GEOTRACES SCIENTIFIC STEERING COMMITTEE
ANNUAL REPORT TO SCOR 2017/2018

May 2018

ANNEX – NATIONAL REPORTS

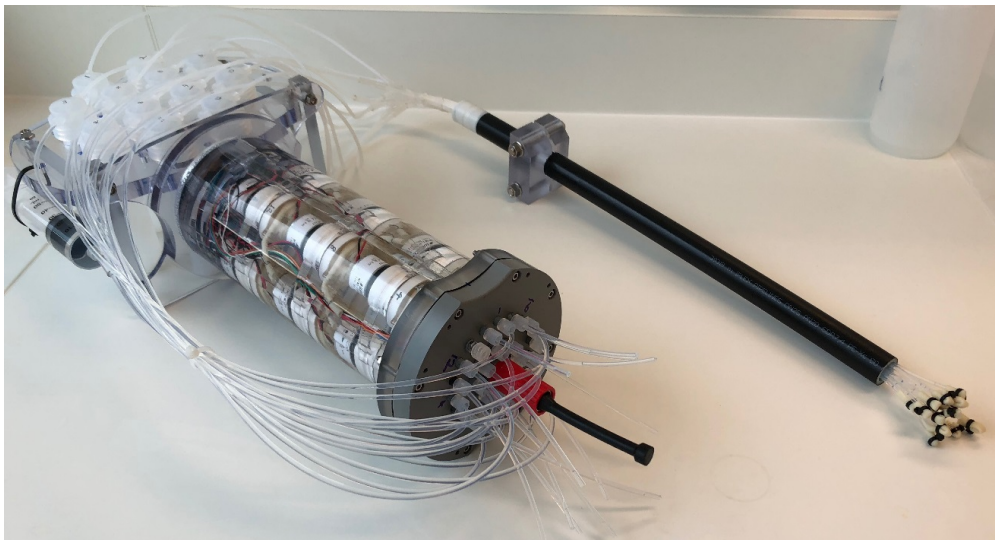
ANNUAL REPORT ON GEOTRACES ACTIVITIES IN AUSTRALIA

May 1st, 2017 to March 30th, 2018

New scientific results

Pier Van Der Merwe, Andy Bowie and colleagues have developed a trace metal clean seawater sampler suitable for 1 year deployments on oceanographic moorings. Twelve samples per unit can be programmed to collect 65 ml of seawater at any time interval. The sample path is made entirely out of Savillex Teflon and 1m intake tubes allow uncontaminated sampling in upstream water. Samples are drawn into the sampling containers via micro-peristaltic pumps. The unit itself is non-contaminating, being made of polycarbonate, Teflon and titanium. The system is pressure compensated and has successfully been tested to 100 m. Blank testing of the system deployed in the Southern Ocean during Geotraces voyage GA01 in January 2018 revealed no significant difference between an industry standard trace metal rosette in the 100 pM range, proving its capability at collecting uncontaminated samples in the oligotrophic open ocean.

A spin off project saw the "TM sampler" partially redesigned for rapid turnaround deployments on the Australian Maritime College autonomous underwater vehicle, '*nupiri muka*' with funding made available through the Antarctic Gateway Project and the Antarctic Climate and Ecosystems CRC, University of Tasmania. During testing, the TM sampler was mounted within the AUV, with its intake tubes extending outside of the turbulent flow around the AUV's hull (see image) to avoid contamination. Samples were successfully collected during a test deployment in an estuary. Testing will continue through 2018 with the ultimate goal of deployment under the Sordsal Glacier in Antarctica during the 2018-2019 field season. If successful, this collaboration will shed light on the fertilisation potential of ice shelf water as well as quantify sub-glacial, melt water trace metal concentrations. As our climate warms and our ice shelves lose mass, this fertilisation pathway may dramatically change into the future. Therefore, observations of this process will enable prediction of Southern Ocean productivity with flow on impacts on global climate.



Cruises

- Completion of the Australian SR3-GEOTRACES section voyage in the Southern Ocean. GEOTRACES section GS01 was completed along the SR3 line (approximately 140ºE) from Hobart (Tasmania, Australia) to the Antarctic ice-edge. Scientists measured TEIs, nutrients, the carbon system and ocean physics along the SR3 section over 6 weeks in January/February 2018. Measurements of trace metals and isotopes (TEIs) are scarce in the Southern Ocean, particularly on repeat sections and in deeper waters. TEI distributions on the SR3 line will be compared to expeditions in spring 2001 and late autumn 2008 to assess seasonal and longer-term changes. The section also sampled for TEIs in marine particles, and stable, radioactive and radiogenic isotopes that have not been measured before in this sector of the Southern Ocean, as well as sampling for TEIs in aerosol particles. Metagenomic analyses will be used to characterise the structure and function of the microbial community as a function of latitude and depth along the repeat transects. Steve Rintoul (CSIRO/ACE CCRC) was the Chief Scientist and Andrew Bowie (IMAS-UTAS/ACE CRC) was the GEOTRACES PI.
- Two transit voyages completed around Australia under the project "Natural iron fertilisation of oceans around Australia: linking terrestrial dust and bushfires to marine Biogeochemistry" (PI Bowie) provided GEOTRACES compliant aerosol data.
- Completion of SOTS time series "Subantarctic Biogeochemistry of Carbon and Iron, Southern Ocean Time Series site". GEOTRACES PIs: Boyd, Ellwood, Bowie. This voyage took place in March 2018 in the Subantarctic Southern Ocean south of Tasmania and follows up a similar voyage in March 2016. A number of overseas scientists participated in this GEOTRACES process study (GprI08), including Ben Twining (Bigelow Marine Labs) and members of the Barbeau (SIO) and Wilhelm (UT) labs. The focus was on particle dynamics and TEI biogeochemistry.

New projects and/or funding

- Rintoul SR, Bowie AR, Tilbrook BD, Bodrossy L, Detecting Southern Ocean change from repeat hydrography, deep Argo and trace element biogeochemistry, CSIRO Marine National Facility, $5625k (in kind)
- Boyd PW, Ellwood M, Bowie AR, Surface and subsurface subantarctic biogeochemistry of carbon and iron, Southern Ocean Time Series site, CSIRO Marine National Facility $1125k (in kind)

- Ellwood M, Boyd PW, Bowie AR, Chase Z, Abbot A, Constraining external iron inputs and cycling in the southern extension of the East Australian Current, Southern Ocean Time Series site, CSIRO Marine National Facility, $2875k (in kind)
- van der Merwe, Bowie Trull, Integration and testing of clean water sampler on ARC Antarctic Gateway Partnership Autonomous Underwater Vehicle (AUV) 'nupiri muka' ($8256 cash)
- Chase, Meissner, Bostock, Ren and Sikes. The Southern Ocean's response to abrupt climate change, Australian Research Council $385,650

GEOTRACES workshops and meetings

- Christina Schallenberg, Sophie Bestley, Diana Davies, Ruth Eriksen, Melanie Gault-Ringold, Andreas Klocker, Michael Sumner, Ashley Townsend, Thomas W. Trull, Pier van der Merwe, Karen Westwood, Kathrin Wuttig, Andrew Bowie. Sustained upwelling of subsurface iron supplies the phytoplankton blooms around the southern Kerguelen plateau. Symposium on Kerguelen Plateau Marine Ecosystem and Fisheries. Second Symposium on Kerguelen Plateau Marine Ecosystems and Fisheries, 13–15 November 2017, Hobart, Tasmania
- Wuttig et al., 2017. Second Symposium on Kerguelen Plateau Marine Ecosystems and Fisheries, 13–15 November 2017, Hobart, Tasmania
- van der Merwe, Wuttig, Holmes, Chase, Trull, Bowie, 2017. Trace metal bioavailability is greater of particles sourced from glacial erosion than hydrothermalism in the Southern Ocean. Second Symposium on Kerguelen Plateau Marine Ecosystems and Fisheries, 13–15 November 2017, Hobart, Tasmania
- Coffin, Arculus, Bowie, Chase, Robertson, Trull, In2016_V01 Science Party, 2017. Volcanism, Iron, and Phytoplankton on the Kerguelen Plateau. Second Symposium on Kerguelen Plateau Marine Ecosystems and Fisheries, 13–15 November 2017, Hobart, Tasmania

Outreach activities

- Iron and anemia in the Southern Ocean, Poster presentations at the Festival of Bright Ideas, Hobart (Tasmania), August 2017
- Royal Society of Tasmania Winter Series public lecture by Philip Boyd, Geoengineering the Planet: Can we, should we try to offset global climate change

Other activities

- Al Tagliabue visited the Institute for Marine and Antarctic Science (IMAS) for six weeks as a University of Tasmania visiting scientist. He worked with worked with Boyd and Bowie on merging results in the Pacific basin from GEOTRACES survey and process stations. The results were presented at the Ocean Sciences Meeting in Portland.

New publications (published or in press)

- Archer, C., Andersen, M.B., Cloquet, C., Conway, T.M., Dong, S., Ellwood, M., Moore, R., Nelson, J., Rehkämper, M., Rouxel, O. and Samanta, M., 2017. Inter-calibration of a proposed new primary reference standard AA-ETH Zn for zinc isotopic analysis. *Journal of Analytical Atomic Spectrometry*, *32*(2), pp.415-419.
- Boyd, P.W., Ellwood, M.J., Tagliabue, A. and Twining, B.S., 2017. Biotic and abiotic retention, recycling and remineralization of metals in the ocean. *Nature Geoscience*, *10*(3), p.167.
- Buchanan, P J, R. J. Matear, Z. Chase, S J Phipps, and N.L. Bindoff. "Dynamic Biological Functioning Important for Simulating and Stabilizing Ocean Biogeochemistry." *Global Biogeochemical Cycles* 42, no. 9 (2018): 1675. doi:10.1002/2017gb005753.
- Durand, A., Z. Chase, T. Noble, H. Bostock, S. L. Jaccard, P. Kitchener, A. T. Townsend, et al. "Export Production in the New-Zealand Region Since the Last Glacial Maximum." *Earth and Planetary Science Letters* 469 (2017): 110–22. doi:10.1016/j.epsl.2017.03.035.
- Durand, A., Z. Chase, T. Noble, H. Bostock, S. L. Jaccard, A. T. Townsend, N. L. Bindoff, H. Neil, and G. Jacobsen. "Reduced Oxygenation at Intermediate Depths of the Southwest Pacific During the Last Glacial Maximum." *Earth and Planetary Science Letters* 491 (June 1, 2018): 48–57. doi:10.1016/j.epsl.2018.03.036.
- Ellwood M.J., Bowie A.R., Baker A., Gault-Ringold M., Hassler C., Law C.S., Maher W.A., Marriner A., Nodder S., Sander S., Stevens C., Townsend A., van der Merwe P., Woodward E.M.S., Wuttig K., Boyd P.W., 2018. Insights into the biogeochemical cycling of iron, nitrate, and phosphate across a 5,300 km South Pacific zonal section (153°E–150°W). Global Biogeochemical Cycles, 32, doi.org/10.1002/2017GB005736. FT130100037 (2014-18)
- Genovese C, Grotti M, Pittaluga J, Ardini F, Janssens J, Wuttig K, Moreau S and Lannuzel D, 2018.Influence of the organic complexation on dissolved iron distribution in East Antarctic pack ice, Marine Chemistry, in press (https://doi.org/10.1016/j.marchem.2018.04.005).
- Hassler, C.S., van den Berg, C.M. and Boyd, P.W., 2017. Toward a regional classification to provide a more inclusive examination of the ocean biogeochemistry of iron-binding ligands. *Frontiers in Marine Science*, *4*, p.19.
- Holmes, T.M., Chase Z., van Der Merwe P., Townsend A.T., Bowie A.R., 2017. Detection, dispersal and biogeochemical contribution of hydrothermal iron in the ocean, Marine and Freshwater Research, 68, 2184-2204, doi:10.1071/mf16335. DP150100345 (2015-17)
- Meyerink, S.W., Ellwood, M.J., Maher, W.A., Dean Price, G. and Strzepek, R.F., 2017. Effects of iron limitation on silicon uptake kinetics and elemental stoichiometry in two Southern Ocean diatoms, Eucampia antarctica and Proboscia inermis, and the temperate diatom Thalassiosira pseudonana. *Limnology and Oceanography*, *62*(6), pp.2445-2462.
- Meyerink, S., Ellwood, M.J., Maher, W.A. and Strzepek, R., 2017. Iron Availability Influences Silicon Isotope Fractionation in Two Southern Ocean Diatoms (Proboscia inermis and Eucampia antarctica) and a Coastal Diatom (Thalassiosira pseudonana). *Frontiers in Marine Science*, *4*, p.217.

- Ratnarajah L., Lannuzel D., Townsend A.T., Meiners K.M., Nicol S., Friedlaender A.S., Bowie A.R., 2017. Physical speciation and solubility of iron from baleen whale faecal material. Marine Chemistry, 294, 79-88, doi.org/10.1016/j.marchem.2017.05.004
- Ratnarajah L., Nicol S., Bowie A.R., Pelagic iron recycling in the Southern Ocean: Exploring the contribution of marine animals. Frontiers in Marine Science Horizon Scan 2018: Emerging Issues in Marine Science, https://doi.org/10.3389/fmars.2018.00109
- Samanta, M., Ellwood, M.J. and Strzepek, R.F., 2018. Zinc isotope fractionation by Emiliania huxleyi cultured across a range of free zinc ion concentrations. *Limnology and Oceanography*, *63*(2), pp.660-671.
- Samanta, M., Ellwood, M.J., Sinoir, M. and Hassler, C.S., 2017. Dissolved zinc isotope cycling in the Tasman Sea, SW Pacific Ocean. *Marine Chemistry*, *192*, pp.1-12.
- Sutton, J.N., André, L., Cardinal, D., Conley, D.J., de Souza, G., Dean, J., Dodd, J., Ehlert, C., Ellwood, M.J., Frings, P.J. and Grasse, P., 2017. A review of the stable isotope bio-geochemistry of the global silicon cycle and its associated trace elements. *Frontiers in Earth Science*, *5*, p.112.
- Tagliabue A., Bowie A.R., Boyd P.W., Buck K.N., Johnson K.S., Saito M.A., 2017. The integral role of iron in ocean biogeochemistry. Nature 543, 51–59, doi:10.1038/nature21058. FT130100037 (2014-18)

Presentations in international conferences (not a comprehensive list)

- Wuttig K., Schallenberg C., van der Merwe P., Chase Z., Gault-Ringold M., Holmes T., Tonnard M., Townsend A., Trull T.W., Bowie A.R., 2018. From bio-essential to toxic: Trace elements around Heard and McDonald Islands and the Kerguelen Axis in the Indian Sector of the Southern Ocean. AGU/ASLO/TOS Ocean Sciences Meeting, Abstract ID: CT34A-1334, Portland (USA), 11-16 February
- Tonnard M., Gonzalez A., Whitby H., Bowie A.R., van der Merwe P., Planquette H., Boutorh J., Cheize M., Menzel J.-L., Pereira Contreira L., Shelley R., Sarthou G., 2017. Iron organic speciation in the North Atlantic Ocean and Labrador Sea along the GEOVIDE section (GEOTRACES GA01). Goldschmidt 2017, Paris (France), 13-18 August
- Chase, Z., Durand, A., Bostock, B., Jaccard, S., Neil, H., Noble, T., Townsend, A. 2017. SW Pacific export production since the Last Glacial Maximum: No evidence for iron fertilization. Goldschmidt 2017, Paris (France), 13-18 August
- Boyd co-chaired the session Abiotic and Biotic Retention, Recycling, and Remineralization of Metals in the Ocean at the AGU/ASLO/TOS Ocean Sciences Meeting in Portland, 11 – 16 February.

