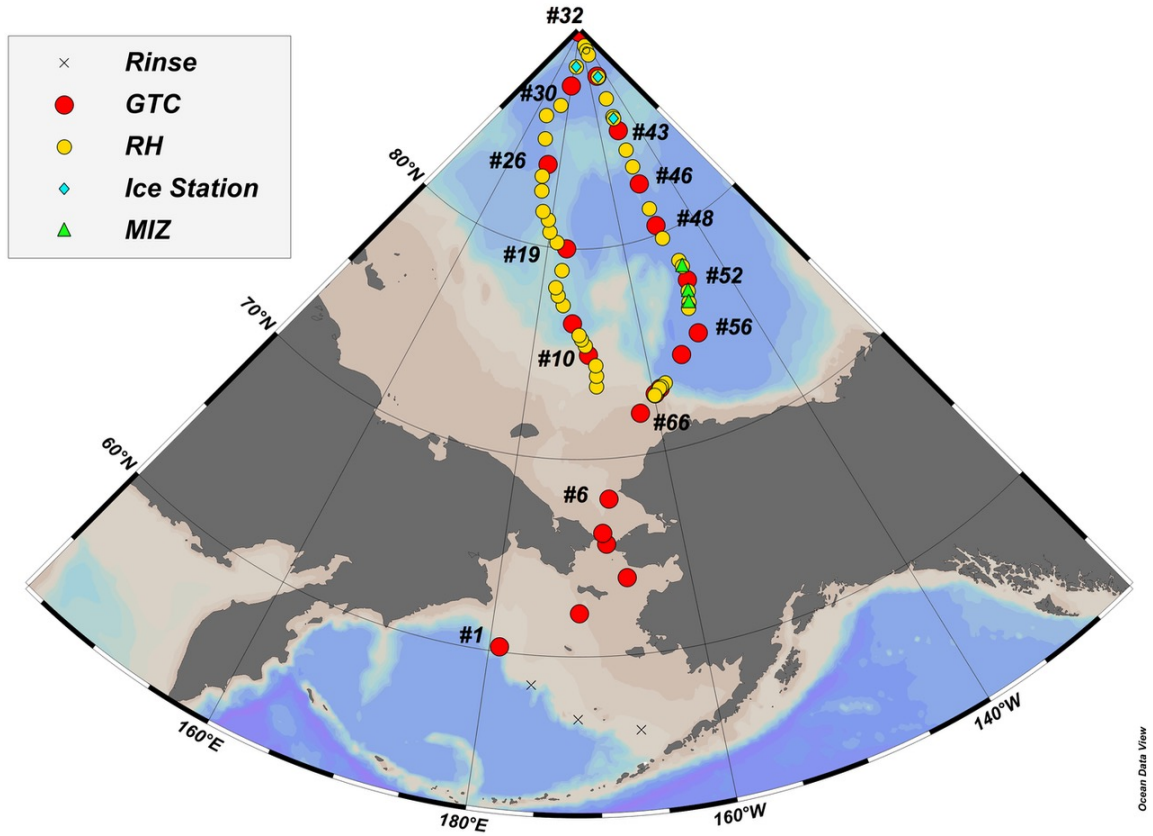

Figure 6. US GEOTRACES cruise track along GN01 (Healy 1502), heading north on the western, Makarov Basin leg, returning south along the eastern, Canada Basin leg. The legend indicates the various types of stations occupied: GTC refers to a full-depth GEOTRACES station; RH indicates a full depth Repeat Hydrography station, which involved a single hydrographic cast to sample the full water column for selected hydrographic parameters and circulation tracers; MIZ refers to stations in the marginal ice zone where sampling of the upper water column was conducted, and Ice Station indicates locations where sea ice and melt pond water were collected. Map compliments of Mariko Hatta, University of Hawaii.

<u>*Pacific Meridional Section*</u> The US GEOTRACES SSC has designated GP15 to be the next section to be carried out by the U.S. program, conditional on funding. A team led by Greg Cutter (Chief Scientist) as well as Phoebe Lam and Karen Casciotti (co-Chief Scientists) plans to submit a proposal to the US NSF Chemical Oceanography program for its 15 August 2016 proposal deadline to secure ship time and cover major logistics costs (e.g., operation of the trace metal clean sampling system) of the expedition. If the plan is approved and funded, then individual U.S. investigators will submit proposals for research on specific TEIs and other tracers for the NSF proposal deadline on 15 February 2017. Cruise dates have been requested to sail southbound from Alaska to Tahiti in period July – September 2018.

Although funding for GP15 is by no means guaranteed, the U.S. GEOTRACES community plans to meet in early October to refine the goals laid out in the U.S. GEOTRACES Pacific Plan (2008) and set scientific priorities for the section. The workshop will also allow individual investigators to coordinate their planned research for GP16 well in advance of the 15 February 2017 proposal deadline.

Town Hall Working together with SCOR and the GEOTRACES IPO, US GEOTRACES co-hosted a town hall at the 2016 Ocean Sciences meeting to inform the oceanographic community about plans for future data products and upcoming cruises, while also seeking feedback from the community to improve the next data product, scheduled for release in 2017.

New Funding

- A proposal to continue funding for the U.S. GEOTRACES project office at the Lamont-Doherty Earth Observatory was submitted to the US NSF in February 2015. The proposal was selected for funding and will cover project office expenses for three years. Funding is provided jointly by the Chemical Oceanography program and the Arctic Natural Sciences program at NSF.

Presentation of results

- A large number of presentations based on results from the GP16 section were made at the 2016 Ocean Sciences meeting dates New Orleans, USA, as described above.

U.S. GEOTRACES Meetings

- As described above, investigators involved in GP16 held a data workshop 8-13 November 2015.

Outreach Activities

Significant effort was invested in outreach for the US Arctic GEOTRACES program under the leadership of Bill Landing, Florida State University, co-chief scientist of the expedition together with chief scientist David Kadko, Florida International University. Several ongoing cruise "blogs" were maintained as well as significant representation at home university web sites and the ship's shore-based web site.

1. Bill Schmoker, the on-board PolarTREC science teacher, posted over 65 blogs (with descriptive text and photos) to the PolarTREC web site: www.polartrec.com/expeditions/us-arctic-geotraces/journals
2. Dr. Peter Morton's blog: http://SeaPeteRun.tumblr.com;
3. Dr. Katlin Bowman maintained a personal blog: http://hginthesea.wordpress.com; she was also invited to write for the Huffington Post: www.huffingtonpost.com/katlin-bowman/
4. Alison Agather's blog: http://alisonsarcticadventure.wordpress.com
5. Laura Whitmore's blog: http://healy-polar-usm.tumblr.com
6. Dr. Jim Swift: http://ushydro.ucsd.edu/outreach
7. Andrew Margolin's blog: http://arctic-andy-usaos2015.blogspot.com;

http://instagram.com/arctic_andy/; http://twitter.com/arctic_andy; http://rsmas.miami.edu/blog/

8. Dr. Tim Kenna's blog: TRACES of Change in the Arctic: http://blogs.ei.columbia.edu/tag/traces-of-change-in-the-arctic/
9. Dr. Dave Kadko, Florida International University news release: http://news.fiu.edu/2015/08/fiu-professor-to-lead-historic-arctic-research-expedition
10. Dr. Bill Landing's home web site: http://www.eoas.fsu.edu/
11. Dr. Ana Aguilar-Islas, University of Alaska Fairbanks news release: https://web.sfos.uaf.edu/wordpress/news/?p=1953
12. Healy cruise track: http://icefloe.net/uscgc-healy-track-map
13. Daily pictures from the aloft conning tower: http://icefloe.net/Aloftcon_Photos/index.php?album=2015

In addition, there were other outreach efforts:

14. Kawerak Conference: As part of the US Arctic GEOTRACES outreach effort, Dave Kadko, Bill Landing and Ana Aguilar-Islas put together a package for presentation at the Kawerak Conference (31 May – 4 June, 2015; Nome, Alaska USA). This was a meeting for rural Alaska natives and other rural Alaska residents. Ana Aguilar-Islas represented GEOTRACES at the meeting where she made a presentation for GEOTRACES, passed out a brochure, and was available for interviews and discussions with attendees. The local radio station did a story that was later picked up by Alaska Dispatch News. http://www.knom.org/wp/blog/2015/06/05/over-50-arctic-researchers-on-coast-guard-cutter-healy-preparing-north-pole-voyage/ http://www.adn.com/article/20150609/arctic-researchers-prepare-voyage-north-pole-aboard-coast-guards-healy

15. US GEOTRACES participated in a novel outreach project designed and coordinated by Dave Forcucci (US Coast Guard Marine Science Coordinator) to involve students and the public with an Arctic research cruise on Healy. GEOTRACES was a perfect match for the inaugural kick off of "Float your Boat". One thousand 8-inch long cedar boats were commissioned (funded by GEOTRACES with 1,300 boats being the final number) from the Center for Wooden Boats (CWB.org) in Seattle, Washington, USA and distributed to school groups, scout troops, and science open-house events around the country. Students personalized their boats with bright colors and after returning to Seattle the boats were branded with floatboat.org and packed into the hold of Healy for journey to the North Pole. During the Geotraces cruise, four groups of boats were deployed on ice floes between 87.5° N and 80° N on the 150° W meridian, each with a small satellite buoy that was deployed by the University of Washington Applied Physics Lab to study ice movement. The iridium satellite-linked buoys provide an opportunistic chance for high-resolution, real-time tracking of the boats for at least the short term (1 year or so). After drifting with the Arctic ice, the boats will eventually be free of its grasp and float to a distant shore to be discovered and reported. This was documented by our on-board PolarTREC teacher, Bill Schmoker, on his PolarTREC web site blog: https://www.polartrec.com/expeditions/us-arctic-geotraces/journals/2015-09-16. The "Float Your Boat" wooden boat project: http://www.floatboat.org/; and https://www.facebook.com/explorethearctic

16. The U.S. Coast Guard offered an oceanography course to its crew aboard the Healy for college credit. US GEOTRACES investigators Dave Kadko, Jim Swift, Chris Measures, Phoebe Lam, Bill Landing, Susan Becker and Greg Cutter contributed lectures to this program. Two students, Alyson Agather and Lauren Kipp also contributed lectures.

17. Science lectures were presented every Wednesday night during the expedition, geared to the Coast Guard crew. Numerous scientists and students contributed to this activity.

Outreach Activities after completion of the Arctic Expedition:

18. Katlin Bowman (University of California Santa Cruz) participated in a community event at Filson's San Francisco store where she discussed working in the Arctic Ocean. Filson is an outdoor clothing brand that highlights the stories of men and women that work outdoors. Her cruise photos were on display during the event and she gave an informal presentation about working in the Arctic and why GEOTRACES is studying the chemistry of the global ocean.