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ANNUAL REPORT ON GEOTRACES ACTIVITIES IN BELGIUM

May 1st, 2017 to March 30th, 2018

New scientific results

- Primary production rates, N_2 fixation rates, ^{234}Th export fluxes, POC export fluxes, particulate Ba profiles, trace element contents of the large (sinking) particle fraction and isotopic compositions ($\delta^{15}N$, $\delta^{18}O$) of nitrate from the GEOVIDE cruise (GA01-GEOTRACES; transect Lisbon to Newfoundland, May-July 2014).
- Isotopic composition ($\delta^{15}N$, $\delta^{18}O$) of nitrate from the SWERUS and ARKXXVIII/3 cruises.
- Primary production, N_2 fixation rates, nitrate isotopic compositions from the Belgica 2014/14 cruise (Bay of Biscay and Iberian Continental margin).
- Dissolved Ba from the Canadian Arctic GEOTRACES cruise (collaboration with H. Thomas, Dalhousie University).
- Trace metal geochemistry in the coastal sediments of the northwestern Black Sea.
- Influence of dissolved iron, phosphate and dust deposition on nitrogen fixation.

New publications (published or in press)

- Fripiat F., M. Declercq, C.J. Sapart, L.G. Anderson, V. Bruechert, F. Deman, D. Fonseca-Batista, C. Humborg, A. Roukaerts, I.P. Semiletov, and F. Dehairs, 2018. Influence of the bordering shelves on nutrient distribution in the Arctic halocline inferred from water column nitrate isotopes, *Limnology and Oceanography*, in press.
- Lemaitre N., H. Planquette, F. Planchon, G. Sarthou, S. Jacquet, M. I. García-Ibáñez, A. Gourain, M. Cheize, L. Monin, L. André, P. Laha, H. Terryn, and F. Dehairs, 2018. Particulate barium tracing significant mesopelagic carbon remineralisation in the North Atlantic, *Biogeosciences,* 15, 2289-2307, https://doi.org/10.5194/bg-15-2289-2018.
- Rembauville M., I. Salter, F. Dehairs, J.-C. Miquel and S. Blain, 2018. Annual particulate matter and diatom export in a high nutrient, low chlorophyll area of the Southern Ocean, Polar Biology, 41, 25-40, DOI 10.1007/s00300-017-2167-3.
- Li, X., Roevros, N., Dehairs, F. & Chou, L., 2017. Biological responses of the marine diatom Chaetoceros socialis to changing environmental conditions: A laboratory experiment, PLoS ONE, 12, p. 1-23, https://doi.org/10.1371/journal.pone.0188615.
- Fonseca-Batista D., F. Dehairs, V. Riou, F. Fripiat, M. Elskens, F. Deman, N. Brion, M. Bode and H. Auel, 2017. Contribution of N_2 fixation to biological productivity along a meridional section in the Eastern Atlantic Ocean, *Journal of Geophysical Research – Oceans*, 122, 1-15, doi:10.1002/2016JC012335.

Cruises

- EMBLAS-II cruise, National Pilot Monitoring Studies and Joint Open Sea Surveys in Georgia, Russian Federation and Ukraine. Leg I, 17-22 May 2016.
- Joint Black Sea Survey (JBSS) 2017 – part Joint Open Sea Survey in Ukraine and Georgia (JOSS GE-UA), EU-UNDP Project 'Improving Environmental Monitoring in the Black Sea' (EMBLAS-II). 27 August – 8 September 2017, Constanta – Odessa – Batumi – Odessa – Constanta.

New projects and/or funding

- OCeANIC, nitrous Oxide and nitrogen Cycling in Antarctic sea Ice Covered zone, Belgium - China Research Cooperation, The role of the oceans in the climate system (CLIMocean).
- Understanding marine benthic hypoxia and its consequences on benthic-pelagic exchanges, diagenesis and the macrobenthos (BENTHOX), founded by FRS-FNRS (Fund for Scientific Research – FNRS), Wallonia-Brussels Federation.

PhD theses

- Arnout Roukaerts: Primary production and nutrient cycling in Antarctic sea-ice and open waters. To be submitted summer 2018.
- Debany Fonseca Batista: Contribution of N_2 fixation to primary and new production in the Atlantic Ocean, Vrije Universiteit Brussel, June 2017, 197pp.
- Xu-Feng Li: The marine iron biogeochemistry under a changing climate: impact on the phytoplankton and the diazotroph communities. Joint PhD Université Libre de Bruxelles – Vrije Universiteit Brussel, Dec. 2017, 204pp.
- Florian Deman: Sea ice primary production at the Pan-Antarctic scale and nutrient cycling in the Antarctic sea ice covered areas (both sea ice and water column). In progress.
- Audrey Plante: Study of marine benthic hypoxia and its consequences on the exchange at the sediment-water interface and diagenesis. In progress.

Meetings

- Plante A., N. Roevros, A. Capet, M. Grégoire, N. Fagel and L. Chou (2018) Black Sea north-western shelf hypoxia: a study based on diagenetic processes and sedimentary proxies. European Geosciences Union (EGU) General Assembly 2018, Vienna, Austria, 8–13 April 2018, EGU2018-11782. Poster.
- Tang W., N. Cassar, S. Wang, D. Fonseca-Batista, F. Dehairs, S.M. Gifford, A.G. Gonzalez and H. Planquette (2018) Contrasting distribution of N2 fixation from the oligotrophic to the coastal ocean in the western North Atlantic Ocean, 2018 Ocean Sciences meeting, 11-16 February, Portland.
- Fonseca Batista D. & F. Dehairs (2017) N_2 fixation in the Atlantic Ocean, Ocean Science Centre Mindelo, 12-17 November, Mindelo, Cabo Verde.

- Plante A., N. Roevros, O. Roman Romin, A. Capet, M. Grégoire, N. Fagel and L. Chou (2017) Hypoxia evolution on the Ukrainian shelf of the Black Sea. Goldschmidt conference Abstract, Paris, France, August 13-17, 2017. Poster.
- Deman F., D. Fonseca-Batista, F. Fripiat, E. Le Roy, D. Nuwam Thilakarathne, N. Lemaitre, A Roukaerts and F. Dehairs (2017) N_2-fixation footprint on nitrate isotopic composition in temperate Norteast Atlantic Ocean, Goldschmidt 2017, August 2017, Paris.
- Fonseca-batista D., F. Deman, X. Li, E. Le Roy, R. Inginiero, C. Mariez, S. Roig, N. Lemaitre, F. Fripiat, L. Chou and F. Dehairs (2017) Patterns of N_2 fixation across the North Atlantic, Goldschmidt 2017, August 2017, Paris.
- Lemaitre N., H. Planquette, F. Dehairs, C. Bassoulet, C. Jeandel, M. Castrillejo and F. Planchon (2017) Particulate trace element export in the North Atlantic, Goldschmidt 2017, August 2017, Paris.
- Fripiat F., M. Declercq, C. Sapart, L. Anderson, V. Bruechert, F. Deman, D. Fonseca-Batista, C. Humborg, A. Roukaerts and F. Dehairs (2017) Goldschmidt 2017, August 2017, Paris.
- Li X., D. Fonseca-Batista, N. Roevros, F. Dehairs and L. Chou, 2017. Environment and nutrient control of nitrogen fixation, Goldschmidt 2017, August 2017, Paris.
- Roukaerts A., F. Deman, F. Fripiat and F. Dehairs (2017) New insights in Antarctic fast ice biogeochemistry: The role of biofilm, XIIth SCAR Biology symposium, 10-14 July 2017.
- Deman, F., Roukaerts, A., Fripiat, F., Lannuzel, D., & Dehairs, F. (2017) Nitrate isotopic composition in landfast sea ice: a time series study. Gordon Research Conference: Polar Marine Science: Understanding Polar Ecosystem Change Through Time Series Observations, Technological Advances, and Biophysical Coupled Modeling, 26-31 March 2017, Ventura.

Submitted by Frank Dehairs (fdehairs@vub.be; Vrije Universiteit Brussel) and Lei Chou (lchou@ulb.ac.be; Université Libre de Bruxelles)

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN BRAZIL

May 1st, 2017 to March 30th, 2018

Activities

- A GEOTRACES section (**Trace elements cycling, processes and fluxes across interfaces**) was held during the 46th World Chemistry Congress (IUPAC-2017) in São Paulo, Brazil between July 9th to July 14th. We had two plenary talks and four invited speakers on GEOTRACES research topics (listed below) and 6 oral presentations.
    - **Antonio Cobelo García** Advances in the Assessment of The Environmental Impact And Cycling of Platinum Group Elements (Pges)
    - **Catherine Jeandel** Which Oceanic Tracers are the Rare Earths and the Nd Isotopes?
    - **Michael Bau** Rare Earth Elements: Critical Resources and Emerging (Micro)Contaminants of The Environment
    - **Peter Croot** The Importance of Kinetics and Redox Reactions on the Speciation of Trace Elements in Marine Biogeochemical Cycles
    - **Gideon Henderson** Chemical Rate-Meters for the Inputs and Cycling of Nutrient Metals in the Ocean
    - **Luis Felipe Niencheski** Advances in the Studies of the Sgd in South Atlantic Ocean
- The GEOTRACES Scientific Steering Committee and Data Management Committee annual meetings were held in Salvador, Bahia, Brazil (16-20 September 2017).
- V. Hatje, a Full Member of SCOR Working Group 145: Modelling Chemical Speciation in Seawater to Meet 21st Century Needs (MARCHEMSPEC), participated in the MARCHEMSPEC workshop in February 2018 in Portland.

Capacity Building

- The Scientific Committee on Oceanic Research (SCOR) awarded US$2500 towards sponsoring a visit by C. Jeandel to Salvador, Brazil in June 2017. C. Jeandel gave a 3 weeks course on “Tracers in the Oceans: applications of isotopes to unveil processes controlling trace element distributions”, and also provided training on isotope dilution techniques for the determination of REE at the laboratories of CIEnAm at Universidade Federal da Bahia. Sixteen graduate students from various universities of Brazil attended the course and had the opportunity to discuss their work with C. Jeandel. As a continuation of this activity one student will visit C. Jeandel for few weeks to deepen her knowledge and practical skills in Nd chemistry.

Projects/grants

- A proposal to fund the project "Ecosystem services and environmental impacts in Todos os Santos Bay and its adjacent seas" was approved by CNPq (441264/2017-4) in December 2017.
- A proposal has been submitted to the MCTIC to repeat the PIRATA-BR XVII/ GEOTRACES GApr10 transect (Figure 1) and also to include two additional transects perpendicular to the Northeastern Coast of Brazil at 5S and 11S to study boundary exchange process along the continental shelf.

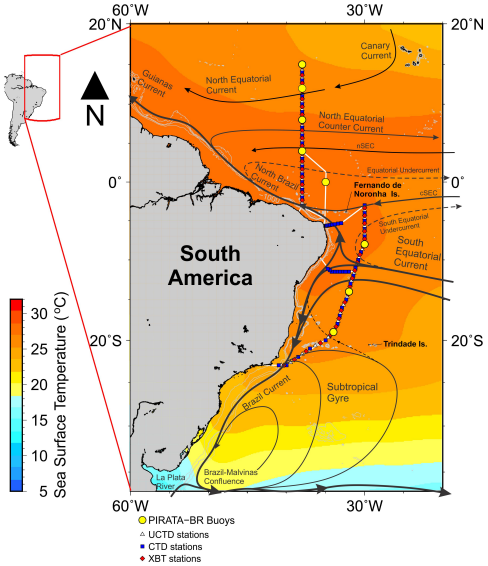

Figure 1. *PIRATA-Br XVIII ship plan, showing the 5S and 11S transects.*

Cruises

- An opportunity cruise with the Brazilian Navy was carried out between Monaco and Rio de Janeiro on the *R/V Vital de Oliveira*. Aerosol samples were collected using two high volume samplers equipped with PM2.5 and PM10 inlets (Thermo Andersen, USA). Trace metals and PHAs are to be determined by Jailson B de Andrade and Gisele O. da Rocha.
- The PIRATA-BR XVII/GEOTRACES GApr10 cruise was performed in four legs between October 2017 and January 2018. Water samples were collected from 16 full depth profiles between 15N and 21S (Fig. 2). The ship does not have a trace metal sampling rosette, hence water samples were collected only for the determination of REE and Nd isotopes. At selected stations, surficial samples were also collected for Ra and trace elements determination using a clean fish system.

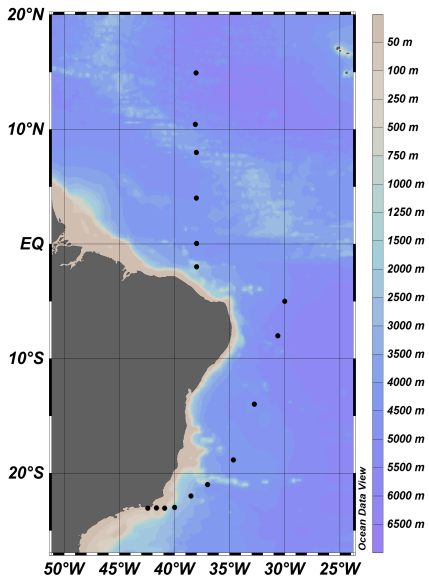

Figure 2. *Location of the 16 full depth profiles performed during the PIRATA-Br XVII/GApr10.*

GEOTRACES-related articles

- Hatje, V., Attisano, K.K., de Souza, M.F.L., Mazzili, B., de Oliveira, J. de Arauó, T., Burnett, W.C. Applications of radon and radium isotopes to determine submarine groundwater discharge and flushing times in Todos os Santos Bay, Brazil. Journal of Environmental Radioactivity v. 178-179, p. 136-146, 2017.

- Hatje, V., Pedreira, R.M.A., de Rezende, C.E., Schettini, C.A.F., de Souza, G.C., Marin, D.C., Hackspacher, P.C. The environmental impacts of one of the largest tailing dam failures worldwide. Scientific Reports, v. 7, p. 10706, 2017.

- Andrade, R.L.B., Hatje, V., Masque, P., Zurbrick, C.M., Boyle, E.A., Santos, W.P.C.. Chronology of anthropogenic impacts reconstructed from sediment records of trace metals and Pb isotopes in Todos os Santos Bay (NE Brazil). Marine Pollution Bulletin, v. 1, p. 1-14, 2017.

Contributions to conferences

GEOTRACES presentations and co-authorships by Brazilian Scientists at the following meetings: OSM (Portland, USA, Fe), and 46th World Chemistry Congress (IUPAC-2017).

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

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN CANADA

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Accomplishments

The Canadian GEOTRACES group had our second and final synthesis meeting May 23-26, 2017 at the Peter Wall Institute on the University of British Columbia campus. The meeting was hosted by Drs. Philippe Tortell (UBC) and Roger François (UBC). The meeting was organized to bring together the bulk of observations made on our Arctic research expedition completed on two legs aboard the Canadian Coast Guard Ship Amundsen in July-October 2015. Over the three days the project was able to compare and compile observations and experiments from individual PI's and plan for submission of a comprehensive dataset for the GEOTRACES data product. The group continues to coordinate its activities using the UBC Workspace 2.0 cloud based file sharing service that provides secure data management capabilities. PI's François and Jay Cullen (UVic) attended the US Arctic GEOTRACES synthesis meeting in Miami in October 2017. This meeting provided the first opportunity for the two countries to compare data for the purpose of intercalibration as well as synthesize results from their respective expeditions. Canadian PI's continue to work closely with US colleagues and a number of jointly authored manuscripts are planned. The Canadian GEOTRACES community continues to support an ongoing process study making observations of bioactive trace elements and trace element-microbe interactions on time-series cruises completed along Line P in the northeast Pacific. The September expedition of 2018 will be extended using a NSERC Ship Time grant to Roberta Hamme (UVic) and colleagues to allow support of the US EXPORTS project at Ocean Station PAPA. Cullen is coordinating with US colleague Dr. Kristen Buck (USF) to qualify the trace element sampling program for EXPORTS as a GEOTRACES compliant activity.

Our new scientific results, publications and presentations are summarized by Individual Investigator below:

Individual Investigator Reports

Jay T. Cullen, University of Victoria

Refereed Journal Publications: (* denotes HQP)

- Schlitzer, R., et al. (in review) The GEOTRACES Intermediate Data Product 2017. Chemical Geology
- *Jackson, S.L., J. Spence, *D.J. Janssen, A.R.S. Ross and J.T. Cullen. (2018) Determination of Mn, Fe, Ni, Cu, Zn, Cd and Pb in seawater using offline extraction and triple quadrupole ICP-MS/MS. Journal of Analytical Atomic Spectroscopy, DOI: 10.1039/C7JA00237H
- Smith, J., V. Rossi, K.O. Buesseler, J.T. Cullen, J. Cornett, R. Nelson, A. Macdonald, M. Robert, and *J. Kellogg. (2017) Time series measurements of the transport of the Fukushima radioactivity plume through the northeast Pacific Ocean. Environmental Science and Technology, 51(18): 10,494-10,502 DOI: 10.1021/acs.est.7b02712
- Crusius, J., A.W. Schroth, J.A. Resing, J.T. Cullen and R.W. Campbell. (2017) Seasonal and spatial variabilities in northern Gulf of Alaska surface water iron concentrations

driven by shelf sediment resuspension, glacial meltwater, a Yakutat eddy, and dust. Global Biogeochemical Cycles, 31 doi: 10.1002/2016GB005493

- Posacka A.M., D.M. Semeniuk, H. Whitby, C.M.G. van den Berg, J.T. Cullen, K. Orians and M.T. Maldonado. (2017) Dissolved copper (dCu) biogeochemical cycling in the subarctic Northeast Pacific and a call for improving methodologies. Marine Chemistry, https://doi.org/10.1016/j.marchem.2017.05.007
- *Janssen, D.J., W. Abouchami, S.J.G. Galer and J.T. Cullen. (2017) Fine-scale spatial and interannual cadmium isotope variability in the subarctic northeast Pacific. Earth and Planetary Science Letters, 472: 241-252 doi:https://doi.org/10.1016/j.epsl.2017.04.048
- *Schallenberg, C., A. Ross, **A. Davidson, G. Stewart and J.T. Cullen. (2017) Temporal variability of dissolved iron species in the mesopelagic zone at Ocean Station PAPA. Journal of Marine Systems, 172: 128-136 https://doi.org/10.1016/j.jmarsys.2017.03.006

Conference Presentations (invited):

- Cullen J.T. Uncharted Waters: A scientific glimpse into the future of the Arctic Ocean. (http://pagse.org/en/breakfasts/Oct%2026%202017.htm) Bacon and Eggheads, Oct. 26 2017, Parliament of Canada (Centre Block), Parliamentary Dining Room, Ottawa ON Canada.
- Xie, R.C, *D.J. Janssen, W. Abouchami, S.J.G. Galer, M.J.A. Rijkenberg, J.T. Cullen, H.J.W. de Baar, J. De Jong and M.O. Andreae. Controls on upper ocean Cd isotope fractionation. Goldschmidt Conference, Aug. 14 2017, Paris France.
- Cullen J.T., *S. Jackson, *K. Purdon and * D. J. Janssen. The distribution of biologically utilized trace metals in the Arctic Ocean. Canadian Chemistry Conference, Jun. 1 2017, Toronto ON Canada.

Conference Presentations:

- Ross, A.R.S., *D.J. Janssen and J.T. Cullen. Capturing "The Blob": inter-annual and seasonal variability in dissolved trace metal concentrations along Line P during a recent warm water anomaly in the subarctic NE Pacific, Ocean Sciences Meeting Feb. 11-16, 2018, Portland OR USA.
- De Vera, J.S., P. Chandan, P. Pinedo-Gonzalez, S. John, J.T. Cullen and B.A. Bergquist. Dissolved lead (Pb) isotopes as water and particle tracers in the Arctic Ocean. Ocean Sciences Meeting Feb. 11-16, 2018, Portland OR USA.
- *Jackson, S.L., *K. Purdon,* D. J. Janssen and J.T. Cullen. The distribution of biologically utilized trace metals in the Arctic Ocean. Ocean Sciences Meeting Feb. 11-16, 2018, Portland OR USA.
- *Janssen D.J., W. Abouchami, S.J.G. Galer, *K. Purdon and J.T. Cullen. Particulate Cd isotopes demonstrate a dynamic oceanic Cd cycle. Ocean Sciences Meeting Feb. 11-16, 2018, Portland OR USA.

Céline Guéguen, Trent University

Refereed Journal Publications

- Z. Gao, C. Guéguen 2018. Distribution of thiol, humic substances and colored dissolved organic matter during the 2015 Canadian Arctic GEOTRACES cruises. Marine Chemistry DOI: 10.1016/j.marchem.2018.04.001

Conference Presentations

- C. Guéguen, Y. Gao 2017 Dynamics and sources of dissolved organic ligands in the Canadian Arctic Archipelago. 100th Canadian Chemistry Conference, Toronto, May28-June01, 2017.

Media Coverage and Outreach Activities

- C. Guéguen 2017. La science à bord d'un brise-glace dans l'Arctique Canadien, Ecole francophone Monseigneur Jamot, Peterborough (two talks: JK-Grade2 and Grade3-Grade8)

Dr. Chris Holmden – University of Saskatchewan

Conference Presentations

- Goldschmidt 2016: Chromium isotope variability in modern ocean (I. Baconnais, C. Holmden, R. François)
- Goldschmidt 2018: Investigation of chromium isotope variability in the Canadian Arctic Archipelagos (I. Baconnais, C. Holmden, R. François)

Markus Kienast, Dept. Oceanography, Dalhousie University

Conference Presentations

- Lehmann N, KIENAST M, Granger J, Bourbonnais A, Altabet M, Tremblay J-E (2018) On the origin of the deep N deficit in Baffin Bay: Insights from isotopic signatures of nitrate and nitrous oxide. Goldschmidt Conference 2018, Boston, MA, USA
- Lehmann N, KIENAST M, Granger J, Bourbonnais A, Altabet M, Tremblay J-E (2018) N cycling in the eastern Canadian Arctic: constraints from dual isotope measurements in nitrate and nitrous oxide. Ocean Science meeting 2018, Portland, Oregon, USA.
- Lehmann N, KIENAST M, Granger J, Bourbonnais A, Altabet M, Tremblay J-E, Spatial variability of d15N and d18O in nitrate and nitrous oxide in the Canadian Arctic: tracing waters from two oceans. ASLO 2017 Aquatic Sciences Meeting, Hawaii, USA

Jody Klymak, University of Victoria

Refereed Journal Publications

- Water mass modification and mixing rates in a 1/12-deg simulation of the Canadian Arctic Archipelago. Hughes, K. G.; Klymak, J. M.; Hu, X.; and Myers, P. G. J. Geophys. Res., 122(2): 803--820. 2017.
- Hughes, K., J. M. Klymak, W. Williams, and H. Melling: Tidally modulated internal hydraulic flow and energetics in the central Canadian Arctic Archipelago, in review J. Geophys. Res.

Alfonso Mucci, Department of Earth and Planetary Sciences, McGill University

Research Activities

- We have analyzed several thousand bottle cast samples for a number of conservative and non-conservative tracers (e.g., S, T, δ18O(H2O), δ13C(DIC), TA) and combined those with data (e.g., nitrate, SRP, O2) acquired by collaborators to identify the properties of source-water types in the study area (Beaufort Sea, Canadian Arctic Archipelago, Baffin Bay/Davis Strait) and estimate the relative contribution of these throughout the water column. These water-mass reconstructions are used by our Canadian Geotraces collaborators to interpret the vertical and horizontal distributions of trace elements and their isotopes (e.g., Varela et al., 2016).
- We have been tracking the temporal evolution of the aragonite compensation depth (ACD) in the waters of the study area over the past decade. Our observations reveal that the surface waters in the eastern Beaufort Sea (Mackenzie Shelf and Amundsen Gulf), part of the Canada Basin and the Queen Maud Gulf are already undersaturated with respect to aragonite, this may have deleterious effects on marine ecosystems, particularly organisms that secrete CaCO3 skeletons/exoskeletons and shells. The Aragonite Compensation Depth in the Canada Basin and Beaufort Sea is shoaling as Atlantic waters, acidified by uptake of anthropogenic CO2 in the North Atlantic, intrude at depth in the Arctic Ocean (Luo et al., 2016). Atlantic waters enter the Arctic Ocean through Fram Strait and Norwegian Sea/Barents Sea and reach the Canada Basin in about 20 years.

Refereed Journal Publications

- Mol J., Thomas H., Myers P.G., Hu X. and Mucci A. (2018) Inorganic carbon fluxes on the Mackenzie Shelf of the Beaufort Sea. Biogeosciences 15: 1011-1027. https://doi.org/10.5194/bg-15-1011-2018.
- Hussherr R., Levasseur M., Lizotte M., Tremblay J.-É., Mol J., Thomas H., Gosselin M., Starr M., Miller L.A., Jarnikovà T., Schuback N. and Mucci A. (2017) Impact of ocean acidification on Arctic phytoplankton blooms and dimethylsulfide production under simulated ice-free and under-ice conditions. Biogeosciences 14: 2407-2427. doi:10.5194/bg-14-2407-2017.
- Luo Y., Boudreau B.P. and Mucci A. (2016) Disparate acidification and carbonate desaturation of deep and shallow waters of the Arctic Ocean. Nature Communications 7:12821, pp. 1-8.

- Varela D.E., Brzezinski M.A., Beucher C.P., Jones J.L., Giesbrecht K.E., Lansard B. and Mucci A. (2016) Heavy silicon isotopic composition of silicic acid and biogenic silica in Arctic waters over the Beaufort Shelf and the Canada Basin. Global Biogeochemical Cycles. 30: 804-823.

Conference Presentations

- Mol J., Thomas H., Myers P.G., Hu X. and Mucci A. (2018) Inorganic carbon fluxes on the Mackenzie Shelf of the Beaufort Sea. Contributed poster. EGU General Assembly, April 8-13, 2018, Vienna, Austria.
- Maldonado M., Li J., Laroche J., Colombo M., Beaupré-Laperrière A., Orians K. and Mucci A. (2018) A hypothetical role of manganese-oxidizing bacteria on the distribution of particulate metals in the Canadian Arctic Ocean. Contributed oral presentation, Ocean Sciences Meeting, February 11-16, 2018. Portland, Oregon, U.S.A.
- Beaupré-Laperrière A., Mucci A. Thomas H. (2018) Time Series of Ocean Acidification in the Canadian Arctic Ocean. Contributed poster. Institut Nordique du Québec-Second Northern Research Day, January 24, 2018, McGill Faculty Club, Montreal, QC.
- Marshall N.R., de Vernal A., Mucci A. and Kucera M. (2017) Biogenic carbonate production and preservation in the northwestern Labrador Sea and central Baffin Bay during the Holocene and the Last Glacial Maximum (LGM). Contributed poster presentation, Fall AGU Meeting, December 11-15, 2017, New Orleans, Louisiana, U.S.A.
- Beaupré-Laperrière A., Mucci A. and Thomas H. (2017) Time Series of Ocean Acidification in the Canadian Arctic Ocean. Arctic Change 2017. Contributed poster, December 11-15, 2017, Québec City, Canada
- Beaupré-Laperrière A. and Mucci A. (2017) Complex vertical distributions of aragonite saturation states in the Canadian Arctic Archipelago and eastern Beaufort Sea explained by a water-mass analysis. Contributed poster, 100th Canadian Chemistry Conference and Exhibition, Canadian Institute of Canada, May 28-June 1, 2017, Toronto, ON.
- Marshall N., de Vernal A., Mucci A., Filippova A. and Kienast M. (2017) The Labrador Sea during the Last Glacial Maximum: Calcite dissolution or low biogenic carbonate fluxes? European Geosciences Union General Assembly, Contributed poster presentation, April 23-28, 2017, Vienna, Austria.