19. Jessica Fitzsimmons (Texas A&M University) prepared four scripts on Arctic Ocean climate change and oceanography for a monthly series of On the Ocean National Public Radio show, produced by Texas A&M Oceanography and radio station KAMU-FM: http://abcmgr.tamu.edu/ontheocean/

20. Both prior to and following the Arctic expedition Mariko Hatta (University of Hawaii) presented talks at the Mid-Pacific Institute (July and December 2015). She provided a pre-cruise lecture to ~150 students (6-10 years old) at Mid-Pacific Institute in order to introduce the GEOTRACES projects as well as the nation-wide project "Float Your Boat." This was followed up by a joint talk between Hatta and Chris Measures (University of Hawaii) showing results and interesting features of the cruise during a December, 2015 presentation. During the cruise, Hatta and Measures sent weekly emails with limited photographs to the teachers at the institute to update real-time cruse projects, life, and wild animal information. Their lectures aboard the Healy are mentioned above.

21. In January 2016 Hatta and Measures made a similar presentation to approximately 100 students, 15 – 18 years old, at the Honolulu Waldorf School.

22. During their institutional (SOEST) open house, 23-24 October 2015, shortly following the cruise, Hatta and Measures presented a 15 min movie made from the photo/movie clips during the cruise to share with students (6-15 years old) our latest knowledge and the highlights of the projects in the Arctic Ocean.

23. Greg Cutter (Old Dominion University, ODU), who was responsible for research logistics aboard the Healy, made several presentations following the expedition. In October 2015 he gave a presentation to the Society of Naval Architects and Marine Engineers, Hampton Roads Section, entitled "US GEOTRACES Expedition to the North Pole." In February he presented "The Changing Arctic Ocean" at the ODU February Science Pub Nights, Wasserhund Brewery, Virginia Beach, Virginia USA. In April 2016 he presented "Arctic Ocean Adventures – A two month expedition to

the North Pole and back" to the Hampton Yacht Club membership, Hampton Virginia USA.

Publications (GEOTRACES, GEOTRACES Compliant and GEOTRACES-related)

During the past year US GEOTRACES investigators published a total of 21 peer-reviewed papers.

- Charette, M.A., Morris, P.J., Henderson, P.B., Moore, W.S., 2015. Radium isotope distributions during the US GEOTRACES North Atlantic cruises. Marine Chemistry, 177, Part 1, 184-195.
- Conway, T.M., John, S.G., Lacan, F., in press. Intercomparison of dissolved iron isotope profiles from reoccupation of three GEOTRACES stations in the Atlantic Ocean. Marine Chemistry.
- Fitzsimmons, J.N., Hayes, C.T., Al-Subiai, S.N., Zhang, R., Morton, P.L., Weisend, R.E., Ascani, F., Boyle, E.A., 2015. Daily to decadal variability of size-fractionated iron and iron-binding ligands at the Hawaii Ocean Time-series Station ALOHA. Geochimica et Cosmochimica Acta, 171, 303-324.
- Haskell II, W.Z., Kadko, D., Hammond, D.E., Knapp, A.N., Prokopenko, M.G., Berelson, W.M., Capone, D.G., 2015. Upwelling velocity and eddy diffusivity from 7Be measurements used to compare vertical nutrient flux to export POC flux in the Eastern Tropical South Pacific. Marine Chemistry, 168, 140-150.
- Hayes, C.T., Fitzsimmons, J.N., Boyle, E.A., McGee, D., Anderson, R.F., Weisend, R., Morton, P.L., 2015. Thorium isotopes tracing the iron cycle at the Hawaii Ocean Time-series Station ALOHA. Geochimica et Cosmochimica Acta, 169, 1-16.
- Kadko, D., Landing, W.M., Shelley, R.U., 2015. A novel tracer technique to quantify the atmospheric flux of trace elements to remote ocean regions. Journal of Geophysical Research: Oceans, 120, 848-858.
- Kipp, L.E., Charette, M.A., Hammond, D.E., Moore, W.S., 2015. Hydrothermal vents: A previously unrecognized source of actinium-227 to the deep ocean. Marine Chemistry, 177, 583-590.
- Lee, J.-M., Boyle, E.A., Gamo, T., Obata, H., Norisuye, K., Echegoyen, Y., 2015. Impact of anthropogenic Pb and ocean circulation on the recent distribution of Pb isotopes in the Indian Ocean. Geochimica et Cosmochimica Acta, 170, 126-144.
- Lerner, P., Marchal, O., Lam, P.J., Anderson, R.F., Buesseler, K., Charette, M.A., Edwards, R.L., Hayes, C.T., Huang, K.-F., Lu, Y., Robinson, L.F., Solow, A., 2016. Testing models of thorium and particle cycling in the ocean using data from station GT11-22 of the U.S. GEOTRACES North Atlantic section. Deep Sea Research Part I: Oceanographic Research Papers, 113, 57-79.
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Submitted by Bob Anderson (boba@ldeo.columbia.edu).

APPENDIX 1 - CANADA GEOTRACES

PROJECT REPORT:

"A BIOGEOCHEMICAL AND TRACER STUDY OF A RAPIDLY CHANGING ARCTIC OCEAN"

1. Research Project

Accomplishments

The main accomplishment during year 3 of our project has been the successful completion of two cruises covering stations from the southern Labrador Sea to the western Beaufort Sea. This was achieved despite a 2-week hiatus in our research program that resulted from the diversion of our ice breaker to open shipping lanes through the ice in eastern Hudson Bay. A cruise synopsis is given below.

1.1 Cruise synopsis

Our 2015 field program consisted of 2 separate legs. The first leg (**Fig. 1**) covered the Labrador Sea, Baffin Bay and the eastern and central Canadian Arctic Archipelago (CAA). The second leg crossed Canada Basin and covered the western CAA (**Fig. 2**). Note that the first leg of the Arctic GEOTRACES cruise corresponds to Leg2 of the CCGS Amundsen summer expedition, while our second leg corresponds to Leg 3b for the Amundsen.

2015 CCGS Amundsen expedition LEG 2 GEOTRACES/ARCTICNET

July 10 – August 20, 2015

Quebec City – Kugluktuk

Chief Scientists: Roger Francois, Philippe Tortell

This leg was shared between the Canadian Arctic GEOTRACES project and ArcticNet. As part of the international GEOTRACES program, the principal mandate of our project was to study the input, removal and cycling of trace elements and isotopes in the water column, and to use this information to document, monitor, and predict the evolution of physical and biogeochemical processes in the Arctic Ocean. Our project was also complemented by very extensive biological and trace gas measurements, which not only meet the broader requirements of the CCAR program but also are of direct relevance to the long-term goals of ArcticNet, facilitating coordination of sampling between the two programs.

Sampling operations for GEOTRACES during this leg consisted of:

- seawater sampling with ArcticNet's 24 x 12 L rosette – CTD (Niskin-type bottles)
- seawater sampling under trace metal clean conditions with a 12 x 12 L rosette – CTD (Go-Flo bottles)
- particle sampling with 6 McLane large volume in-situ pumps
- aerosol sampling with a volumetric flow controlled high volume sampler
- underway trace gas analysis with a Membrane Inlet Mass Spectrometer (MIMS) and a Gas Chromatograph (GC)

Additional GEOTRACES activities included:

- incubations for productivity measurements with different isotopic tracers (^{13}C, ^{15}N, ^{32}Si, ^{18}O, 2h ^{14}C and FRRF) complementing incubations conducted by ArcticNet (24h ^{14}C) and productivity estimates from water column measurements (O_2/Ar, triple O isotopes, ^{234}Th deficit)
- Ship-board manipulation experiments to examine the impacts of ocean acidification and enhanced mixed layer stratification on phytoplankton productivity and physiological ecology.
- river sampling to assess continental input into the CAA (15 rivers draining into the Canadian Arctic Archipelago; **Fig. 1**)

2015 CCGS Amundsen Expedition LEG 3b GEOTRACES/ARCTICNET

September 4 – October 1, 2015

Sachs Harbour – Resolute

Chief Scientists: Roger Francois, Kristin Orians

The second leg was also shared between the Canadian Arctic GEOTRACES project and ArcticNet. As during our first leg, the main GEOTRACES sampling operations consisted of seawater sampling with ArcticNet's 24 x 12 L rosette – CTD, GEOTRACES' trace metal clean 12 x 12 L rosette – CTD, and particle sampling with 6 McLane large volume in-situ pumps. The biogeochemical study conducted during this leg was complemented by a 4-day process study during which mesoscale mixing was measured by conducting a Moving Vessel Profiler and CTD mesoscale and mixing survey in Wellington, Maury and Perry Channels (**Fig. 2**). The goal of this work was to assess the impact of physical processes on the supply of micronutrients to surface waters. Toward the same goal, a glider was deployed in Canada Basin during Leg 3a (August 21 – September 3), which preceded leg 3b. The glider data provided high resolution 2d observations of water column hydrography and micro-structure that will provide new insight into mixing and turbulence across the Arctic continental shelf.

1.2 Cruise Tracks and discrete sampling summary

1.2.1 2015 CCGS Amundsen Expedition LEG 2

The initial plan for Leg 2 was to occupy 15 stations (2 stations in the Labrador Sea, 4 in Baffin Bay, and 9 in the Canadian Arctic Archipelago). Additional stations were to be occupied for ArcticNet on a section between Greenland and Devon Island, and in Kane Basin, Kennedy Channel and Petermann Fjord. Time was also allocated for additional stations in Queen Maud Gulf as part of The W. Garfield Weston Foundation - Parks Canada - ArcticNet collaborative project.

The work in the Labrador Sea was completed on schedule, but on July 19th the ship was unexpectedly diverted to Hudson Bay for ice-breaking duties. The resulting 2-week hiatus (from July 19th to August 3rd) demanded a dramatic re-organization of the cruise plan. To the benefit of the GEOTRACES program, ArcticNet cancelled nearly all its stations and the remaining science plan was reduced to occupying 3 of the 4 GEOTRACES Baffin Bay stations and 7 of the 9 archipelago (CAA) stations (Fig. 1). GEOTRACES sampling strategy

in the CAA was also adjusted to existing ice conditions and to optimize scientific return within the remaining time. By the end of leg 2, GEOTRACES only lost 3 of its 15 stations (one station in eastern Baffin Bay and 2 stations in the CAA). The latter two of this skipped stations were sampled during the following leg 3B, so that our program only lost one station, which was deemed less important for the program (the CAA through flow into Baffin Bay, which was our main target, occupies the eastern side of the bay). Overall, the change in ship-operations had a large negative impact on proposed ArcticNet work, but almost no detrimental effect on the GEOTRACES program. We are extremely grateful to our collaborators at ArcticNet who went out of their way to ensure that our field campaign was successful. The scheduling and logistical issues we encountered highlight the larger problems associated with oceanographic ship-time allocations in Canada. Our situation garnered national and international attention, and was the subject of several news pieces on the CBC and Globe and Mail. Tthree of the GEOTRACES PIs wrote an Op-Ed on this topic:

http://www.theglobeandmail.com/globe-debate/canadas-ocean-science-capacity-is-limited-with-resource-constraints/article25729123/.