Paul Myers, Department of Earth and Atmospheric Sciences, University of Alberta

Refereed Journal Publications

- Hughes, K. G., J. M. Klymak, X. Hu, and P. G. Myers (2017), Water mass modification and mixing rates in a 1/128 simulation of the Canadian Arctic Archipelago, J. Geophys. Res. Oceans, 122, 803–820, doi:10.1002/2016JC012235.
- Nathan Grivault, Xianmin Hu & Paul G. Myers (2017) Evolution of Baffin Bay Water Masses and Transports in a Numerical Sensitivity Experiment under Enhanced Greenland Melt, Atmosphere-Ocean, 55:3, 169-194, DOI: 10.1080/07055900.2017.1333950

- Jacoba Mol, Helmuth Thomas, Paul G. Myers, Xianmin Hu, and Alfonso Mucci (2017), Inorganic carbon fluxes on the Mackenzie Shelf of the Beaufort Sea, Biogeosciences, 15, 1011–1027, 2018 https://doi.org/10.5194/bg-15-1011-2018

Conference Presentations

- FAMOS 2017 (Woods Hole, US) L. Castro de la Guardia, M. Claret, X. Hu, P. G. Myers, & E.G. Galbraith. Evaluating the importance of nutrient sources to primary production in the Arctic, a high resolution modelling experiment using BLINGv0-NEMO-LIM2 framework (poster) - Won 2nd Prize in HQP Poster Competition (~40-50 HQP posters)
- ESSA 2017 (Tromso, Norway). L. Castro de la Guardia, M. Claret, X. Hu, P. G. Myers, & E.G. Galbraith. A novel biogeochemical module for the NEMO ocean circulation model community, suitable for long-term simulations of ocean primary production and gas exchanges. Ecosystem Studies of Subarctic and Arctic Seas open science meeting 2017 in Tromso Norway. (poster)
- ESSA 2017 (Tromso, Norway). L. Castro de la Guardia, M. Claret, X. Hu, P. G. Myers, & E.G. Galbraith. Modelling the response of phytoplankton to storms. Ecosystem Studies of Subarctic and Arctic Seas open science meeting 2017 in Tromso Norway. (oral)
- Flow through the Canadian Arctic Archipelago: numerical model vs observations: Perspectives and improvements Nathan Grivault and Paul G. Myers. IGR 2018 (talk), Edmonton, April 4th
- Frequency of volume and freshwater events leaving the Arctic Ocean: A numerical study. Nathan Grivault, Laura Castro de la Guardia and Paul G. Myers. Ocean Sciences 2018 (poster): Portland, Feb. 11th-16th 2018
- Canadian Arctic Archipelago sea-ice motion and consequences on ocean transport: numerical errors and potential improvements from the addition of tides. Nathan Grivault, Xianmin Hu and Paul G. Myers. DRAKKAR Meeting (talk): Grenoble (France), Feb. 1st-4th
- Frequency of Volume and Freshwater Events Leaving the Arctic Ocean: A Numerical Study. Nathan Grivault, Laura Castro de la Guardia and Paul G. Myers. IGR 2017, October 2017

Training

- Winter School in Marine Environmental Prediction, Université du Québec à Rimouski (UQAR), March 4th-10 2017

<u>Dr. Andrew R.S. Ross</u>
Research Scientist, Institute of Ocean Sciences, Fisheries and Oceans Canada (DFO)
Assistant Adjunct Professor, Biochemistry and Microbiology, University of Victoria (UVic)

Refereed Journal Publications: 2 in preparation

Conference Presentations: 2

- Ross, A.R.S., Nixon, R.L. 2017. Profiling Marine Copper Ligands in the Arctic using Immobilized Metal-ion Affinity Chromatography and Tandem Mass Spectrometry. 100th Canadian Society for Chemistry (CSC) Conference, Toronto ON, 28-31 May.

- Ross, A.R.S., Janssen, D.J., Cullen, J.T., Spence, J., Simpson, K., Robert, M. 2018. Capturing "The Blob": Variability in Dissolved Trace Metal Concentrations along Line P During a Warming Anomaly. 19th Ocean Sciences Meeting, Portland OR, 21-26 February.

Summary:

During 2017-18 we used the Cu(II)-IMAC method published in 2016 (Nixon and Ross) to extract copper-complexing organic ligands from all of the samples collected during the Fall 2015 Canadian Arctic GEOTRACES cruise. The resulting depth profiles were presented during the Arctic GEOTRACES Workshop at UBC (May 23-25, 2017) and at the 100th CSC Conference in Toronto (May 28-31, 2017) in a session organized by members of Canadian Arctic GEOTRACES. These profiles constitute the first comprehensive survey of (operationally-defined) Cu ligands across the Canadian Arctic, from the Canada Basin through the CAA to Baffin Bay and the Labrador Sea. A manuscript presenting and interpreting these results in the context of complementary data collected by other GEOTRACES researchers during the same cruise (e.g. dCu, Chl-a, CDOM, nutrients, microbial taxonomy) is currently in preparation.

During the past year we also submitted replicate Cu(II)-IMAC extracts from samples collected during the Arctic GEOTRACES cruise and the Line P Iron Program (a GEOTRACES Process Study) for analysis by high performance liquid chromatography-high resolution mass spectrometry (HPLC-HRMS) at the UVic/Genome BC Proteomics Centre. Preliminary results revealed the presence of organic molecules with the same accurate mass/elemental composition and relative abundance in replicate IMAC extracts from the same location and depth. Elemental compositions suggest that these compounds contain O, N and/or S atoms capable of forming functional groups that can bind Cu^{2+} (and, possibly, other metal ions). Similar samples have been submitted to fellow GEOTRACES researcher Celine Gueguen at Trent University for further HRMS experiments involved tandem mass spectrometry (MS/MS) and the addition of copper to form complexes with the extracted ligands. Detection and identification of such complexes using parallel molecular (ESI-MS/MS) and elemental (ICP-MS) analysis is also being investigated.
Some IMAC extracts have been submit to Hannah Whitby at the University of Brest for voltammetric analysis in order to measure the concentrations and Cu-binding strengths of the recovered ligands. To help identify which species of phytoplankton/cyanobacteria produce copper ligands, and to generate sufficient quantities of these ligands for characterization and identification using MS and other techniques, we also plan to perform culture experiments in 2018/19 using large volume bioreactors now being installed at the Institute of Ocean Sciences.

Results from all these experiments are expected to shed new light on the structures, identities and ecological roles of marine Cu ligands in the NE Pacific and Arctic Oceans.
Filtered seawater samples collected as part of the Line P GEOTRACES Process Study have also been analysed for several trace elements (Mn, Fe, Co, Ni, Cu, Zn, Cd and Pb) using a recently published method (Jackson et al., 2017). The goal was to study changes in the distributions of these elements during a warm water anomaly (the 'Blob') that occurred in the subarctic NE Pacific between 2012 and 2016. Dissolved Fe, Cu, Ni, Co and Cd were

significantly depleted in surface waters along Line P during the intense stratification associated with the 'Blob'. Results were presented at the Ocean Sciences Meeting in Portland, OR (February 21-16, 2018) and at the annual Line P Workshop at the Institute of Ocean Sciences in Sidney, BC (March 20, 2018). A manuscript describing these results and interpreting them in the context of changes in plankton ecology and other oceanographic parameters (T, S, major nutrients) is currently in preparation.
We intend to submit these data to the GEOTRACES/BODC database once this is done.

References:

Nixon, R.L., Ross, A.R.S. 2016. Evaluation of immobilized metal-ion affinity chromatography and electrospray ionization tandem mass spectrometry for recovery and identification of copper(II)-binding ligands in seawater using the model ligand 8-hydroxyquinoline. Frontiers in Marine Science 3: 246. doi: 10.3389/fmars.2016.00246 (Marine Biogeochemistry Research Topic: Organic ligands - A key control on trace metal biogeochemistry. Sponsored by SCOR Working Group 139).

Jackson, S.L., Spence, J., Janssen, D. J. J., Ross, A. R. S., Cullen, J. T. 2017. Determination of Mn, Fe, Ni, Cu, Zn, Cd and Pb in seawater using offline extraction and triple quadrupole ICP-MS/MS. Journal of Analytical Atomic Spectroscopy. doi: 10.1039/C7JA00237H

John N. Smith, *Head, Atlantic Environmental Radioactivity Section*, *Bedford Institute of Oceanography*, *Fisheries and Oceans Canada, 1 Challenger Dr.*, *Dartmouth, NS Canada B2Y 4A2*

Summary:
On March 11, 2011, an earthquake-triggered tsunami off Japan severely damaged the Fukushima Dai-ichi Nuclear Power Plants resulting in the release of 15-20 PBq of ^{137}Cs in the greatest accidental discharge of radioactivity that has ever occurred directly into the ocean. The large inventory of radioactivity spread rapidly eastward across the ocean during the following five years and is now almost entirely resident in the eastern North Pacific. During 2017-18, continuing time series measurements of ^{129}I, ^{134}Cs and ^{137}Cs in seawater were carried out on samples collected in August, 2017 on a cruise of the CCGS Tully on Line P, an oceanographic section extending 1500 km westward from the British Columbia (BC) coastline. Large volume water samples were also collected by a University of Victoria student under the supervision of J. Cullen during the CCGS Laurier cruise on a transect from BC to Alaska in July, 2017. ^{129}I measurements on seawater samples collected in 2016 mainly indicate the presence of fallout-derived ^{129}I on Line P, although there are reports of a significant Fukushima ^{129}I signal that will continue to be investigated. This monitoring program sponsored by DFO and InFORM represents the major international effort to document the transport history of the Fukushima signal through the northeast Pacific Ocean. Fukushima derived ^{134}Cs was first observed at the westernmost station on Line P in the interior of the subpolar gyre in June 2012, about 1.3 years after the accident. By June 2013 the Fukushima signal had spread eastward at very low levels onto the Canadian continental shelf and by August 2014 had increased at the western end of Line P to a value of 5 Bq/m^3, four times the fallout background from atmospheric nuclear weapons tests. Fukushima ^{137}Cs levels continued to increase through 2016 to values of 6-8 Bq/m^3 as the Fukushima plume spread eastward on Line P at variable speeds depending on proximity to the core of the Alaska Current. By February and August, 2017 Fukushima ^{137}Cs levels had begun to level off

and very slightly decline by a factor of about 10% compared to 2016 maximum values. This result is in agreement with ocean circulation model predictions (Smith et al., 2017) that future levels of Fukushima ^{137}Cs off the BC coast will begin to decline in 2017-2018 in the upper 200 m and approach levels close to the fallout background of about 1 Bq/m^3 by 2021. Although present levels of ^{137}Cs in the eastern North Pacific from Fukushima inputs represent a return of eastern North Pacific seawater concentrations to the fallout levels that prevailed during the 1970s, they do not represent a radiological threat to human health or the environment.

Refereed Journal Publications

- Buesseler, K., Dai, M., Aoyama, M., Benitez-Nelson, C., Charmasson, S., Highley, K., Maderich, V., Masque, P., Oughton, D. and J.N. Smith, 2017. Fukushima Daiichi–Derived Radionuclides in the Ocean: Transport, Fate, and Impacts. *Annual Reviews Marine Science* 9:173-203.
- Smith, John N., Vincent Rossi, Ken O. Buesseler, Jay Cullen, Jack Cornett, Richard Nelson, Alison M. Macdonald, Marie Robert, and Jonathan Kellogg, 2017. Recent Transport History of Fukushima Radioactivity in the Northeast Pacific Ocean. *Environ. Sci. Tech.*, DOI: 10.1021/acs.est.7b0271.

Conference Presentations (invited)

- J.N. Smith, Transport of Fukushima radioactivity to the Eastern North Pacific, Sept 22, 2017; Plenary Presentation. 2017 Annual PICES Meeting, Vladivostok, Russia, Sept 20-27, 2017

Conference Presentations

- J.N. Smith, Marine applications of nuclear fuel reprocessing tracers in the global ocean. 2017 Goldschmidt Conference, Paris, France, August 12-18, 2017.
- Smith, J.N.; Casacuberta, N.; Christl, M.; Vockenhuber, C.; Cornett, J.; Kenna, T.; Guilderson, T. Synoptic tracer 129I sections across the Arctic Ocean from the 2015 German, US and Canadian GEOTRACES cruises. Ocean Sciences Meeting, Portland, Oregon, February 10-16, 2018

Media Coverage and Outreach Activities

- SCOR Training Course on Marine Radioactivity, Paris, France August 11, 2017,
- J.N. Smith, Artificial radionuclides from Fukushima used as tracers of marine processes,
- Media interviews on radioactivity transport: BBC, London Times, Christian Science Monitor.

Philippe Tortell, Earth and Ocean Sciences, University of British Columbia

Refereed Journal Publications

- Jarnikova T., Dacey J., Lizotte M., Levasseur, M. and P. Tortell. 2018. The distribution of methylated sulfur compounds, DMS and DMSP, in Canadian Subarctic and Arctic waters during summer, 2015. *Biogeoscience*. doi.org/10.5194
- Hoppe, CJM; Schuback, N; Semeniuk,; Giesbrecht, K; Mol, J; Thomas, H; Maldonado, MT; Rost, B; Varela, DE; Tortell, PD. 2018. Resistance of Arctic phytoplankton to ocean acidification and enhanced irradiance. Polar Biology Volume 41(3) p. 399-413.
- Hoppe, C, Schuback, N, Seminuik D., Giesbrecht K., Mol J., Thomas H., Maldonado M., Rost B., Tortell P. Compensation of Ocean Acidification effects in Arctic phytoplankton assemblages. 2018. Nature Climate Change, accepted, NCLIM-17081528B\

Conference Presentations

- 2018, ALSO / AGU Ocean Sciences Meeting (Portland, Oregon). Influence of mixing dynamics on net community production and CO2 uptake in Canadian Arctic and Subarctic ocean waters: P D Tortell, R Izett, M Chanona, J L Thibault, P G Myers
- 2018, ALSO / AGU Ocean Sciences Meeting (Portland, Oregon). Biogeochemical and physical controls on interannual and spatial variability in CH4 and N2O distributions across the North American Arctic Ocean: C C Manning, D W Capelle, L Fenwick, E Damm, P D Tortell

Diana Varela, University of Victoria

During the 2015 Canadian Arctic GEOTRACES, our group conducted primary productivity experiments that involved 24-hr incubations throughout the euphotic zone using 13-C, 15-NO3, 15-NH4, and 32-Si isotopic tracers. We also collected samples for particulate silica concentrations and the natural abundance of silicon isotopes. Phytoplankton productivity experiments were only conducted on the first leg of the 2015 Canadian Arctic Geotraces cruise, whereas samples for particulate silica concentrations and silicon isotopes were collected on both legs of the cruise. Analysis has been completed for all samples with the exception of the silicon isotope samples, for which analysis is currently underway.

Concentrations of bSiO2 and rates of Si utilization exhibited subsurface maxima, and followed similar spatial patterns, with a general increase from east to west. Subsurface maxima in C and NO3 utilization rates were less consistent, whereas high NH4 utilization rates always occurred at the bottom of the euphotic zone where NH4 concentrations increased. Both C and NH4 utilization rates showed the opposite trend to Si, with a decrease from east to west, while NO3 utilization rates showed little spatial variability. Initial results for Si isotopes potentially reflect Si utilization in modified Pacific water as this water mass travels from east to west through the Canadian Arctic Archipelago. This observation is supported by the eastward decrease in Si utilization rates and Si(OH)4 concentrations in the same direction.

Refereed Journal Publications

- Hoppe, C.J.M, N. Schuback, D. Semeniuk, K. Giesbrecht, J. Mol, H. Thomas, M.T. Maldonado, B. Rost, D.E. Varela, and P.D. Tortell (2017) Resistance of Arctic phytoplankton to ocean acidification and high irradiance. Polar Biology. doi:10.1007/s00300-017-2186-0.