By the end of leg 2, the GEOTRACES project completed:

- 67 hydrocasts with ArcticNet's CTD-rosette
- 31 hydrocasts with GEOTRACES' trace metal clean CTD- rosette
- 24 casts with GEOTRACES' six large volume pumps
- 22 deployments of XCTDs
- 1 GEOTRACES trace metal clean deck pump deployment (to sample clean water for large volume incubation experiments).

This resulted in 1,545 seawater or marine particle samples for multi-element and isotopic analysis (Table 1), which will amount to >6,000 individual measurements.

We also conducted 278 incubations for carbon fixation and nutrient uptake measurements (88 two-hour ^{14}C incubations/FRRF, 60 ^{13}C and ^{15}N incubations, 60 ^{32}Si incubations, 60 ^{18}O incubations, 10 ^{55}Fe incubations), which were complemented by ArcticNet's 156 twelve-hour ^{14}C incubations.

Two CO_2 / light manipulation experiments and sampling at 15 Arctic rivers draining in the CAA (**Fig. 1**) were also successfully completed.

1.2.2 2015 CCGS Amundsen Expedition LEG 3b

The CCGS *Amundsen* left Sachs Harbour on September 4th for our first station (CB1) in McClure Strait (Fig. 2) before crossing Canada Basin to occupy our next three stations (CB2 - CB4). The latter station was the location chosen for a cross-over station for inter-calibration with the US Arctic GEOTRACES program. Two stations were occupied in the archipelago (CAA8 and CAA9) to make up for the two stations lost during Leg 2.

During leg 3b, the GEOTRACES project completed:

- 22 hydrocasts with ArcticNet's CTD-rosette
- 21 hydrocasts with GEOTRACES' trace metal clean CTD- rosette
- 12 casts with GEOTRACES' six large volume pumps

This resulted in 709 seawater or marine particle samples for multi-element and isotopic analysis.

1.3 Parameters measured or sampled in the water column

1.3.1 2015 CCGS Amundsen Expedition LEG 2

Seventy-six chemical and biological parameters (**Table 1**) were measured on board or sampled for later analysis for vertical water profiles

In addition, several parameters were continuously measured or sampled along the cruise track:

- Atmospheric Hg concentration (Gaseous Elementary Mercury [GEM], Reactive Gaseous Mercury [RGM] and Particulate Hg [PHg]) with an automated Tekran atmospheric mercury speciation system. Discrete GEM measurements were obtained every 5 minutes. Analysis of PHg and RGM samples occurred after 2-hour collection periods.
- Surface gas measurements were conducted using automated purge and trap gas chromatography (PT-GC; for DMS/P/O), and membrane inlet mass spectrometry (MIMS; for CO2, DO2/Ar, and DMS) from the ship's seawater intake (**Figs. 3 and 4**).
- Photo-physiological measurements (e.g. variable Chla fluorescence, Fv/Fm, and cross sectional absorption area, s) were measured from the ship's seawater intake using an FRRF equipped with a flow-through measurement cuvette (**Fig. 5**).

Using the MIMS DO_2/Ar data, and a steady-state mixed layer O_2 model, we were able to derive quantitative estimates of Net Community Production along the cruise track (**Fig. 6**).

1.3.2 2015 CCGS Amundsen ExpeditionLEG 3b

Fifty-seven chemical and biological parameters (**Table 2**) were measured on board or sampled for later analysis for vertical water profiles

1.4 Cruise participants

The GEOTRACES group on board the CCGS *Amundsen* during LEG 2consisted of:

- 4 Principal Investigators (Francois, Tortell, Cullen, Thomas)
- 2 Research Technicians
- 4 Postdoctoral Fellows
- 9 PhD students
- 3 MSc students
- 1 BSc student

from 7 Canadian universities (University of Victoria, University of British Columbia, University of Manitoba, Trent University, University of Toronto, McGill University, Dalhousie University) and 2 partner foreign institutions (Alfred Wegener Institute, Woods Hole Oceanographic Institution)

The GEOTRACES group on board the CCGS *Amundsen* during LEG 3b consisted of:

- 3 Principal Investigators (Francois, Orians, Klymak)
- 3 Research Technicians
- 9 PhD students

- 3 MSc students
- 1 BSc student

from 8 Canadian universities (University of Victoria, University of British Columbia, University Saskatchewan, University of Manitoba, University of Toronto, University of Ottawa, McGill University, Dalhousie University)

Anticipated research direction for the remaining of the award

Some analyses were performed on board (e.g. underway trace gases, ^{14}C primary productivity measurements, FRRF, incubation experiments) and these data are now being processed for interpretation and publication (e.g. **Fig. 3 – 6**). Indeed, a number of PIs and students have already prepared GEOTRACES-based presentations for the upcoming ArcticNet meeting in Vancouver. Other measurements, particularly the core parameters of the international GEOTRACES program, require extensive sample processing in laboratories, which will be completed during year 4.

We have organized a first PI meeting in Vancouver on December 7, which coincides with the annual ArcticNet meeting. The purpose of this meeting is to take stock of the data and samples in hand, coordinate analysis, and start discussing publication of results (see agenda in the appendix). We have already made plans to set up a linked computer server to more freely exchange core and ancillary data among the different research groups.

Coordination will carry on during year 4 at several levels:

- Collaborations within the PIs of the Canadian GEOTRACES program
- Collaborations at the national level with the Network of Centres of Excellence ArcticNet, with the CCAR project VITALS, and with JOIS and C3O programs of the Department of Fisheries and Ocean.
- Collaborations at the international level with our US, German and French partners to produce a quasi-synoptic database over most of the Arctic Ocean

2. Growth of the research team and management structure

With the successful conclusion of two major oceanographic cruises, our group has become tightly consolidated. Almost all of the PIs had at least one representative at sea, and the field work provided an ideal opportunity to further enhance our collaborative relationships. Indeed, we were extremely happy with the positive working atmosphere maintained on the ship, and the extent to which all group members (from senior PIs to B.Sc. students) worked collectively as a unified team. PIs Tortell, Cullen, Orians and Francois worked closely (in conjunction with PDF Kristina Brown and Technician Maureen Soon) to oversee the field operations. In a number of instances (e.g. during our two week sampling hiatus in Hudson Bay), this group needed to make 'executive decisions' regarding sampling priorities. The success of our field program is a testament to the ability of our group leaders to manage the broader research group and achieve consensus on critical issues (often under difficult conditions).

There has also been a further deepening of our partnership with DFO collaborators, and with the Vancouver Aquarium. We had significant representation from DFO scientists in our GEOTRACES Amundsen cruises, and we also participated in two additional DFO-led sampling programs on the CCGS Wilfrid Laurier and CCGS Louis St. Laurent. The joint GEOTRACES-DFO research will ensure that our results are efficiently translated into DFO-

led modelling activities in support of enhanced monitoring and ecosystem management. We worked closely with the staff at the Vancouver Aquarium in the development of summer camp programs. DFO managers and representatives from the Aquarium will attend our project meeting in December.

3. HQP training

As indicated above, 26 students (19 PhD, 6 MSc, 2 BSc), 2 postdocs, and 5 research staff were responsible for most of the analysis and sampling during the 2015 field season. Additional HQP were also involved in the project, but did not need to participate to field work (e.g. modelers) or could not be accommodated because of berth limitation.

The total number of HQP involved in the project to date is:

57 students (16 BSc, 17 MSc, 24 PhD), 6 postdocs, and 13 research assistants, for a total of 76 HQPs

Students and postdocs have been involved in all important aspects of the research, including the development of research questions and methodologies, data collection and interpretation. They will also play a leading role in the presentation and publication of the results.

4. Collaboration and interaction with federal government researchers and foreign partners

International collaboration is at the core of the GEOTRACES program, and the 2015 Arctic GEOTRACES program is built on the coordination of field work between 3 nations (US, Germany, Canada) to produce a quasi-synoptic database over the entire Arctic Ocean (**Fig. 7**). The overall Canadian transect links the North Atlantic, which was visited in 2014 by the French GEOVIDE program, to the US transect, which entered the Arctic from the North Pacific to cross over the German cruise track at the North Pole. The Canadian contribution will also document the transformation of Pacific waters along their transit through the CAA towards the North Atlantic.

One key aspect of the international GEOTRACES program is inter-calibration of analyses conducted on each individual section. The Canadian Arctic section is being inter-calibrated with the French GEOVIDE section which covered the North Atlantic in 2014, and with the US Arctic GEOTRACES section. For inter-calibration with the French transect, Canadian PIs have collected duplicate samples that will be analyzed by those who conducted similar analysis on the French cruise. For inter-calibration with the US, the plan was to occupy the same station in Canada Basin (Canadian station CB4 or US Station GTC56) at approximately the same time. Bad weather prevented the US group from deploying their trace metal clean rosette when they occupied this station, approximately one week after our own occupation. Therefore, while we will be able to conduct our inter-calibration as planned for the parameters collected with the regular rosette, we will rely on another accepted inter-calibration method for trace metals and isotopes. We have collected duplicate samples at CB4, which we will send to our US colleagues, who have, likewise, collected duplicate samples for us at a nearby station (GTC57; **Fig. 7**). In addition, since they have sampled trace elements and isotopes profiles at two stations that bracket our CB4 station, we will also compare these results using the Carina routine (Lauvset, S. K. and Tanhua, T. (2015), A toolbox for secondary quality control on ocean chemistry and hydrographic data. Limnology and Oceanography: Methods. doi: 10.1002/lom3.10050). We have confirmed that this approach will satisfy GEOTRACES' Standards and Inter-calibration Committee.

Collaboration with DFO partners has been strengthened by the participation of DFO scientists (Ross, Smith, Miller, Williams, Vagles) in the interpretation of the data and/or measurements of the samples collected in our Amundsen Cruises, and by our participation on DFO-led cruises on the CCGS *Laurier* and *Louis St Laurent*. For example, in collaboration with Svein Vagle and Bill William (IOS), we collected hundreds of additional samples for N_2O and CH_4 analysis in the Bering / Chuchki Sea and Canada Basin. These additional samples provide nearly unprecedented coverage of N_2O and CH_4 analysis across a wide swath of the Arctic Ocean continental shelf. They also provide significant 'value-added' measurements to the background DFO-led monitoring programs. An example of our recently obtained results is shown in **Fig. 8**. We have also continued to collaborate with DFO/EC modeller Nadja Steiner, who is working on a new marine Arctic ecosystem model. The results of CO_2 / light incubation experiments will help guide parameterizations of phytoplankton responses to climate perturbations.

5. Data management

Ultimately, our data will be integrated into the international GEOTRACES database. The GEOTRACES International Data Assembly Centre (GDAC) is hosted by the British Oceanographic Data Centre, located in Liverpool, and is jointly funded by the Scientific Committee on Oceanic Research, US National Science Foundation and the UK Natural Environment Research Council. The GDAC compiles data received from core international GEOTRACES cruises, and works closely with the GEOTRACES steering committee and scientists to establish common metadata and format protocols. The metadata for the two Canadian GEOTRACES cruises have already been sent to GDAC. We will send our data following completion of our analysis to the GEOTRACES' Standard and Intercalibration Committee for evaluation before their integration in the database. By the beginning of next year, we will also set up a suitable electronic platform for sharing raw and processed data between PIs to facilitate interaction and synergy between the sub-projects.

6. Communication, promotion and publication of research results

Publications:

It is expected that publications from the Canadian Arctic GEOTRACES project will reach a peak during year 4 and 5 of the project. In the meantime, publication of preliminary results and methods development continue apace. During year 3, the group has published 19 peer-reviewed papers and 37 conference abstracts related to method development associated with our work.

Outreach:

We developed a highly successful program with the Vancouver Aquarium summer camps. PI Tortell worked closely with a number of UBC graduate students who spend several hours per week over the summer working with children (ages 8 - 14). Specifically, we designed a number of interactive, hands-on modules dealing with Ocean Acidification and Remote Sensing, with a particular focus on the Arctic. The modules included field-sampling at the beach next to the Aquarium, wet-chemistry work with pH buffers etc., computer-based analysis of ocean color imagery, and drone-based imaging of the Vancouver coastline. Our

activities were highly successful, and plans are already under way to continue and expand this work for next summer. We also arranged for a live skype-call from the research vessel, with several scientists and Captain of the Amundsen spending about 30 minutes answering questions from children in the Aquarium gallery. The children and camp leaders seemed to be very excited by this opportunity.

7. Reply to reviewers' comments from the previous year's report

Two of the reviewers were fully satisfied with the progress made in year 2. A third reviewer had a few comments and questions (reproduced in *italics*) that are addressed below.

"*As a GEOTRACES program the issue of an intercalibration station is important. According to the planning this station coincides with the GEOVIDE station in the Labrador Sea sampled in 2014. However that station has been moved to a location which is part of the VITALS section. What will be the implications, since intercalibration will now exclusively concern analytical methodologies and not the sampling from different platforms, and by different operators?"*

To address the issue of inter-calibration in the absence of a specific cross-over station, we followed the protocols outlined by the International GEOTRACES Program Office:

Inter-calibration Procedures required for GEOTRACES Cruises without Crossover Stations and recommended for cruises with crossover stations.

1. Cruises without a crossover station are required to sample at least 3 depths in replicate at 2 different stations, at least for all key parameters, and samples from these inter-calibration depths must be distributed to at least one other laboratory for TEI determinations. Replicate sampling is recommended for other parameters as well.

2. The primary analysts for each TEI(s) should arrange for other independent laboratories to conduct the analyses of replicate samples.

3. Examine replicate data taking into account (i) Certified Reference Materials(CRM's) data for the two labs involved (e.g. SAFe and /or GEOTRACES, GoShip protocols for nutrient CRMs) and (ii) the use of isotope double spikes where appropriate.

4. Produce a report on the inter-calibration process stating what the level of agreement is between data, and whether any changes (e.g., recalibration) were required to one or both datasets/methods to bring data into agreement. In this report, please provide all metadata, which should include sample handling details, overall precision and accuracy of results, details about calibration and blanking, and subsequent data processing. Recoveries of CRM's or consensus reference materials (e.g.,SAFe and /or GEOTRACES) appropriate for selected TEIs should also be reported.

"*Primary productivity:*

It is not Clear whether 15N enrichment experiments will also be conducted for NH4+ uptake (in dual labelling mode with 13C). It is important that this be done at all selected PAR depths. If possible, some 15N-N02 uptake experiments would be useful as well."

Incubations with $^{15}NH_4^+$ were conducted at selected PAR depths at all stations during leg 2. $^{15}N\text{-}NO_2^-$ uptake experiments were not part of planned activities (due to time/berth constraints).

"*Measurement of NH4+ and also N02- profiles seem crucial to me. In the report (Productivity Group notes, page 5) it seems uncertain that these will be measured on board (NO_2^- is not mentioned at all).*"

NH_4^+ and NO_2^- concentrations were measured at all of the main hydrographic stations during leg 2. NH_4^+ was not measured on leg 3b, which had a much smaller biological component.

"*It is mentioned that 234Th analyses (L. Miller) will be integrated in the results of the productivity group. The report does not detail much about the planned approach to achieve this. Will this be done at all PP stations?*"

During Leg 2, samples for ^{234}Th measurements (total, suspended particles, and sinking particles collected with a large volume pump) were collected at the 13 stations were primary productivity was measured. No ^{234}Th or productivity measurements were planned for leg 3b, due to logistical constraints and lack of biological context.

"*Trace metals: The group note on particulate trace metals mentions that sampling will be done from Go-Flo bottles and clean rosette, and I understand that matching of these data with POC will depend on sampling with LVP's . Would it be possible to fit some LVP's with QMA filters (acid pre-cleaned.) which would allow for at least some TM's a direct comparison with POC*."

Particulate trace metals were obtained by filtering 12L of seawater collected with the TM rosette at the same depths as for dissolved metals, which also coincided to the depths POC and particulate Si were collected using the regular rosette. LVPs were used to collect particles for ^{230}Th, ^{231}Pa, Nd isotopes, Cr isotopes, Si isotopes, and elements not prone to contamination.

"In any case LVP's will need to be used to assess 234Th/POC ratios to calculate export production".

A LVP was deployed at the base of the euphotic zone at each station to collect size-fractionated particles for Th-234 and POC analysis

"*Most TM's are measured in the particulate and the dissolved phase. This seems not to be the case for Ba. It would be useful to analyse also dissolved Ba*"

Samples for dissolved Ba analysis were collected at all stations during Leg 2 and Leg 3b.

Tables and Figures

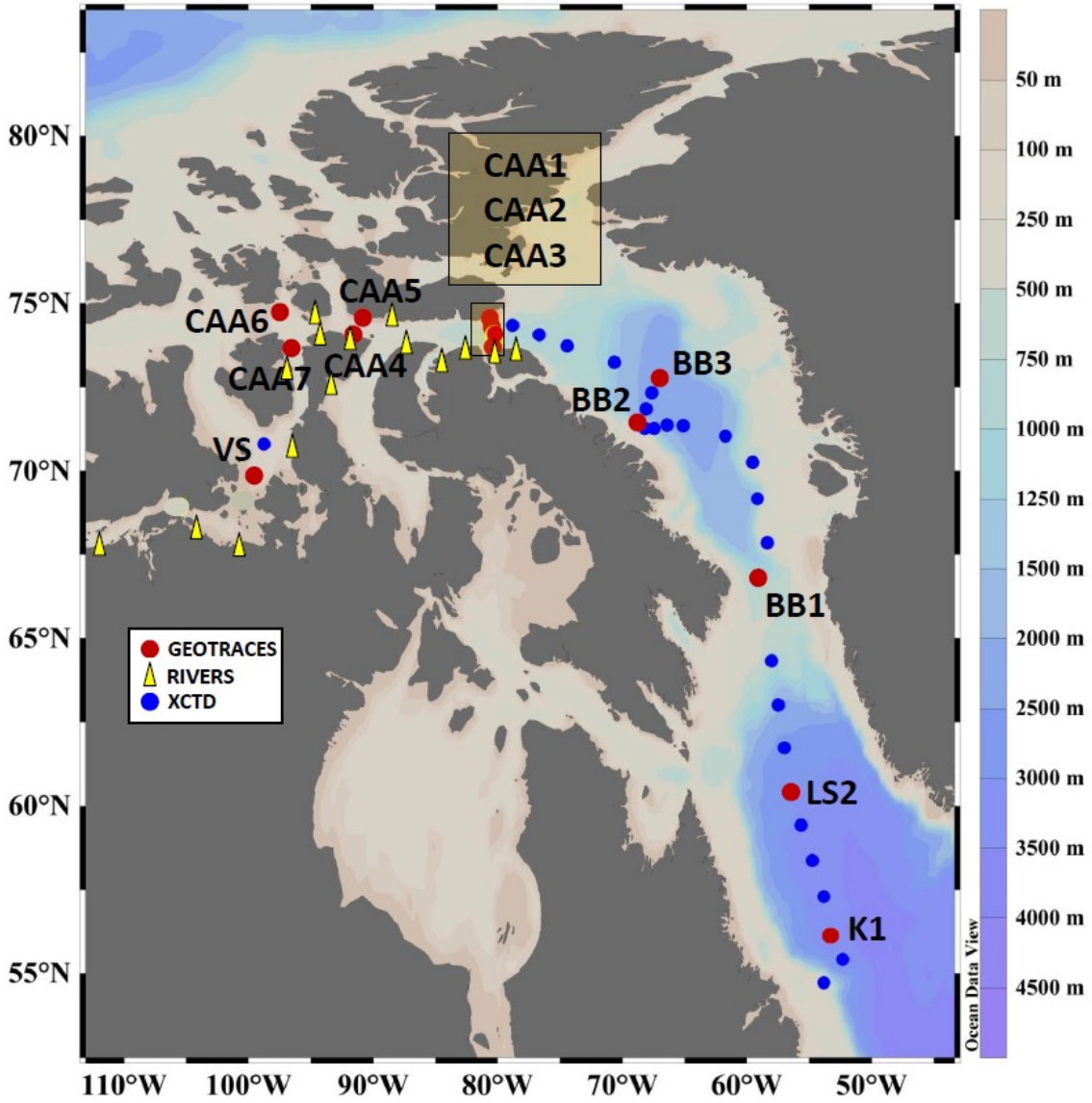

Figure 1. GEOTRACES station locations on the first sampling section (2015 CCGS *Amundsen* Expedition Leg 2)