- 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, doi:10.1002/2015GB005277.

Conference Presentations

- Varela, D.E., Giesbrecht, K.E., de Souza, G.F, and Maden, C. (2018) From the Bering Sea to Baffin Bay: Biogenic Silica Production and Natural Silicon Isotopic Signatures across the Arctic Ocean. (Talk). AGU Ocean Sciences Conference, Portland, OR, USA.
- Giesbrecht, K.E. and Varela, D.E. (2017) Tracing biological silicon utilization in Arctic surface waters using Si incubation experiments and natural variations of Si isotopes. (Talk). Isotopes in Biogenic Silica (IBiS) Conference, Blanes, Spain.
- Giesbrecht, K.E. and Varela, D.E. (2017) Silicon Biogeochemistry in Arctic waters during 2015 Canadian Geotraces: Biogenic silica production and natural silicon isotopic signatures. (Talk). Canadian Arctic GEOTRACES Workshop, Vancouver, Canada.
- Timmerman, A., Giesbrecht, K.E., Shuback, N., Li, J., Hamme, R.H. Varela, D.E., Maldonado, M., and Tortell, P. (2017) Primary Productivity during 2015 Canadian Arctic Geotraces. (Talk). Canadian Arctic GEOTRACES Workshop, Vancouver, Canada.
- Varela, D.E., and Giesbrecht, K.E. (2017) Silicon Biogeochemistry in Arctic and Sub-Arctic waters during 2015 Canadian Geotraces: Biogenic silica production and natural Si isotopic signatures. (Talk). ASLO Aquatic Sciences Conference, Honolulu, HI, USA.
- Timmerman, A., Hamme R.H., Miller L.A., Francois R., Soon M., Giesbrecht K., and Varela, D.E. (2017) Spatial Variability of Carbon Export from the Sub-Arctic to the Arctic Ocean. (Talk) *ASLO Aquatic Sciences Conference, Honolulu, HI, USA.*
- Hoppe, C.J.M., Schuback, N., Wolf, K., Semeniuk, D., Giesbrecht, K.E., Varela, D., Maldonado, M.T., Rost, B., and Tortell, P.D. (2016) Combined effects of ocean acidification and enhanced irradiances on Arctic phytoplankton assemblages – Why don't they care? (Poster). Gordon Research Conference on Ocean Global Change Biology, Waterville Valley, NH, USA.
- Hoppe, C.J.M., Schuback, N., Semeniuk, D., Giesbrecht, K.E., Maldonado, M.T., Varela, D., and Tortell, P.D. (2015) Combined effects of ocean acidification and enhanced irradiances on Arctic phytoplankton assemblages – Why don't they care? (Talk). ArcticNET Annual Scientific Meeting 2015, Vancouver, BC.

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

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN CHINA

May 1st, 2017 to April 30th, 2018

This year, GEOTRACES-China continued to develop albeit the lack of formal recognition as a special group with specific funding. Its major activities are highlighted in two aspects below.

(1) Several groups in China have been doing analysis of the seawater samples collected during the 2015 GEOTRACE GP06-CN cruise to the Yellow Sea and East China Sea. Results are being put together for publication. The main findings include: trace metal is high in Yellow Sea than East China Sea; high Ni, Cu, and Cd in Changjiang diluted waters, but low Zn and Pb; Pb shows different distribution patterns from the other metals, minima found in subsurface; high metal concentrations was found near coast; conservative behavior of Cu in the whole East China Sea, only one single strong Cu binding ligand; an interception of 72.83 nM Cu, suggested higher Cu endmember from Changjiang, i.e. higher than 1980s-2000s, higher than the US east coast rivers; much higher Cu in the Yellow Sea and Bohai Sea, suggested anthropogenic input? Pb is from atmospheric deposition and with short residence time in surface waters; hydrothermal influenced sediment might be an important source for Fe and other metals to overlying water column in Okinawa Trough.

(2) Two sea trial cruises (2-14 August, 2017 and 9-18 March, 2018) with the newly launched R/V *Tan Kah Kee* of Xiamen University were completed in the South China Sea and western Pacific. Sampling systems were tested and seawater samples collected are being analyzed. A international planning meeting for the first GEOTRACES-China cruise is scheduled for May, 2018.

Other cruises included the one to Yangtze River Estuary in August, 2017, the other one in Jinzhou Bay in September, 2017.

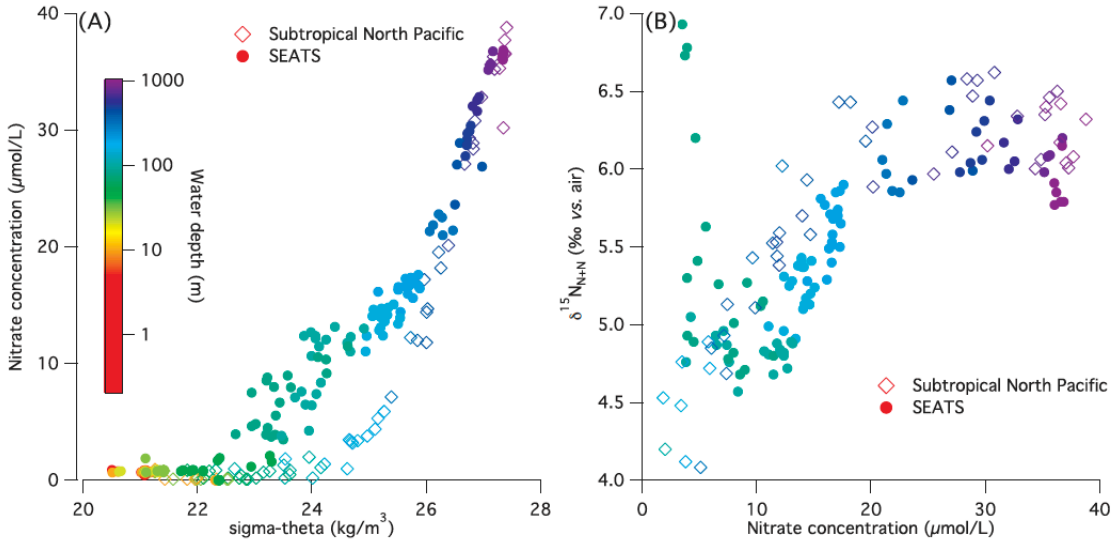
Another Open Day for the R/V *Tan Kah Kee* was successfully held in April, which coincided with the visit of the Tara to Xiamen China.

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

New scientific results

Dr. Haojia Ren at National Taiwan University have set up denitrifier method in conjunction with gas chromatography and isotope ratio mass spectrometry (Thermo MAT 253 plus) for isotopic measurements on N_2O gas. The current sensitivity is 5nmol N, precision is 0.07‰ and 0.1‰ for $\delta^{15}N$ and $\delta^{18}O$ in seawater nitrate samples. They have also set up clean lab for treatment of dissolved and particulate organic nitrogen which would be oxidized into nitrate using persulfate and analysed for $\delta^{15}N$ using denitrifier method.

Dr. Ren's group have analysed seawater samples from open subtropical North Pacific and South China Sea (SCS), in order to better constrain the nitrate $\delta^{15}N$ minimum in the shallow thermocline. The shallow thermocline (i.e. the depth range of 100-200 m) of the modern SCS has much higher nitrate concentration (10-15 μM) than the same water depth or density level in the open subtropical North Pacific (<5 μM; Figures 1). As a result, lateral exchange of the upper 200 m of the water column with the open western North Pacific has minimal capacity to change the $\delta^{15}N$ of nitrate in this depth range of the SCS. Therefore, the upward decline in nitrate $\delta^{15}N$ observed in the SCS thermocline is probably mostly generated within the SCS.



Dr. Tung-Yuan Ho's group has studied the major source of soluble iron in the surface water of the Northestern Pacific Ocean and its marginal seas. In addition to metal concentrations and their solubility in the size-fractionated aerosols, Dr. Ho's group also measured Fe isotope ratios in both the total digested samples and the soluble fractions of the size-fractionated aerosols collected daily size-fractionated aerosol samples, including PM 2.5 and PM 2.5-10, at Taiwan Dongsha Atoll Research Station, an ideal location for monitoring seasonal aerosol deposition in the NWPO and its marginal seas. Evidently confirmed by specific metal elemental ratios and characteristic Fe isotopic ratios in the size-fractionated aerosols, Dr. Ho and his group members have demonstrated that the major source of soluble Fe in the surface water originates from anthropogenic aerosols but not lithogenic dusts.

New projects and/or funding

A five year project proposed by Haojia Abby Ren to Taiwan Ministry of Science and Technology (MOST) has been funded. The title of the project is: *Past and Present Evolution of Global Ocean Nitrogen Cycle: Implications from Studies in the Western Tropical North Pacific and South China Sea*. We propose four GEOTRACES cruises and one long-term monitoring station in the WTNP and the SCS to quantify temporal and spatial changes in nitrogen fluxes using nitrogen isotopes. The main objectives of four cruises and station are: 1) to offer routine and reliable measurements of water column nitrate isotope, which could be used to expand modern ocean database and evaluate paleoceanographic proxies; 2) to measure spatial and seasonal changes in N fixation rate, major nutrient and trace element, atmospheric deposition, that could be used to yield insights to the controls of marine N cycle; 3) to quantify and study the dynamics of dissolved inorganic nitrogen, suspended and sinking particulate organic nitrogen, and surface living cells of different phyto- and zoo- planktons as well as detritus in the surface ocean, which will be used to understand the surface N recycling processes in this region with implications for general seasonally stratified oligotrophic surface ocean systems. The GEOTRACES scientific cruises are most likely to be carried out from 2019 to 2022.

GEOTRACES workshops and meetings

- 2018 GEOTRACES SSC meeting and training workshop would be held in Taipei from July 23 to 26, 2018, which is hosted by Tung-Yuan Ho. A GEOTRACES training workshop will be held on 26th at Academia Sinica with topics including the introduction of GEOTRACES and IDP2017, TEI sampling and analysis, and ODV application and operation.

Outreach activities

- "Learning Oceanography by cartoon posters & Q&A with gifts", October 28, 2017, Academia Sinica Open house, https://openhouse.sinica.edu.tw/#/

New publications (published or in press)

- Yang, S.-C., J. Zhang, Y. Sohrin, and T.-Y. Ho (2018) Cd cycling in the water column of the Kuroshio-Oyashio Extension region: insights from dissolved and particulate isotopic composition. *Geochimica et Cosmochimica Acta in press*
- Rodriguez, I. B. and T.-Y. Ho (2018) Trace metal requirements and interactions in *Symbiodinium kawagutii*. *Frontiers in Microbiology* doi: 10.3389/fmicb.2018.00142.
- Rodriguez, I. B. and T.-Y. Ho (2017) Interactive effects of spectral quality and trace metal availability on the growth of *Trichodesmium* and *Symbiodinium*. *PLoS ONE* doi: 10.1371/journal.pone.0188777.
- Haojia Ren, Daniel M. Sigman, Alfredo Martinez-Garcia, Robert F. Anderson, Min-Te Chen, Ana Christina Ravelo, Marietta Straub, George T.F. Wong, Gerald Haug (2017), Impact of glacial/interglacial sea level change on the ocean nitrogen cycle, *PNAS*, 114(33), 6759-6766.

Presentations in international conferences

- Haojia Ren, Ocean fertilization by natural and anthropogenic nitrogen input in the past and present, AOGS Early Career Researcher Distinguished Lecture, Singapore, 2017 (invited talk).

Submitted by Haojia Abby Ren (abbyren@ntu.edu.tw)

New scientific results

The Croatian GEOTRACES activities were mainly 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 a new sample changer for an automated system for determination of trace metals in natural waters (Voltammetric AutoAnalyser - Volt-AA) and solid (gold array micro disc) micro sensors for analysis of trace metals, 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 colloidal S species, including nanoparticles, in natural waters, 5) characterization of marine aerosolos (PM2.5) regarding presence of organic matter, sulfur species and trace metals; 6) improvement od multielemental analysis in geological materials; 7) study of trace elements as indicators of environmental changes in lakes; 8) study of organotin persistence in marine sediments; 9) study of stability of silver nanoparticles in seawater

New projects and/or funding

Current 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”
- 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: National Monitoring program of coastal Adriatic Sea (Croatian side) (trace metals, organic matter, organic pollutants)
- Collaboration on VALSE project (2017-2020) "Nouvelles ressources transfrontalières : vers une validation de scenarii de valorisation de sédiments et autres matériaux” INTERREG France - Wallonie – Vlaanderen

Outreach activities

- Accreditation of TOC, DOC, POC measurements in natural waters, including seawater and sediments according to HRN EN ISO/IEC 17025:2007. Accreditation Nb.1577.

Other activities

Active participation in the COST Actions TD 1407and SCOR WG 139 and 145.

- N. Mikac, F. Pošćić, Ž. Fiket, N. Bačić, S. Perica, Rare earth elements (REE) transport from soil to olive and olive oil (2018). Ospina-Alvarez, N., Zimmermann, S. and Aruoja, V. (Eds). Book of Abstracts of the Workshop on Technology Critical Elements in Ecosystem and Human Health. NOTICE-COST action TD1407. Tallinn, Estonia. 19-20.4.2018.
- Participation in intercalibration exercise organized by COST action TD1407 on TCE (and other elements) in sediment.

New publications (published or in press)

- Bura-Nakić, E., Andersen M.B., Archer C., de Souza F., Marguš M., Vance D., Coupled Mo-U abundances and isotopes in a small marine euxinic basin: constraints on processes in euxinic basins, Geochimica et Cosmochimica Acta. 222 (2018); 212-229
- Furdek Turk, Martina; Senta, Ivan; Kniewald, Goran; Mikac, Nevenka.Determination of organotin compounds (OTC) at low levels in seawater by solid-phase extraction (SPE) and gas chromatography-pulsed flame photometric detection (GC-PFPD). // International journal of environmental analytical chemistry. 98 (2018), 1; 1-15).
- Fiket, Željka; Ivanić, Maja; Furdek Turk, Martina; Mikac, Nevenka; Kniewald, Goran. Distribution of trace elements in waters of the Zrmanja River estuary (eastern Adriatic coast, Croatia). // Croatica Chemica Acta. (2018), accepted.
- Filip Pošćić; Marko Runjić; Maja Jukić Špika; Nevenka Mikac; Zed Rengel; Marija Romić; Branimir Urlić; Niko Bačić; Mavro Lučić; Helena Bakić; Željka Fiket; Frane Strikić; Tatjana Klepo; Slavko Perica., Nutrient deficiencies in olives grown on typical Mediterranean soils (Terra rossa, Rendzina, Lithosol). // Archives of Agronomy and Soil Science. (2018), accepted.
- Fiket, Željka; Mikac, Nevenka; Kniewald, Goran. Influence of the geological setting on the REE geochemistry of estuarine sediments: a case study of the Zrmanja River estuary (eastern Adriatic coast). // Journal of geochemical exploration. 182 (2017), Part A; 70-79.
- Fiket, Željka; Pikelj, Kristina; Ivanić, Maja; Barišić, Delko; Vdović, Neda; Dautović, Jelena; Žigovečki Gobac, Željka; Mikac, Nevenka; Bermanec, Vladimir; Sondi, Ivan; Kniewald, Goran. Origin and composition of sediments in a highly stratified karstic estuary: an example of the Zrmanja River estuary (eastern Adriatic, Croatia). // Regional Studies in Marine Science. 16 (2017); 67-78.
- Ivanić, Maja; Lojen, Sonja; Grozić, Dino; Jurina, Irena; Škapin, Srečo D.; Troskot-Čorbić, Tamara; Mikac, Nevenka; Juračić, Mladen; Sondi, Ivan. Geochemistry of sedimentary organic matter and trace elements in modern lake sediments from transitional karstic land-sea environment of the Neretva River delta (Kuti Lake, Croatia). // Quaternary international. (2017), accepted.