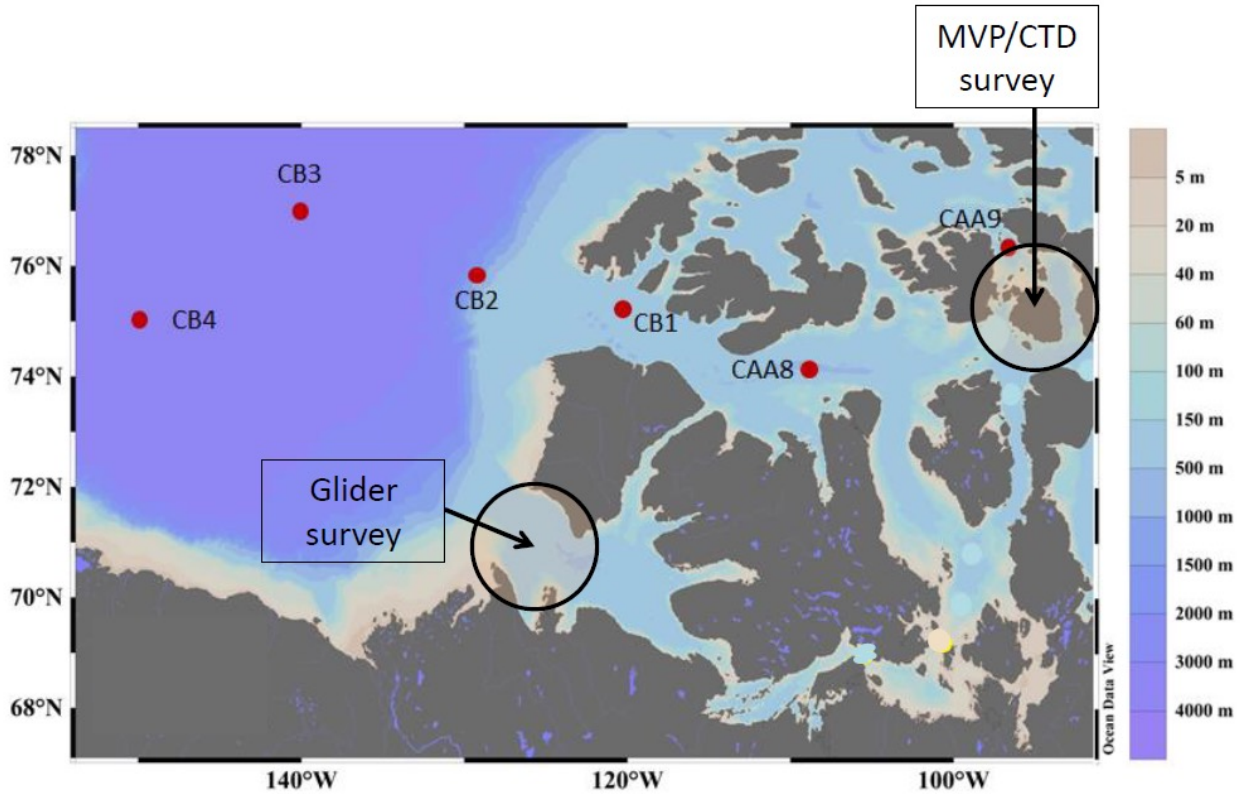

Figure 2. GEOTRACES station locations on the second sampling section (2015 CCGS *Amundsen* ExpeditionLeg 3b). The glider survey was conducted during 2015 CCGS *Amundsen* Expedition Leg 3a (August 21 – September 3).

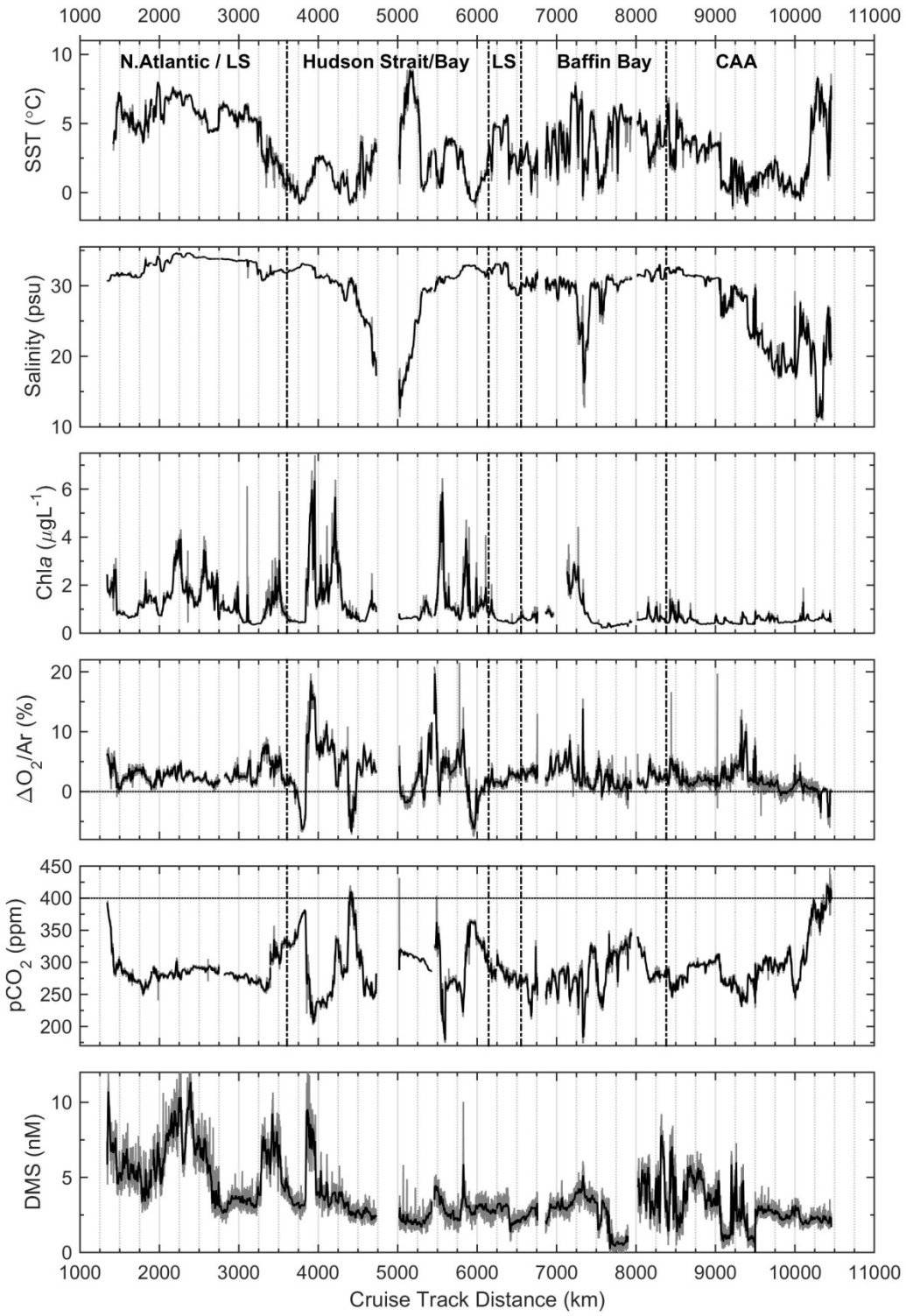

Figure 3. Underway measurements of surface water hydrography (temperature and salinity), phytoplantkon biomass (inferred from Chlorophyll a levels) and bio-active gases (ΔO_2/Ar, pCO_2 and DMS). Gases were measured using ship-board membrane inlet mass spectrometry.

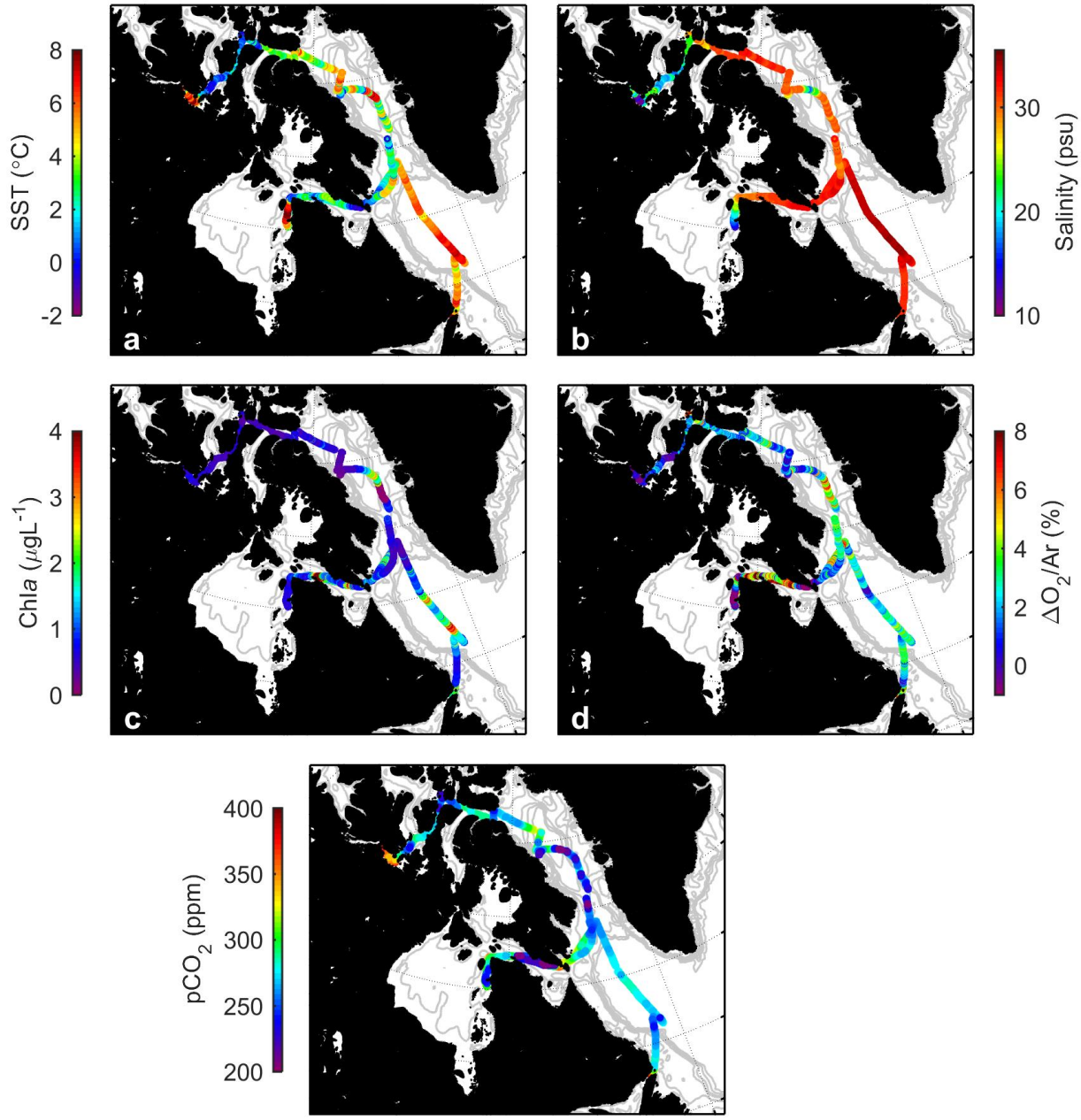

Figure 4. Underway hydrgrography and surface water gases (as in Fig. 3), but showing the spatial distribution along the cruise track. Note the areas of high apparent biological productivity indicated by elevated $\Delta O_2/Ar$ and low surface water pCO_2.

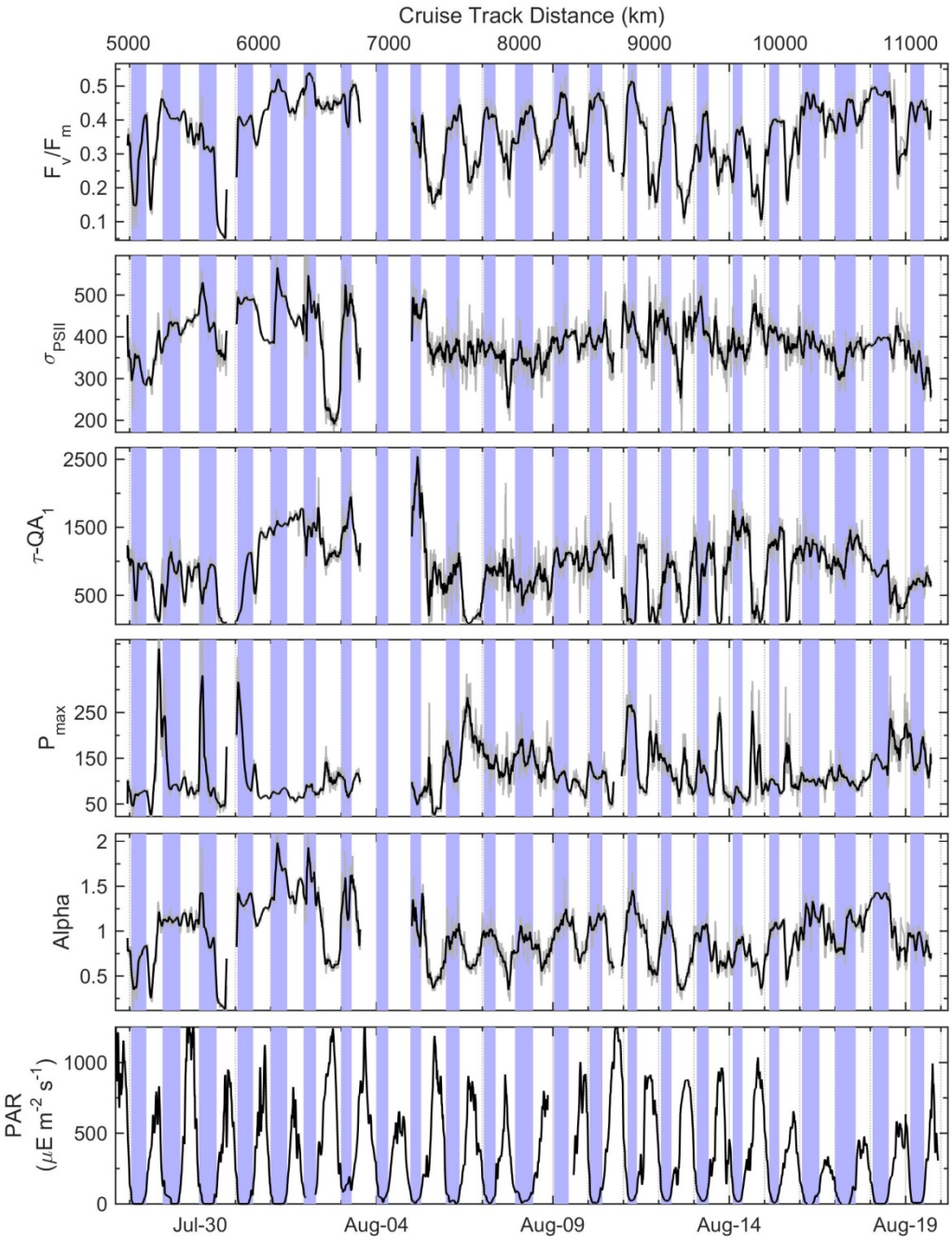

Figure 5. Continuous underway measurements of phytoplankton photo-physiological properties measured using Fast Repetition Rate Fluorometry (FRRF). Bottom panel shows the daily cycles in photosynthetically active radation (PAR), while upper panels show derived values of photosynthetic efficiency (Fv/Fm), cross-sectional area of photosystem-II (σ), time constant for reoxidation of primary electron acceptor Qa (τ) and the maximum and light-dependent slope of photosynthetic electron transport in short-term P vs. I curves (Pmax and α, respectively).

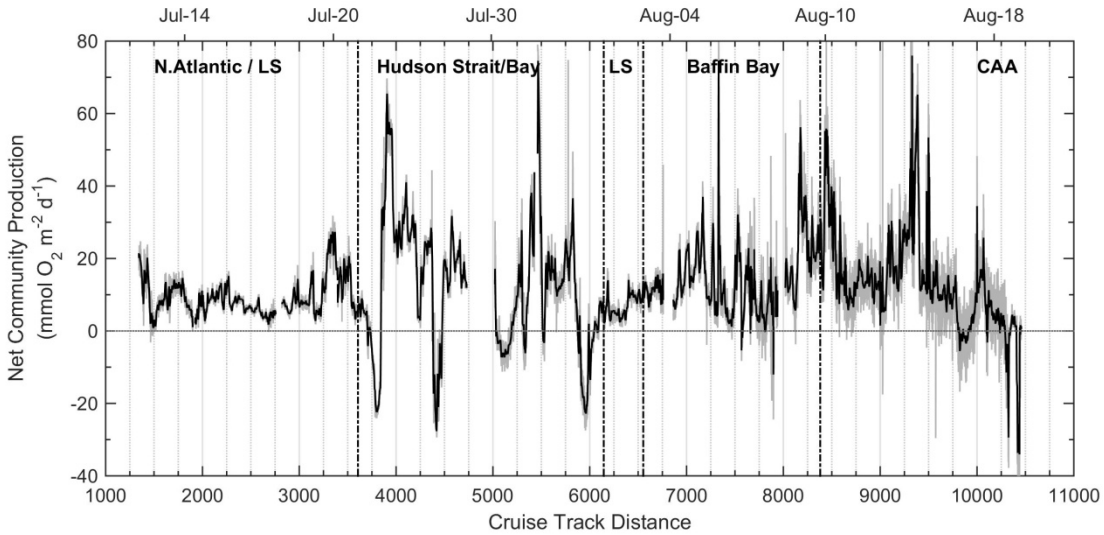

Figure 6. Derived Net Community Production (NCP = photosynthesis minus mixed layer respiration) obtained from MIMS $\Delta O_2/Ar$ data and wind-speed dependent gas exchange parameterization. The calculations were conducted following the steady-state mixed layer mass balance model (Reuer et al. 2007) that has been used in a number of previous studies.

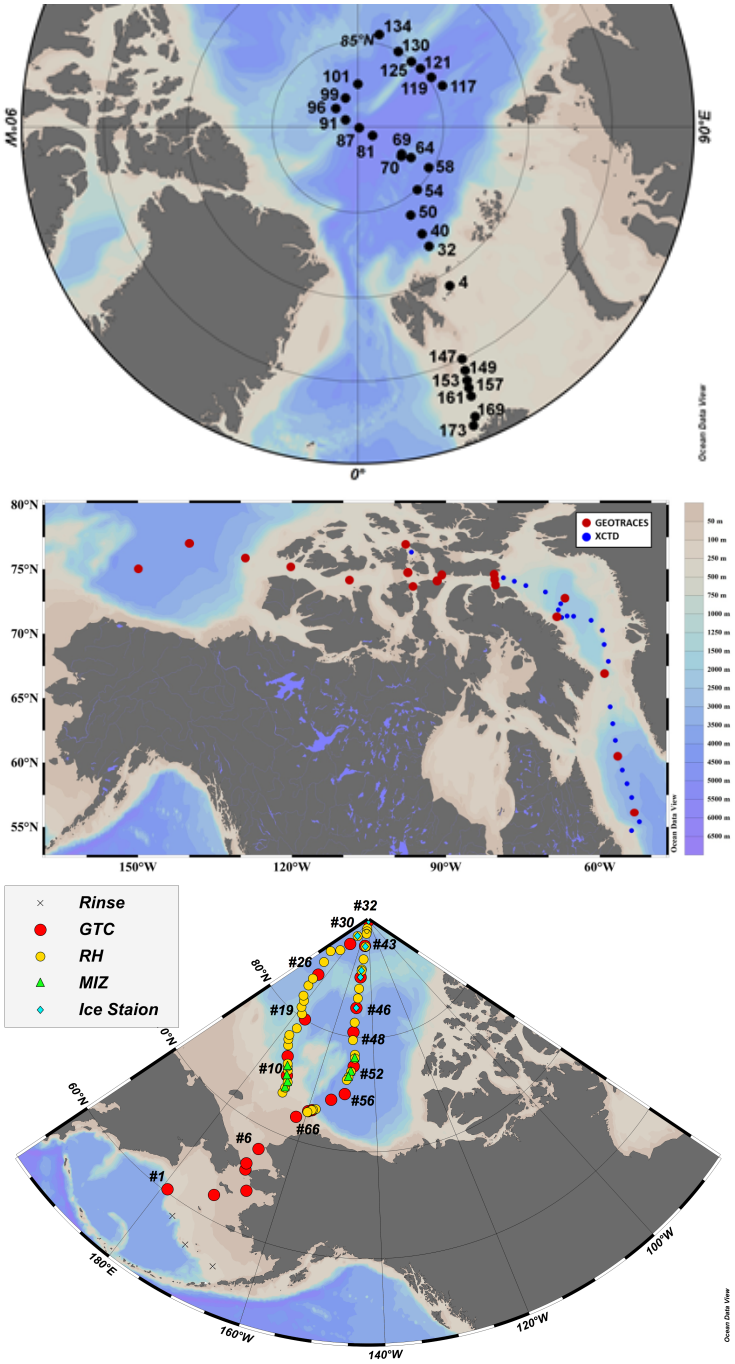

Figure 7: German (top), Canadian (middle) and US (bottom) GEOTRACES stations occupied between July and October 2015.