- Participation in publication of the e-book: "Organic Ligands in Marine Trace Metal Biogeochemistry" https://www.frontiersin.org/books/Organic_Ligands_in_Marine_Trace_Metal_Biogeochemistry/1431

Presentations in international conferences

- Ciglenečki I, Marguš M, Čankovic M, Cvitešić A, Petrić I, Collins G, Redox regime shifts in euxinic marine environment (Rogoznica Lake, eastern Adriatic coast), 255th ACS Meeting, New Orleans March 2018, Geochemistry session
- Helz GR, Ciglenečki, I, The phantom of euxinia: zero-valent sulphur, Goldschmidt Conference Paris 2017, France

Submitted by Irena Ciglenečki-Jušić (irena@irb.hr).

New scientific results

- 1. Dissolved element distribution along GEOVIDE section (GA01) in the North Atlantic

  1.1 Dissolved Fe (DFe): Tonnard et al. (2018)

  Elevated DFe concentrations were observed above the Iberian, Greenland and Newfoundland Margins likely due to riverine inputs from the Tagus River, meteoric water inputs and sedimentary inputs (Figure 3). Increasing DFe concentrations along the flow path of the Labrador Sea Water were attributed to sedimentary inputs from the Newfoundland Margin. Bottom waters from the Irminger Sea displayed high DFe concentrations likely due to the dissolution of Fe-rich particles from the Denmark Strait Overflow Water and the Polar Intermediate Water.

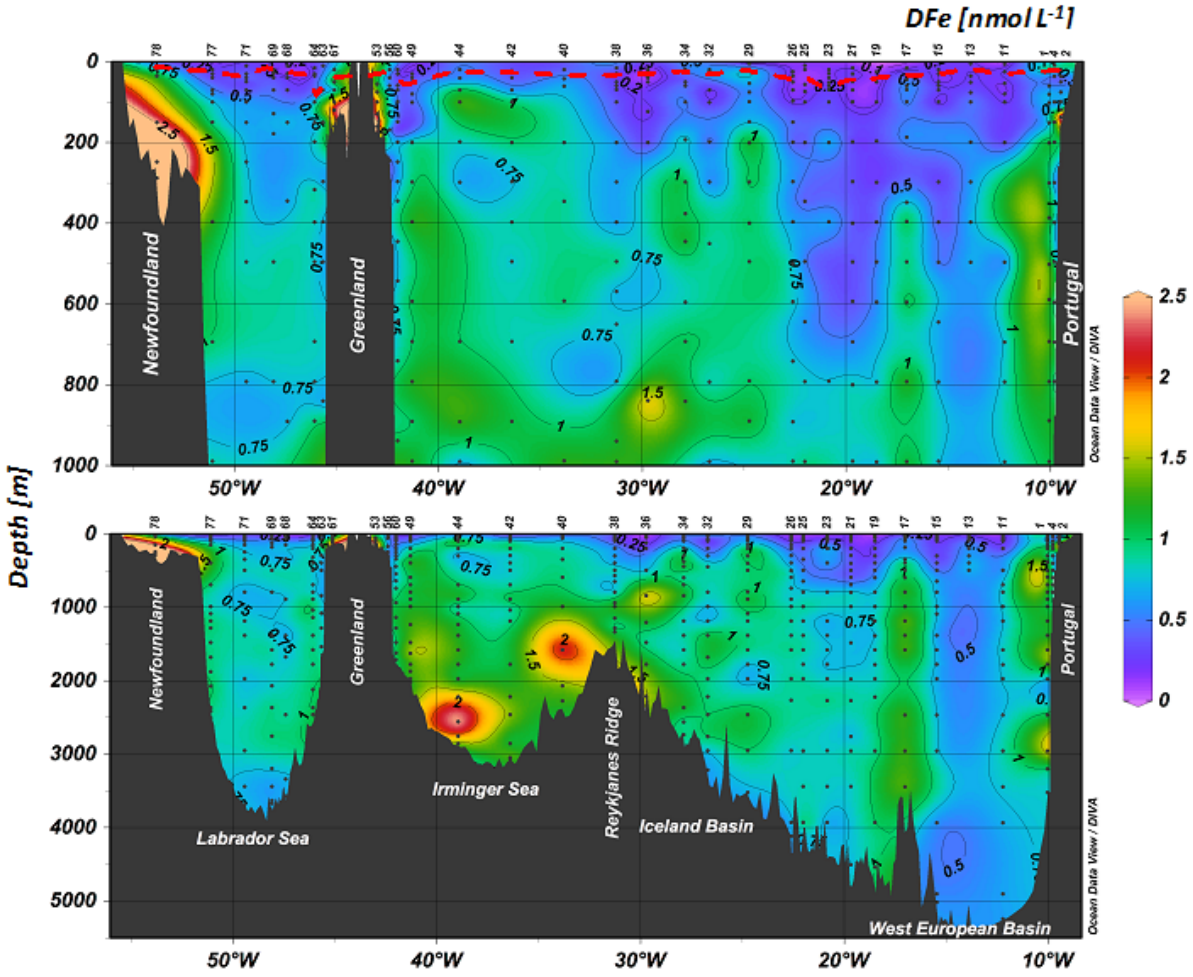


Figure 3. *DFe concentrations along the GA01 transect: upper 1000 m (top) and full depth range (bottom). The red dashed line indicates the depth of the Surface Mixed Layer (SML). Small black dots represent collected water samples at each sampling station. (Ocean Data View (ODV) software, version 4.7.6, R. Schlitzer, http://odv.awi.de, 2016).*

1.2. ^{226}Ra: Le Roy et al. (2017)

Dissolved ^{226}Ra and Ba are strongly correlated along the GA01 section, a pattern that may reflect their similar chemical behavior (Figure 4). Results show that the measured ^{226}Ra and Ba concentrations can be explained by conservative mixing, notably at intermediate depth, away from the ocean interfaces. Decoupled behaviors were identified, mostly at the ocean boundaries (seafloor, continental margins, and surface waters).

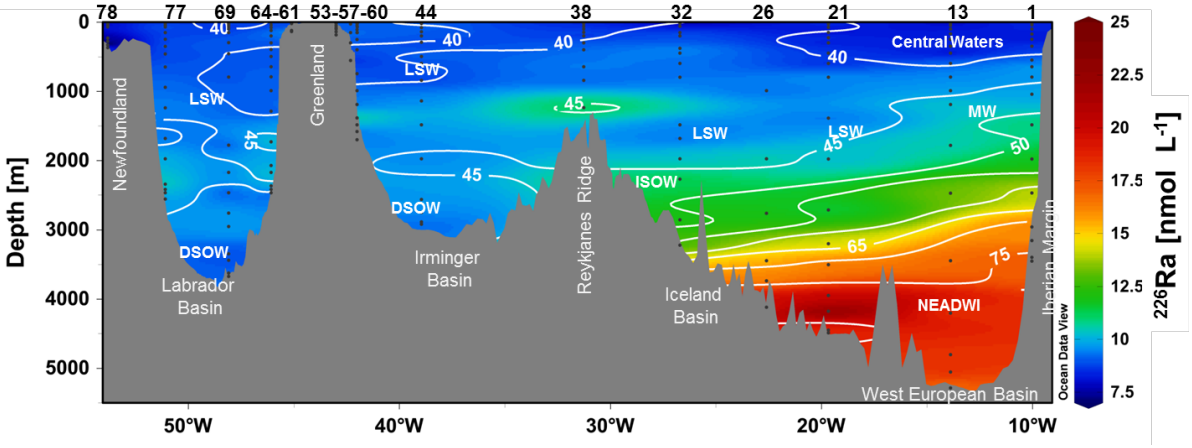


Figure 4. *Distribution of dissolved ^{226}Ra activities and dissolved Ba concentrations (nmol/L white contour lines) along the GA01 section. Station numbers are found on top of the panel. The sampling depths for ^{226}Ra are shown for each vertical profile (black dots). (Ocean Data View (ODV) software, version 4.7.6, R. Schlitzer, http://odv.awi.de, 2016).*

- 2. Atmospheric inputs to North Atlantic and Mediterranean Sea

2.1. Regional trends in the fractional solubility of Fe and other metals from North Atlantic aerosols: Shelley et al. (2018)

The fractional solubility of a suite of aerosol elements (Al, Ti, Fe, Mn, Co, Ni, Cu, Zn, Cd and Pb) was investigated on samples collected during three GEOTRACES cruises to the North Atlantic Ocean using a two-stage leaching (ultra high-purity water and 25% acetic acid). Results show that 1) the aerosols from the North Africa were always the least soluble, and the most homogeneous, 2) aerosols from the most remote locations were generally the most soluble and 3) primarily pollution-derived TEs (Ni, Cu, Zn, Cd and Pb) were significantly enriched above crustal values in aerosols. The same leaching technique can be used to estimate trace element solubility from suspended particulate matter (SPM), which facilitates direct comparison of soluble fractions between SPM and aerosols.

2.2. Release of Fe, N and P from Saharan dust to the Mediterranean Sea under future pH conditions: Louis et al. (2017a)

To evaluate potential influence of ocean acidification on partial dust dissolution, minicosms experiments were carried out by adding Saharan dust to Mediterranean Sea water under lower pH conditions. Results indicate that Fe, N and P release is not sensitive to examined pH range.

Cruises

- GEOTRACES **PEACETIME** process study took place in the Western/Central Mediterranean Sea May 10–June 11, 2017 cruise onboard the *R/V 'Pourquoi Pas?'* (Chief and co-chief Scientists C. Guieu and K. Desboeufs).

  http://peacetime-project.org/

  https://twitter.com/peacetimecruise and vimeo.com/channels/peacetime

- Participation to UK Fridge cruise GEOTRACES section (PhD students L. Artigue and D. Gonzalez-Santana, PIs M. Lohan and A. Tagliabue)

New projects and/or funding

- GEOTRACES **TONGA** process study aims at studying the control of ocean productivity and carbon sequestration by micronutrients of hydrothermal origin (PIs S. Bonnet and C. Guieu). The cruise proposal was ranked Priority 1 by the National Fleet Commission and the cruise is likely to be scheduled in Nov-Dec 2019. Several projects for funding (included preselected project to the ANR) are currently under evaluation and one letter of intent were submitted to the French programs LEFE and TELLUS for submission of proposal for the next call.
- **SWINGS** (South West Indian Geotraces Section) cruise proposal was submitted (PIs C. Jeandel and H. Planquette). The National scientific committee which attributes the ship time gave the highest priority to SWINGS on the R/V Marion-Dufresne for 2019-2020. CJ and HP are presently seeking funds to pay the research related to SWINGS.

GEOTRACES workshops and meetings

- Participation to the **27th Goldschmidt Conference** in Paris, Aug 27: presentation of works related to KEOPS (Geotraces process study), PANDORA and GEOVIDE (Geotraces Fr Section) and analytical developments.
- GEOVIDE meeting 2017: 17 oral presentations, http://www.geovide.obs-vlfr.fr/post-cruise-meeting-18-19-december-2017/

Outreach activities

- Contribution to the realization of the **Geotraces video** "21 questions and answers about GEOTRACES" published in 2017 on the Geotraces website (C. Jeandel and E. Masferrer Dodas)
  http://www.geotraces.org/outreach/other-outreach-materials/videos/1468-21-questions-and-answers

Other activities

- Organization of the **first GEOTRACES Summer School**. 60 participants from 18 countries and 26 international lecturers (https://geotracesschool.sciencesconf.org/). Participation of C. Jeandel and F. Lacan as lecturer.
- **Special issue** related to the **GEOVIDE project** in Biogeosciences. https://www.biogeosciences.net/special_issue900.html. Guest editor: G. Henderson, M.

Lohan, L. Bopp, C. Jeandel, and G. Reverdin. 2 published, 3 accepted, 5 submitted, 11 to be submitted.

- A 2-week full course to 16 master students and miscellaneous professional colleagues from Rio and Sao Paolo about oceanic cycles of TEIs and more specifically REEs & Nd isotopes by C. Jeandel (following an invitation of Pr V. Hatje (UFBahia, Brazil) and a SCOR travel support).
- Participation to the Salvador DMC & SSC meetings (C. Jeandel).
- Presentation EXploring the role of PArticles in Trace Element cycling in the central Arctic Ocean (TransarcII cruise, GEOTRACES GN04) during French programme LEFE meeting 2018, Bordeaux by Planquette et al.

New publications (published or in press)

Publications of which French investigators are leading authors or co-authors.

- Abadie, C., Lacan, F., Radic, A., Pradoux, C., and Poitrasson, F., 2017. Iron isotopes reveal distinct dissolved iron sources and pathways in the intermediate versus deep Southern Ocean. Proceedings of the National Academy of Sciences 114, 858-863.
- Bejannin, S., van Beek, P., Stieglitz, T., Souhaut, M., and Tamborski, J., 2017. Combining airborne thermal infrared images and radium isotopes to study submarine groundwater discharge along the French Mediterranean coastline. Journal of Hydrology: Regional Studies 13, 72-90.
- Benetti, M., Reverdin, G., Lique, C., Yashayaev, I., Holliday, N. P., Tynan, E., Torres Valdes, S., Lherminier, P., Tréguer, P., and Sarthou, G., 2017. Composition of freshwater in the spring of 2014 on the southern Labrador shelf and slope. Journal of Geophysical Research: Oceans 122, 1102-1121.
- Cossa, D., Heimbürger, L. E., Pérez, F. F., García-Ibáñez, M. I., Sonke, J. E., Planquette, H., Lherminier, P., Boutorh, J., Cheize, M., Menzel Barraqueta, J. L., Shelley, R., and Sarthou, G., 2018a. Mercury distribution and transport in the North Atlantic Ocean along the GEOTRACES-GA01 transect. Biogeosciences 15, 2309-2323.
- Cossa, D., Heimbürger, L. E., Sonke, J. E., Planquette, H., Lherminier, P., García-Ibáñez, M. I., Pérez, F. F., and Sarthou, G., 2018b. Sources, cycling and transfer of mercury in the Labrador Sea (Geotraces-Geovide cruise). Marine Chemistry 198, 64-69.
- Ganachaud, A., Cravatte, S., Sprintall, J., Germineaud, C., Alberty, M., Jeandel, C., Eldin, G., Metzl, N., Bonnet, S., Benavides, M., Heimburger, L.-E., Lefèvre, J., Michael, S., Resing, J., Quéroué, F., Sarthou, G., M., R., Berthelot, H., Baurand, F., Grelet, J., Hasegawa, T., Kessler, W., Kilepak, M., Lacan, F., Privat, E., Send, U., Van Beek, P., Souhaut, M., and Sonke, J., 2017. The Solomon Sea: its circulation, chemistry, geochemistry and biology explored during two oceanographic cruises. . Elementa Science of the Anthropocene doi.org/10.1525/elementa.221.
- Kipp, L. E., Sanial, V., Henderson, P. B., van Beek, P., Reyss, J.-L., Hammond, D. E., Moore, W. S., and Charette, M. A., 2018. Radium isotopes as tracers of hydrothermal inputs and neutrally buoyant plume dynamics in the deep ocean. Marine Chemistry GEOTRACES Special Issue 201, 51-65.