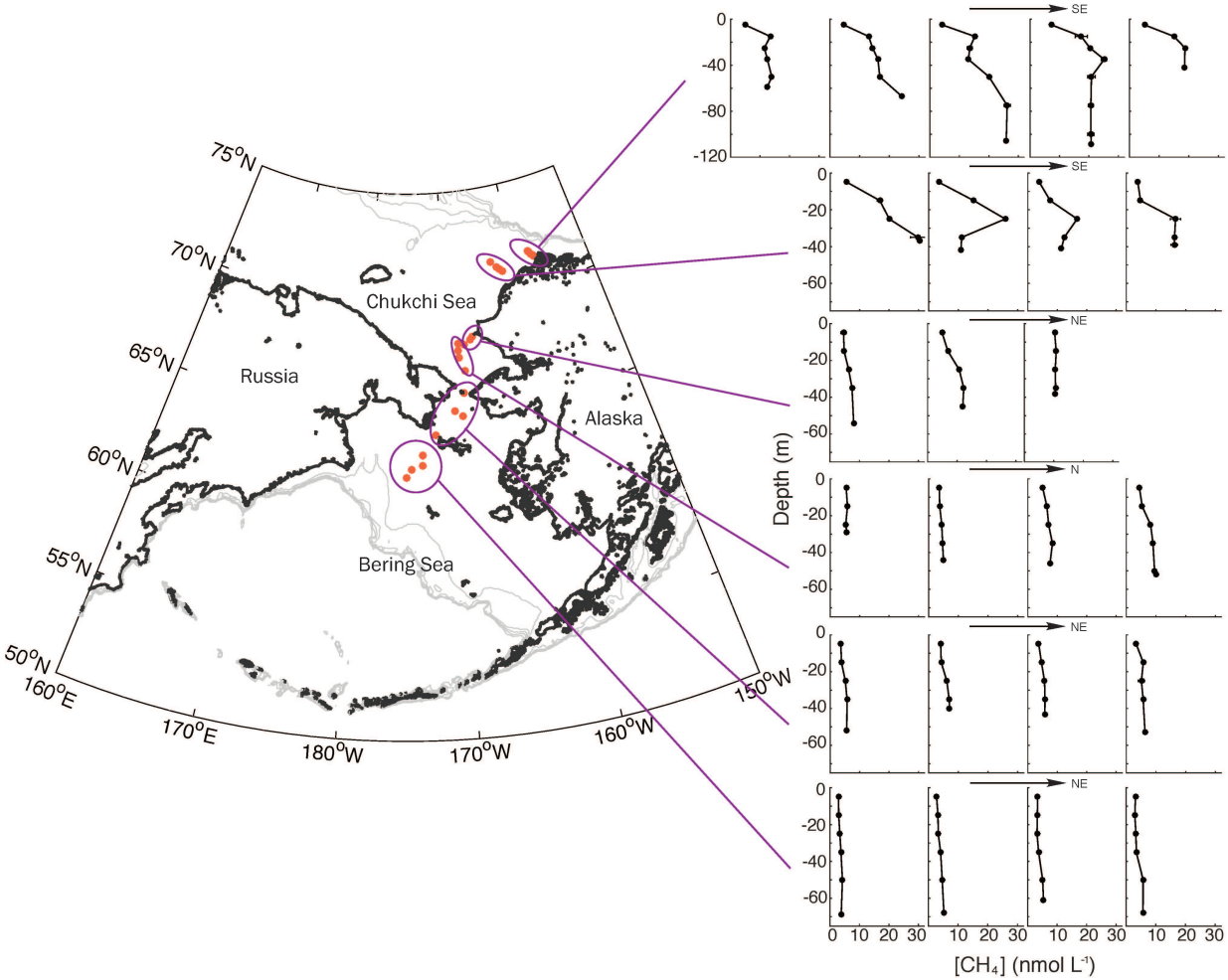

Figure 8: Depth profiles of CH_4 concentrations collected on the CCGS Laurier during July, 2015 (chief scientist S. Vagle, IOS-DFO). These measurements were supported by a collaboration with DFO that enabled us to greatly expand our sampling activities and provide significant 'value-added' information to on-going DFO time-series work.

Table 1: List of parameters measured or sampled in the water column

Hydrography/CTD sensors	**Trace gases**
Pressure	Biogenic gases
Temperature	CH_4, N_2O
Salinity	O_2/Ar, N_2/Ar (K1; LS2; BB1, 2, 3; CAA1, 3, 4, 5, 6, 7)
Oxygen	Triple oxygen isotopes (K1; LS2; BB1, 2, 3; CAA1, 3, 4, 5, 6, 7)
Fluorescence	Noble gases (K1 and BB2)
Light transmission	**Trace elements and isotopes**
Nutrients	Dissolved and particulate trace metals
Phosphate	Al, Mn, Fe, Cd, Zn, Cu, Pb, Ga, Ba, REE, Hg, MeHg
Nitrate/Nitrite	Dissolved and particulate radioisotopes
Ammonia	^{230}Th, ^{231}Pa, ^{234}Th, ^{228}Ra, ^{224}Ra, ^{223}Ra
Silicate	Dissolved and particulate radiogenic isotopes
Chemical parameters	Nd, Pb
Dissolved inorganic carbon	Dissolved and particulate stable isotopes
Total alkalinity	$\delta^{18}O$ in water
pH	δ^{13C} in DIC
Dissolved organic carbon	$\delta^{15}N$ and $\delta^{18}O$ in nitrate
Fluorescent dissolved organic matter	$\delta^{30}Si$
Coloured dissolved organic matter	$\delta^{53}Cr$
Thiols	$\delta^{56}Fe$
Organic ligands	Anthropogenic isotopes
Biological parameters	^{129}I, ^{236}U, ^{135}Cs
Particulate organic carbon	**Large volume in-situ pumps**
Particulate organic nitrogen	Paticulate ^{230}Th, ^{231}Pa, ^{234}Th
Size fractionated chlorophyll a	Paticulate Si, Nd and Cr isotopes
Pigments	
Particulate biogenic silica	
Flow cytometry	
Genomics	
Proteomics	
Incubations	
^{14}C uptake (K1; LS2; BB1, 2, 3; CAA1, 2, 3, 4, 5, 6, 7; VS)	
^{13}C uptake (K1; LS2; BB1, 2, 3; CAA1, 3, 5, 6, 7)	
$^{15}NO3$ uptake (K1; LS2; BB1, 2, 3; CAA1, 3, 5, 6, 7)	
$^{15}NH4$ uptake (LS2; BB1, 2, 3; CAA1, 3, 5, 6, 7)	
^{32}Si uptake (LS2; BB1, 2, 3; CAA1, 3, 5, 6, 7)	
$H_2{}^{18}O$ uptake (K1; LS2; BB1, 2, 3; CAA1, 3, 5, 6, 7)	
^{55}Fe uptake (CAA3, 7)	

Table 2: List of parameters measured or sampled in the water column

Hydrography/CTD sensors	**Trace elements and isotopes**
Pressure	Dissolved and particulate trace metals
Temperature	Al, Mn, Fe, Cd, Zn, Cu, Pb, Ga, Ba, REE, Hg, MeHg
Salinity	Dissolved and particulate radioisotopes
Oxygen	^{230}Th, ^{231}Pa, ^{234}Th, ^{228}Ra, ^{224}Ra, ^{223}Ra
Fluorescence	Dissolved and particulate radiogenic isotopes
Light transmission	Nd, Pb
Nutrients	Dissolved and particulate stable isotopes
Phosphate	δ^{18}O in water
Nitrate/Nitrite	δ^{13C} in DIC
Silicate	δ^{15}N - nitrate
Chemical parameters	δ^{30}Si
Dissolved inorganic carbon	δ^{53}Cr
Total alkalinity	δ^{56}Fe
pH	Anthropogenic isotopes
Dissolved organic carbon	^{129}I, ^{236}U, ^{135}Cs
Fluorescent dissolved organic matter	**Large volume in-situ pumps**
Coloured dissolved organic matter	Paticulate ^{230}Th, ^{231}Pa
Thiols	Paticulate Si, Nd and Cr isotopes
Organic ligands	
Biological parameters	
Particulate organic carbon	
Particulate organic nitrogen	
Pigments	
Particulate biogenic silica	
Genomics	
Proteomics	

Canadian Arctic-GEOTRACES Project Meeting
Dec. 7th, 2015, 4pm - 6:30pm (Oak Room, Westin Bayshore, Vancouver)

Agenda

1. Overview of this summer's Canadian Arctic-GEOTRACES field sampling activities (*Roger Francois*)

2. Overview of Cruise – Underway Observations, Surface Data and Remote Sensing (*Philippe Tortell*)

3. Status of common data sets (*e.g.* CTD, TSG, nutrient, O_2 etc.) (*Kristina Brown*)

4. Practical considerations regarding data sharing – electronic platform (*e.g.* dropbox) and preferred file formats. Other considerations? (*Group Discussion*)

5. Transfer of data to GEOTRACES database GDAC (*Jay Cullen, Kristin Orians*)

6. Group summaries (2 – 3 slides each) with overview of sampling/results to date (*Summaries presented by R. Francois and P. Tortell*)

7. Interaction between observations / data producers and modelers - what is the current status of the various models, and how can we best feed in our field data to these models? (*Nadja Steiner, Susan Allen*)

8. Interactions / synergies with DFO - How will DFO use GEOTRACES data / models to support their scientific mission? (*Andrew Ross*)

9. Plans for the first data synthesis work shop in 2016

10. Preliminary discussion regarding joint publications (*Group Discussion*)

APPENDIX 2 - US GEOTRACES

GP16 DATA WORKSHOP REPORT

Results of the GEOTRACES GP16 Synthesis Workshop held at the University of Southern California Wrigley Institute for Environmental Studies 8 - 13 November 2015.

An Informal Summary by James Moffett, University of Southern California, Co-chief Scientist

A synthesis workshop for the Eastern Tropical South Pacific Zonal Section (GEOTRACES GP16) was held Nov 8-13 at the USC Wrigley Institute for Environmental Studies on Catalina Island. Approximately 65 attendees represented all of the research groups who were funded to participate in the project. In addition, four modelers attended the workshop, plus an expert on continental weathering who studies the Andes. The meeting was scheduled like a Gordon Conference, with morning and evening sessions and including a break in the afternoon. The primary objectives of the meeting were to bring everyone up to speed with the latest results, and to identify important problems where small groups could work together to generate synthesis papers.

The first evening was devoted to characterizing the basic features of the section. Chris German gave an overview of the hydrography of GP16 with a contribution from Jim Swift. Brian Peters (graduate student at Stanford University) presented an OMPA water mass analysis of GP16 and Dan Ohnemus (Bigelow Laboratory) described an approach to assign a consistent value for the mixed layer depth over the section.

Each group gave 1 to 3 15-minute presentations. Monday's presentations focused on the western half of the section, particularly the hydrothermal plume, while Tuesday was focused on the eastern margin and OMZ. On Monday evening, four modelers (Tim De Vries, Keith Moore, Curtis Deutsch and Thomas Weber) described results specifically focused on GP16. Their contributions are included in the discussion below.

The remainder of the meeting focused on important observations and highlights, many of which were made by different groups with very different experimental approaches and a different suite of key parameters. Breakout groups were organized around these phenomena. Of primary importance were the two plumes that were featured on the cover of Nature in July 2015, associated with the report by Resing et al. Basic features of each plume were studied in breakouts, and they were compared in plenary. Iron in the hydrothermal plume (hereafter designated "HTP") was of great interest because of its persistence, and the linear relationship with dissolved Fe and ^{3}He. However, a closer inspection revealed that the particulate Fe maxima showed an increase with depth moving offshore (Sherrell and Lam groups). Results indicate that there may be a significant adsorption and desorption of Fe from these particles, leading to a net removal that may have significant implications for the fraction of Fe that ultimately makes it to surface waters. It was also shown that much of the dissolved Fe was actually colloidal – in the plume and elsewhere (Wu group, University of Miami). Comparison with the organic ligand data indicated that the colloidal fraction probably appears as a very strong Fe complex with no excess ligand. Indeed, in the high Fe environments such as these plumes, there did not appear to be any excess ligands. There was generally a feeling that the earlier paradigm of Fe speciation and transport being determined by a strong ligand

class (with Fe concentrations ultimately controlled by whatever is controlling the ligand) need significant revision. It was also apparent that Mn was controlled by very different processes, in spite of the cursory similarities of the plume. Particulate Mn sank more slowly (with respect to ^{3}He) and there was no colloidal component in the dissolved fraction (Wu group). Particulate Fe was predominantly Fe oxides, according to synchotron data (Toner group, University of Minnesota). There are no Mn data yet from the Synchrotron, but it was assumed that particulate Mn is probably associated with free-living Mn oxidizing bacteria, which sink slowly. Participants strongly encouraged the Toner lab to pursue more synchrotron work on Mn with HTP particulate samples.