- Le Gland, G., Mémery, L., Aumont, O., and Resplandy, L., 2017. Improving the inverse modeling of a trace isotope: how precisely can radium-228 fluxes toward the ocean and submarine groundwater discharge be estimated? Biogeosciences 14, 3171-3189.
- Le Roy, E., Sanial, V., Charette, M. A., van Beek, P., Lacan, F., Jacquet, S. H. M., Henderson, P. B., Souhaut, M., García-Ibáñez, M. I., Jeandel, C., Pérez, F. F., and Sarthou, G., 2017. The 226Ra-Ba relationship in the North Atlantic during GEOTRACES-GA01. Biogeosciences Discuss (Geovide Special Isse). 2017, 1-36.
- Lemaitre, N., Planquette, H., Planchon, F., Sarthou, G., Jacquet, S., García-Ibáñez, M. I., Gourain, A., Cheize, M., Monin, L., André, L., Laha, P., Terryn, H., and Dehairs, F., 2018. Particulate barium tracing of significant mesopelagic carbon remineralisation in the North Atlantic. Biogeosciences 15, 2289-2307.
- Louis, J., Gazeau, F., and Guieu, C., 2017a. Atmospheric nutrients in seawater under current and high pCO2 conditions after Saharan dust deposition: Results from three minicosm experiments. Prog. Oceanogr. https://doi.org/10.1016/j.pocean.2017.10.011
- Louis, J., Guieu, C., and Gazeau, F., 2017b. Nutrient dynamics under different ocean acidification scenarios in a low nutrient low chlorophyll system: The Northwestern Mediterranean Sea. Estuar. Coast. Shelf Sci. 186, 30-44.
- Menzel Barraqueta, J. L., Schlosser, C., Planquette, H., Gourain, A., Cheize, M., Boutorh, J., Shelley, R., Pereira Contreira, L., Gledhill, M., Hopwood, M. J., Lherminier, P., Sarthou, G., and Achterberg, E. P., 2018. Aluminium in the North Atlantic Ocean and the Labrador Sea (GEOTRACES GA01 section): roles of continental inputs and biogenic particle removal. Biogeosciences Discuss. 2018, 1-28.
- Prestes, Y. O., Silva, A. C., and Jeandel, C., in press. Amazon water lenses and the influence of the North Brazil Current on the continental shelf. Estuarine & Continental Shelf Research.
- Sanial, V., Kipp, L. E., Henderson, P. B., van Beek, P., Reyss, J. L., Hammond, D. E., Hawco, N. J., Saito, M. A., Resing, J. A., Sedwick, P., Moore, W. S., and Charette, M. A., 2018. Radium-228 as a tracer of dissolved trace element inputs from the Peruvian continental margin. Marine Chemistry GEOTRACES Special Issue 201, 20-34.
- Shelley, R. U., Landing, W. M., Ussher, S. J., Planquette, H., and Sarthou, G., 2018. Regional trends in the fractional solubility of Fe and other metals from North Atlantic aerosols (GEOTRACES cruises GA01 and GA03) following a two-stage leach. Biogeosciences 15, 2271-2288.
- Shelley, R. U., Roca-Martí, M., Castrillejo, M., Sanial, V., Masqué, P., Landing, W. M., van Beek, P., Planquette, H., and Sarthou, G., 2017. Quantification of trace element atmospheric deposition fluxes to the Atlantic Ocean (>40°N; GEOVIDE, GEOTRACES GA01) during spring 2014. Deep Sea Research Part I: Oceanographic Research Papers 119, 34-49.
- Tonnard, M., Planquette, H., Bowie, A. R., van der Merwe, P., Gallinari, M., Desprez de Gésincourt, F., Germain, Y., Gourain, A., Benetti, M., Reverdin, G., Tréguer, P., Boutorh, J., Cheize, M., Menzel Barraqueta, J. L., Pereira-Contreira, L., Shelley, R., Lherminier, P., and Sarthou, G., 2018. Dissolved iron in the North Atlantic Ocean and Labrador Sea along the GEOVIDE section (GEOTRACES section GA01). Biogeosciences Discuss. 2018, 1-53.

- Zurbrick, C. M., Boyle, E. A., Kayser, R., Reuer, M. K., Wu, J., Planquette, H., Shelley, R., Boutorh, J., Cheize, M., Contreira, L., Menzel Barraqueta, J. L., and Sarthou, G., 2018. Dissolved Pb and Pb isotopes in the North Atlantic from the GEOVIDE transect (GEOTRACES GA-01) and their decadal evolution. Biogeosciences Discuss. 2018, 1-34.

PhD theses

- Viet Pham (2017-2020) REE and Nd isotopes collected as part of PANDORA (GP12), LEGOS.
- Lise Artigue (2016-2019): Biogeochemical cycles in the Austral and Southern Ocean, studied with iron isotopes, LEGOS
- Emilie Le Roy (2016-Dec 2018) The distribution of natural radionuclides along the GA01-GEOTRACES section (GEOVIDE) in the N. Atlantic, LEGOS.
- Simon Bejannin (2016-2018) The fluxes of chemical elements associated with SGD (Submarine Groundwater Discharge) and transferred to the coastal seas, LEGOS.
- Houda Beghoura (2016-2019) Modelling the role of sedimentary particulate Fe, LOPS and LEMAR.
- Guillaume Le Gland (2014-2018) GEONAM (GEOtraces North Atlantic Modeling) ^{228}Ra and ^{234}Th, LEMAR and LOCEAN.
- Manon Tonnard, Iron biogeochemical cycle: distribution, speciation and co-impact on the phytoplankton growth in the North Atlantic and Southern Oceans, started in October 2015 (defense on 6 July 2018), LEMAR/UBO (Brest) and UTAS (Tasmania, Australia)
- David Gonzalez Santana, Impact des sources hydrothermales sur les cycles biogéochimiques des métaux traces (2017-2020), LEMAR
- Natasha Van Horsten, Seasonal characterization of Fe speciation in the Southern Ocean (Atlantic sector) (2017-2020), LEMAR and Stellenbosch University.

Presentations in international conferences

Presentation of which French investigators are leading authors or co-authors.

- Artigue L., Lacan F., C. Pradoux. Iron isotopic fractionation by phytoplankton uptake off Kerguelen Islands. Goldschmidt Conference, Paris (France), Poster, August 2017.
- Artigue L., Lacan F., Pradoux C., Sarthou G., Iron isotopic insights into the iron cycle around the Kerguelen Islands, 2018, Ocean Sciences Meeting, 11-16 February.
- Benetti M., Reverdin G., Holliday N., Olafsdottir S., Lherminier P., Sarthou G., de Steur L., Sveinbjörnsdóttir A., Olafsson J., Freshwater fluxes between the Arctic Ocean and the North Atlantic from water stable isotopes: study of coastal currents and interior of the subpolar gyre, 2018, Ocean Sciences Meeting, 11-16 February
- Baker A., Sarin M, Duce R, Jickells T, Kanakidou M, Myriokefalitakis S., Ito A., Turner D, Mahowald N, Middag R, Guieu C, Gao Y, Croot P, Shelley R, Perron M, Changing Atmospheric Acidity and the Oceanic Solubility of Nutrients, EGU General Assembly Conference, 2017

- Bejannin S., Tamborski J., Souhaut M., Radakovitch O., Claude C., Stieglitz T., Crispi O., Pujo-Pay M., Conan P., Caparros J., Heimburger L.-E., Petrova M., Le Roy E., Lacan F., van Beek P. Combining airborne thermal infrared images, radium isotopes and radon to study Submarine Groundwater Discharge along the French Mediterranean coastline (Cote Bleue). EGU, Vienna, Austria. Oral, April 2017.
- Boutorh J., G. Sarthou, A.G. Gonzalez, M. Cheize, H. Planquette, E. Bucciarelli, Mickaël Vaïtilingom, Laurent Deguillaume, Virginie Vinatier, Anne-Marie Delort, G. Mailhot, Iron Organic Complexation In Cloud Water Samples From The Puy De Dôme Station (France). ATMOCHEMBIO meeting (19-June 2017, Clermont-Ferrand)
- Bressac M., MJ Ellwood, M Fourquez, P Masqué, V Puigcorbé, S Jacquet, P G Strutton, T W Trull, T Wagener, C Guieu, P W Boyd, Mesopelagic Iron Remineralization Patterns in High-Latitude, Low-Iron and Low-Latitude, High-Iron Oceanic Regions, AGU, ASLO, Ocean Sciences Meeting, 11-16 Feb, 2018, Portland, USA (oral presentation)
- Cheize M., H. Planquette, D. Gonzalez-Santa, H. Whitby, A. Gourain, T. Holmes, V. Guyader, Y. Germain, M. Roudaut, C. Cathalot, G. Sarthou, E. Pelleter, Y. Fouquet, High resolution particulate trace metals dispersion from the TAG hydrothermal vent (Mid-Atlantic Ridge), 2018, Goldschmidt conference, Boston, August 12-17.
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- Cheize M, Baudoux A-C, Bucciarelli E, Tagliabue A, Desboeufs K, Baker AR, Gonzalez GA, & Sarthou G, A Potential Source of Fe Binding Organic Ligands to the Surface Ocean from Wet Deposition, 2017, Goldschmidt conference, Paris, 13-18 August
- Desboeufs K, Doussin JF, Giorio C, Triquet S, Fu Y, Riffault V, Dulac F, Féron A, Formenti P, Maisonneuve F, Siour G, Zapf P and Guieu C, Overview of atmospheric composition in Western Mediterranean during PEACETIME cruise, EGU2018, General Assembly Conference Vienna (poster)
- Estrade N., S. Fabre, C. Cloquet, A. Probst and C. Jeandel Isotopic and modelling constraints on experimental dissolution of lithogenic material Intl Goldschmidt Conf. Paris, 2017 POSTER
- Fabre, S., Zambardi, T., Roustan, M., Almar, R. and Jeandel, C. (2017) Clastic coasts: an overlooked term of the geochemical Si cycle? Intl Goldschmidt Conf. Paris, 2017 POSTER.
- Gonzalez-Santana D., A. Lough, N. J. Wyatt, L. Artigue, M. C. Lohan, H. Planquette, G. Sarthou, dFe(II) variability across hydrothermal vents in the Mid Atlantic Ridge, 2018, Goldschmidt conference, Boston, August 12-17.
- Gonzalez AG, Sarthou G, Chever F, Bowie A, van der Merwe P, Cheize M, Sirois M, Bucciarelli E, Obernosterer I, Catala P & Blain S, The Impact of Fe and Cu on the Natural Phytoplankton Communities and on the Complexing Organic Ligand Pool Through Incubation Experiments at the Vicinity of Kerguelen Islands (Southern Ocean), 2017, Goldschmidt conference, Paris, 13-18 August
- Gourain A., P Salaun, A Tagliabue, S. van den Berg, J. Boutorh, M. Cheize, L. Pereira Contreira, P. Lherminier, J.-L. M. Barraqueta, H. Planquette, G. Sarthou and R. Shelley, Speciation of dissolved copper in North Atlantic along the GEOTRACES GA01 section, 2018, Ocean Sciences Meeting, 11-16 February

- Gourain A, Salaun P, Tagliabue A, Vanden Berg C, Boutorh J, Cheize M, Contreira-Pereira L, Lherminier P, Menzel J-L, Sarthou G & Shelley R, Organic Complexation of Copper along the GEOTRACES GA01 Section, 2017, Goldschmidt conference, Paris, 13-18 August
- Guieu C., Desboeufs K. and the PEACETIME team, ProcEss studies at the Air-sEa Interface after dust deposition in the MEditerranean sea: results from the PEAcEtIME project, EGU General Assembly Conference 2018, Vienna (oral presentation)
- Jeandel, C. Revisiting the land-ocean fluxes (REE and Nd isotope contribution) Invited Seminar at Univ. Federal do Bahia, July 6th, 2017, invited
- Jeandel, C. Which oceanic tracers are the Rare Earths and the Nd isotopes? Invited talk (opening session) at the IUPAC Intl Conf., Sao Paolo, July 10th, 2017, invited
- Lacan F., Pradoux C., Chmeleff J. Interferences and matrix effects during 57Fe-58Fe double spike iron isotope MC-ICPMS measurements. Goldschmidt Conference, Paris (France), Poster, August 2017.
- Le Roy E., Sanial V., Charette M., Henderson P., Jacquet S., Garcia-Ibanez M., Perez F., Lherminier P., Souhaut M., Jeandel C., Lacan F., van Beek P. Radium-226 and barium as tracers of water masses in the North Atlantic (GA01-GEOTRACES). EGU, Vienna, Austria. Poster, April 2017.
- Le Roy E., Sanial V., Charette M.A., Henderson P.B., Lacan F., GarcíaI-ibáñez M.I., Pérez F.F., Jacquet S.H.M., Lherminier P., Souhaut M., Jeandel C. & van Beek P. Distribution of radium-226 along the GA01-GEOTRACES section in the North Atlantic, Goldschmidt Conference, Paris (France), Oral, August 2017.
- Lemaitre N, Planquette H, Dehairs F, Sarthou G, Bollinger C, Jeandel C, Castrillejo M & Planchon F, Particulate Trace Element Export in the North Atlantic (GA01 Transect), 2017, Goldschmidt conference, Paris, 13-18 August
- Michael S., Resing J., Lacan F., Pradoux C., Jeandel C. Using Aluminum and Manganese to Constrain the Contribution of the Solomon Sea to the Equatorial Undercurrent Trace Metal Pool. Goldschmidt Conference, Paris (France), Oral, August 2017.
- Nicosia A., D. Picard, P. Villani, R. Dupuy, B. D'Anna, M. D. Mallet, S. Mas, M. Peltola, M. Bloss, E. Freney, P. Amato, F. Belosi, G. Santachiara, M. Rinaldi, D. Lefevre, K. Desboeufs, C. Guieu, K. Sellegri, Ice nucleating properties of primary marine aerosols observed from an Artic and a Mediterranean field campaign, EGU2018, General Assembly Conference Vienna (oral presentation)
- Nicholas S. L, D. Ceburnis, M. Marcus, M. Iris Heller, H. Planquette, G. Sarthou, and P. L Croot, μXAS Speciation of Iron in Anthropogenic and Natural Aerosol Particles Entering the Irish Shelf at Mace Head, 2018, Ocean Sciences Meeting, 11-16 February
- Pham V, Jeandel C., Belhadj M, Nachez Y & Grenier M. Land-Ocean Processes Traced by Rare Earth Elements in the Solomon Seas (Pandora, GEOTRACES Cruise GP#12) 2017, Goldschmidt conference, Paris, 13-18 August
- Tachikawa, K., 2017. The large-scale evolution of neodymium isotopic composition in the global modern and Holocene ocean revealed from seawater and archive data. PAGES-OSM ID: 01984, 12, Zaragoza, Spain, 9-13 May 2017. Invited talk.
- Tonnard M, Gonzalez AG, Whitby H, Bowie AR, van der Merwe P, Planquette H, Boutorh J, Cheize M, Menzel J-L, Pereira Contreira L, Shelley R & Sarthou G, Iron-