Comparison of Zn to Si suggests that there is a slight excess of Zn within the plume, suggesting the hydrothermal sources of zinc may lead to significant revisions of global Zn budgets. For other TEIs, including Th-230, the particles within the plume acted as important scavenging sinks (Anderson Group, Lamont-Doherty Earth Observatory).

Resing et al. (2015) argued that the HTP was significant because it is probably an important source of Fe to the Southern Ocean. This assertion was examined by the group. Dissolved Fe data determined by ICPMS, particularly at the core of the HTP, were ~25% lower than the shipboard Fe data reported by Resing et al (2015). Moreover, models presented at the workshop suggested that a smaller fraction of Fe makes its way to the Southern Ocean. Nevertheless, there was a consensus that the HTP is still a significant source of dissolved Fe to the plume.

The Eastern Boundary Plume (EBP) received less attention in Resing et al. (2015), but a lot of attention at the workshop. There were similarities and important differences in these two plumes. Fe concentrations were similar in both of these features and dissolved Fe was persistent, in spite the EBP being in highly oxygenated water (as was the HTP). This suggested chemical transformation into fairly non-reactive Fe(III) species. Speciation data indicated that the dissolved Fe was strongly complexed, but it may have been colloidal. Samples for colloids within the EBP were collected by the Wu group but were not analyzed at the time of the meeting. The plume was much deeper than the oxygen minimum zone and disconnected from the overlying Fe(II) plume extending westward off the shelf (Moffett group, University of Southern California).

Nevertheless, several aspects of the EBP chemistry suggest that the Fe in the EBP has undergone redox cycling. Firstly, there is the virtual absence of Al and Mn in the EBP. This is in stark contrast to the HTP, where Al and Mn are abundant. It is surprising given the crustal ratios of both elements to Fe. Fe redox cycling could decouple it from Mn and Al in a variety of ways if there are significant benthic transformations associated with the source. For example if Fe and Al are delivered to reducing margin sediments in sinking particles, Fe would be released as Fe(II) whilst Al remains. This would decouple the two elements even if Fe(II) were re-oxidized in the overlying waters. Mn could be decoupled from Fe as a result of its slow oxidation and exceedingly long residence time in the upper water column, where it is strongly correlated with Ra-228 (see below). Consistent with this mechanism is the very light delta Fe-56 signature of the EBP (John Group, University of Southern California) in contrast to the HTP which showed no fractionation. The isotopically light Fe indicates fractionation associated with partial reduction of Fe(III) to Fe(II).

The source of Fe in the EBP was not determined at the meeting. While dissolved Fe is very high on the Peruvian shelf, I argued that much of this Fe is retained on the shelf by redox

'trapping' (Vedamati et al (2015) and is not exported. Moreover, fluvial sources in Peru are small. However, there are several large rivers in Ecuador that could be the source of this Fe. A northern source is consistent with the water mass associated with the core of the EBP – Pacific Deep Water. This was established in the water mass analysis performed by Brian Peters (Stanford) and presented at the start of the meeting. Josh West, a weathering expert from the University of Southern California who works on the Andes, gave a presentation making this case. Josh also pointed out that there is a strong volcanic signature in Ecuadorean source rocks very distinct from the Peruvian Andes. Neodymium isotope ratios are influenced by a volcanic source and might provide important insight when those data become available.

The oxygen minimum zone itself was characterized by high concentrations of Fe over the shelf, predominantly as Fe(II), and a plume of Fe extending west of the shelf/slope break that was composed of Fe(II) and Fe(III) and coincident with the secondary nitrite maximum. The feature was coincident with a maximum in iodide, which was presumably generated from the microbial reduction of iodate.

A major question is whether these features (and the secondary nitrite maximum itself) are generated from in situ processes or lateral advection from more reducing and biologically active regions on the shelf. Ra-228 isotopes provided important insight. Within the core of the oxygen minimum zone there was a strong correlation between Ra-228 and Fe(II) and iodide, suggesting that offshore transport may be more important than we had previously thought.

Curtis Deutsch (University of Washington) presented a high resolution model of cross-shelf transport at the eastern end of the transect. His model revealed the importance of wind-driven eddies generated over the broad Peruvian shelf that transport materials offshore. Surprisingly, he was able to generate extensive westward transport of dissolved Fe offshore without invoking redox chemistry. However, his boundary conditions were not correct, in that he did not include the exceedingly high dissolved Fe concentrations we actually measured over the shelf. If he had done so, there would have been a massive offshore flux of Fe that is inconsistent with our observations. Instead, it appears that redox cycling traps much of the Fe on the shelf. But is there any direct evidence for internal redox cycling over the shelf and shelf/slope break? In fact, the cruise produced the best evidence yet for that process. The Lam group (University of California Santa Cruz) showed that much of the particulate Fe forming within shelf waters and the secondary nitrite maximum beyond the shelf-slope break was Fe oxide (specifically lepidocrocite). This is presumably produced by the abiotic oxidation of Fe(II) by nitrite, or the microbial oxidation by nitrate or nitrite. This was the first evidence for the occurrence of this process in the marine water column. It has important implications for the transport of Fe within this system, but also for the linkage of the Fe and nitrogen cycles in the evolution of early ocean chemistry.

Mark Altabet (University of Massachusetts, Dartmouth) posed an interesting question for the group. He pointed out that the Peruvian OMZ has a global significance for the nitrogen cycle. Could we make the case that the Peruvian OMZ has a global significance for metals? This question is still not settled. Redox dynamics and coastal physics within the OMZ are clearly important in supplying Fe to the interior of the eastern tropical Pacific, but this is a regional impact. The real question is whether the features of the massive EBP which is much deeper than the OMZ arise in whole or in part because of the presence of the OMZ and associated reducing sediments along the margin. If so, then the OMZ does indeed have a global impact. That is because the EBP is almost certainly an important source of Fe to the Southern Ocean, based on simulations performed by Tim DeVries (University of California Santa Barbara)

using his inverse model and presented at the workshop. Aside from the redox signature of the Fe isotopes, a compelling role for the OMZ is simply that such boundary plumes are rare elsewhere.

Plumes of Ra-228 extended far to the west from the Peruvian shelf and slope (Charette group, Woods Hole Oceanographic Institution). The most westward plume was in the surface waters and was strongly correlated with a strong maximum in dissolved Mn. This suggested that the strong surface Mn maximum in the eastern tropical Pacific arises from a boundary source, rather than atmospheric deposition within the interior of the basin. The absence of a surface Al maximum is consistent with this observation. Subsurface Ra-228 plumes were also observed extending west from the slope. The presence of such plumes at different depths reflects the complex interplay of eastward and westward flowing filaments within the OMZ. Interestingly, these subsurface Ra-228 plumes were coincident with local iodide, Fe and Fe(II) maxima, suggesting that at least some component of the novel redox chemistry within the OMZ arises from slope sediment processes.

Nitrogen and oxygen isotope measurements of nitrite suggest that there is an important oxidation pathway of nitrite within the OMZ (Casciotti group, Stanford University). It is not clear what the terminal electron acceptor might be in this process, in the absence of oxygen. Iodate is an obvious choice, and iodide accumulation (Cutter group, Old Dominion University) is consistent with this. But there is no direct evidence that this reaction is important.

Next Steps

The group agreed to publish a special issue with a target deadine of November 1. However, some groups will publish sooner in high profile journals. We collectively encouraged that. It was felt that the Resing et al. paper in Nature was an important step in elevating the profile of GEOTRACES.

My original goal had been to use the workshop to identify sub-groups who would work on synthesis topics. But I was a bit overly optimistic about getting to this point in the workshop. Nevertheless, I expect some collaboration will get spun up soon and hopefully the special issue will see some good synthesis papers. Here are some representative interactions I see developing (a bit more focused on me, but just because that is what I am most certain about).

1. I expect that Bruland's student, Claire Parker, will work with the Ra folks given the remarkable relationship between Ra-228 and Mn in the upper ocean west of Peru.
2. Dave Kadko and I are collaborating to use his ^{7}Be –derived upwelling rates over the shelf to estimate a shelf-wide oxidation flux of Fe(II) as anoxic waters outcrop into the mixed layer. We can compare this with German estimates of 'redox recycled Fe' from sediment trap data to see how much Fe(II) oxidation can be attributed to aerobic oxidation coupled with upwelling, or if we must invoke internal oxidation by nitrite and nitrate.
3. Curtis Deutsch's high resolution model of eddy-driven transport across the shelf will lead to numerous collaborations, I expect. I want to collaborate with him on a redox-driven model of Fe transport across the shelf. I anticipate that the model will show that we must have a non-oxygen dependent Fe(II) oxidation pathway to account for the abrupt Fe gradients at the shelf-slope break. This collaboration will explicitly include the formation of particulate Fe oxides as an oxidation product, so Phoebe Lam will be involved. I also recognized that Ra isotopes, especially Ra-228, might be very valuable in constraining his model. But the issue there is

how to define the Ra-228 end-member on the shelf. We did not make as much progress there as I was hoping.

4. Greg Cutter and I will collaborate on a redox paper characterizing the redox potential of the OMZ. Our iodide and Fe(II) numbers were virtually identical.

5. I expect that Tim DeVries and Seth John will continue their collaboration on a global zinc scavenging model.

6. Bob Anderson is getting really engaged in atmospheric deposition processes these days, using Th-232 and Th-230. I expect that he will work closely with Cliff Buck and Ana Aguilar-Islas on
atmospheric deposition at the eastern end of the transect. The paradox of high surface Mn and low surface Al is challenging our conventional approaches there.

7. I expect that the Wu group and Kristen Buck will work closely on Fe speciation in the HTP in order to determine what fraction of the 'ligand-bound' Fe is actually colloidal.

Role of Modelers in the Future

Tim DeVries, Curtis Deutsch and Keith Moore (University of California, Irvine) invested a lot of time and effort into their presentations, and presented model data that were highly relevant to two aspects of our program: explaining the features we observed and determining the fate of the two major plumes identified in the section. We all agreed that modelers need financial support soon.

Student Participation

Many of the presentations at the workshop were made by students. These included veterans of the cruise – Saeed Roshan (RSMAS), Claire Parker (UCSC), Nick Hawco (WHOI), Erin Black (WHOI), Dan Ohnemus (WHOI, now Bigelow) and Cheryl Zurbrick (UCSC – now MIT), as well as students who are now working on cruise-derived data, such as Molly Martin (RSMAS). They were important participants in breakout. Dan Ohnemus also did a good job leading the particle inter-comparison session.

Acknowledgments

Financial support from the NSF Chemical Oceanography Program is gratefully acknowledged. I would also like to than Karen Benedetto at Lamont for her assistance with financial issues, and Ms. Sandy Nguyen at USC for help with travel logistics. Thanks also to the staff at the Wrigley Institute for Environmental Studies.

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