Binding Ligands in the North Atlantic Ocean and Labrador Sea along the GEOVIDE Section (GEOTRACES GA01), 2017, Goldschmidt conference, Paris, 13-18 August

- van Beek P, Tamborski J, Bejannin S, Petrova M, Souhaut M, Lacan F, Stieglitz T, Radakovitch O, Claude C, Pujo-Pay M, Conan P, Crispi O, Garcia-Orellana J & Heimburger L-E. Study of the Chemical Fluxes Associated with SGD in Several Hotspots along the French Mediterranean Coastline. Goldschmidt Conference, Paris (France), Poster, August 2017.
- van Beek P., Tamborski J., Bejannin S., Souhaut M., Garcia-Orellana J., Stieglitz T., Claude C., Olivier R., Lacan F., Crispi O., Pujo-Pay M., Conan P., Caparros J., Guéneuguès A., Monnin C., Seidel J.-L., Anschutz P. Estimating groundwater discharge in the coastal lagoons of La Palme and Salses-Leucate along the French Mediterranean coastline by using radium isotopes. EGU, Vienna, Austria. Poster, April 2017.
- Whitby H., H. Planquette, M. Cheize, J.-L. Menzel-Barraquetta, R. Shelley, J. boutorh, L. Pereira, A. Gonzalez, M. Tonnard, E. Bucciarelli, G. Sarthou, Iron-binding humic substances along the GEOVIDE transect in the North Atlantic (GEOTRACES, GA01, 2014), 2018, Ocean Sciences Meeting, 11-16 February
- Yeghicheyan D, Aubert D, Bouhnik-Le Coz M, Chmeleff J, Delpoux S, Djouraev I, Granier G, Lacan F, Piro J-L, Rousseau T, Cloquet C, Marquet A, Menniti C, Pradoux C, Freydier R, Vieira da Silva-Filho E & Suchorski K. A New Compilation of Element Concentrations in the Natural River Water Standard SLRS-6 (NRC-Cnrc). Goldschmidt Conference, Paris (France), Poster, August 2017.
- Yinghe Fu, Triquet S, Doussin JF, Giorio C, Dulac F, Maisonneuve F, Zapf P, Feron A, Tovar-Sánchez A, Bressac M, Guieu C, and Desboeufs K, Trace metals and nutrients fluxes and solubility during the PEACETIME cruise of May-June 2017 in the western and central Mediterranean, EGU2018, General Assembly Conference Vienna Vienna (poster)

Submitted by Kazuyo Tachikawa (kazuyo@cerege.fr).

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN GERMANY

May 1st, 2017 to March 30th, 2018

New scientific results

- Phytoplankton play a fundamental role in the global carbon cycle and fuel marine food webs. Globally, phytoplankton productivity is regulated by the availability of essential nutrients, such as nitrogen and iron. Tom Browning (GEOMAR Helmholtz Centre for Ocean Research Kiel) and co-workers have shown that the growth of phytoplankton in the transition zones between eastern boundary upwelling regions and oceanic gyres are not limited by a single nutrient, but by multiple nutrients simultaneously. Measurements of nutrient concentrations in the SE Atlantic have shown widespread depletion of multiple elements simultaneously, with Fe and N co-limitation and a secondary limitation by Co.
- Browning, T.J., E.P. Achterberg, I. Rapp, A. Engel, E. M. Bertrand, A. Tagliabue, C. M. Moore (2017): Nutrient co-limitation at the boundary of an oceanic gyre. Nature, Advance Online Publication, http://dx.doi.org/10.1038/nature24063

Cruises

- GEOTRACES Process Study Meteor M147 (GEOTRACES Process study GApr11 to the Amazon mouth Chief-Scientist: Andrea Koschinsky (IUB Bremen). Other PIs Martin Frank, Martha Gledhill, Eric Achterberg (GEOMAR), Thorsten Dittmar (ICBM, Oldenburg). Brazilian partner institutes: Universidade Federal de Rio Grande do Sul-UFRGS, Universidade Estadual do Norte Fluminense-UENF, Universidade Federal de Santa Maria-UFSM, Universidade Federale de Rio de Janeiro-UFRJ.

  The aim of the cruise is to investigate interactions of trace metals, dissolved organic matter (DOM), and particles in the Amazon estuary and the associated plume as key processes for trace metal and DOM fluxes into the Atlantic.

New projects and/or funding

- Melanie Behrens' (ICBM, University of Oldenburg) application for a 2-year DFG grant to work on samples from the French CASSIOPEE cruise in the western tropical Pacific was successful (in collaboration with C. Jeandel and K. Pahnke, approved as GEOTRACES compliant cruise).
- GP21 section cruise on *FS Sonne* in the South Pacific has been awarded (Achterberg and Frank). We will now wait for the scheduling of the cruise.

GEOTRACES workshops and meetings

- Reiner Schlitzer - Presentation at IDP2017 townhall release event during Goldschmidt 2017 in Paris.

Other activities

- Reiner Schlitzer - Creation of Intermediate Data Product 2017 (versions v1 and v2) and of eGEOTRACES electronic atlas (http://egeotraces.org).
- Reiner Schlitzer - Service as SSC co-chair until Dec 2017.

New publications (published or in press)

- Basak, C., Fröllje, H., Lamy, F., Gersonde, R., Benz, V., Anderson, R.F., Molina-Kescher, M., Pahnke, K., 2018. Break-up of last glacial deep stratification in the South Pacific. Science 359, 900-904. doi: 10.1126/science.aao2473
- Behrens, M.K., Pahnke, K., Paffrath, R., Schnetger, B., Brumsack, H.J., 2018. Rare earth element distributions in the West Pacific: Trace element sources and conservative vs. non-conservative behavior. Earth and Planetary Science Letters 486, 166-177. doi: 10.1016/j.epsl.2018.01.016.
- Behrens, M.K., Pahnke, K., Schnetger, B., Brumsack, H.-J., 2018. Sources and processes affecting the distribution of dissolved Nd isotopes and concentrations in the West Pacific. Geochimica et Cosmochimica Acta 222, 508-534. doi: doi: 10.1016/j.gca.2017.11.008.
- Böning, P., Ehlert, C., Niggemann, J., Schnetger, B., Pahnke, K., 2017. Thallium dynamics in the Weser estuary (NW Germany). Estuarine and Coastal Shelf Science 187, 146–151.
- Stichel, T., Pahnke, K., Duggan, B., Goldstein, S.L., Hartman, A.E., Paffrath, R., Scher, H., 2018. TAG plume: revisiting the hydrothermal neodymium contribution to seawater. Frontiers in Marine Science 5. doi: doi:10.3389/fmars.2018.00096.
- Browning, T.J., Achterberg, E.P., Rapp, I., Engel, A., Bertrand, E.M., Tagliabue, A. and Moore, C.M., 2017. Nutrient co-limitation at the boundary of an oceanic gyre. Nature, 551(7679), 242–246, doi:10.1038/nature24063.
- Rusiecka, D., M. Gledhill, A. Milne, E.P. Achterberg, A.L. Annett, S. Atkinson, A. Birchill, J. Karstensen, M. Lohan, C. Mariez, R. Middag, J. M. Rolison, T. Tanhua, S. Ussher, and D. Connelly (2018): Anthropogenic signatures of lead in the Northeast Atlantic. Geophysical Research Letters, http://dx.doi.org/10.1002/2017GL076825.
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- Achterberg, E.P., Steigenberger, S., Marsay, C.M., LeMoigne, F.A.C., Painter, S.C., Baker, A.R., Connelly, D.P., Moore, C.M., Tagliabue, A., Tanhua, T. (2018). Iron Biogeochemistry in the High Latitude North Atlantic Ocean. Scientific Reports, 8, Article number: 1283. doi:10.1038/s41598-018-19472-1.
- Bridgestock, L., Rehkämper, M., van de Flierdt, T., Paul, M., Milne, A., Lohan, M.C., Achterberg, E.P. (2018). The distribution of lead concentrations an isotope compositions in

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- Hopwood, M., Rapp, I., Schlosser, C., Achterberg, E.P. (2017). Hydrogen peroxide in deep waters from the Mediterranean Sea, South Atlantic and South Pacific Oceans. Scientific Reports, 7:43436, DOI: 10.1038/srep43436.
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- Hopwood, Mark J., Cantoni, C., Clarke, Jennifer S., Cozzi, S. and Achterberg, Eric P. (2017). The heterogeneous nature of Fe delivery from melting icebergs. Geochemical Perspectives Letters, 3. 200-209. DOI 10.7185/geochemlet.1723.
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- Laukert, G., Frank, M., Bauch, D., Hathorne, E.C., Gutjahr, M., Janout, M., and Hölemann, J. (2017): Transport and transformation of riverine neodymium isotope and rare

earth element signatures in high latitude estuaries: A case study from the Laptev Sea.- Earth and Planetary Science Letters 477, 205-217.

- Laukert, G., Frank, M., Hathorne, E.C., Krumpen, T., Rabe, B., Bauch, D., Werner, K., Peeken, I., and Kassens, H. (2017): Pathways of Siberian freshwater and sea ice in the Arctic Ocean traced with radiogenic neodymium isotopes and rare earth elements.- Polarforschung 87, 3-13.
- Molina-Kescher, M., Hathorne, E.C., Osborne, A.H., Behrens, M.K., Kölling, M., Pahnke, K., and Frank, M. (2018): The influence of basaltic islands on the oceanic REE distribution: A case study from the tropical South Pacific.- Frontiers in Marine Science 5:50, doi: 10.3389/fmars.2018.00050.

PhD theses

- Sandra Poehle (2017): Input and particle-reactivity of transition metals from subgroups IV, V and VI in the water column of the Atlantic Ocean. Defended 1st June 2017.

Master theses

- Matthias Rehbein, 2017, Rare Earth Elements in the Subtropical South Pacific Ocean, MSc thesis, University of Oldenburg (supervisor: K. Pahnke).
- Mareike Gutensohn, 2017, Processes controlling dissolved rare earth elements in the southern South Pacific, MSc thesis (supervisor: K. Pahnke).
- MSc Theses: Rachel Morrison „Investigation of North Atlantic Water Mass Mixing and Exchange With Icelandic Sediments Using Neodymium Isotopes" (Supervisor: M. Frank)

Presentations in international conferences

- Böning, P., Pahnke, K., Schnetger, B., Brumsack, H.-J., 2017, Iron Cycling in Sediments from the Benguela Upwelling System (BUS), Goldschmidt Abstract 2123.
- Liguori, B.T.P., Ehlert, C., Pahnke, K., 2017, A Terrestrial Influence on the Central Arctic Ocean Silicon Biogeochemical Cycle, IBiS Conference, Blanes, Spain.
- Pahnke, K., Behrens, M., Rehbein, M., Paffrath, R., 2017, Dissolved rare earth element ratios trace hydrothermal scavenging and water mass transport. Goldschmidt Abstract (talk).
- Paffrath, R., Pahnke, K., Schnetger, B., Brumsack, H.-J., 2017, Dissolved Rare Earth Element Concentrations from the Barents Sea to the Central Arctic. Goldschmidt Abstract 2212.
- Pedreira, R.M.A., Hatje, V., Böning, P., Pahnke, K., 2017, Anthropogenic Impacts on the Distributions of Rare Earth Elements in Coastal Waters. Goldschmidt Abstract 2193.
- Goldschmidt, Paris, August 2017. Browning, T.J., Achterberg, E.P., Rapp, I., Engel, A., Bertrand, E.M., Tagliabue, A. and Moore, C.M. Direct experimental evidence for nutrient co-limitation from the South Atlantic GA08 GEOTRACES expedition.
- 9th International Workshop on Sand/Duststorms and Associated Dustfall, Tenerife, May 2018. J.C. YONG, T.J. BROWNING, M. GLEDHILL, Z.B. SHI, E.P. ACHTERBERG.

Sources and composition of water-soluble trace elements in aerosols over the South Atlantic, Arctic and Equatorial Pacific oceans.

- Xie RC, Janssen DJ, Abouchami W, Galer SJG, Rijkenberg MJA, Cullen JT, de Baar HJW, De Jong J & Andreae MO, Controls on Upper Ocean Cd Isotope Fractionation (invited). Goldschmidt conference, Paris, August 1318, 2017
- Galer S, Abouchami W, Middag R & de Baar H, Barite Control on the Southern Ocean Barium Isotopic Signature. Goldschmidt conference, Paris, August 1318, 2017
- Guinoiseau D & Galer SJG, Effect of CdS Precipitation on the Partitioning of Cd Isotopes Ocean Sciences. Goldschmidt conference, Paris, August 1318, 2017
- Janssen D, Abouchami W, Galer SJG, Purdon K and Cullen JT. Particulate Cd isotopes demonstrate a dynamic oceanic Cd cycle. Portland, Oregon, 2018
- Guinoiseau D, Abouchami W, Galer SJG. Effect of CdS precipitation on the partitioning of Cd isotopes: implications for Cd oceanic cycle. EGU (Vienna, 2018).

Submitted by Eric Actherberg (eachterberg@geomar.de).

GEOTRACES activity is continuing in India. Major source of funding for GEOTRACES programme in India is coming from the Ministry of Earth Sciences, Government of India. Last year we procured two *in-situ* pumps for sampling particulates. These pumps were used during cruise SK338 to collect particulates.

Sampling in the Indian Ocean

Several cruises were undertaken in the Indian Ocean as part of GEOTRACES (India) programme (Figure 5). Last cruise, SK 338 was conducted in 2017.

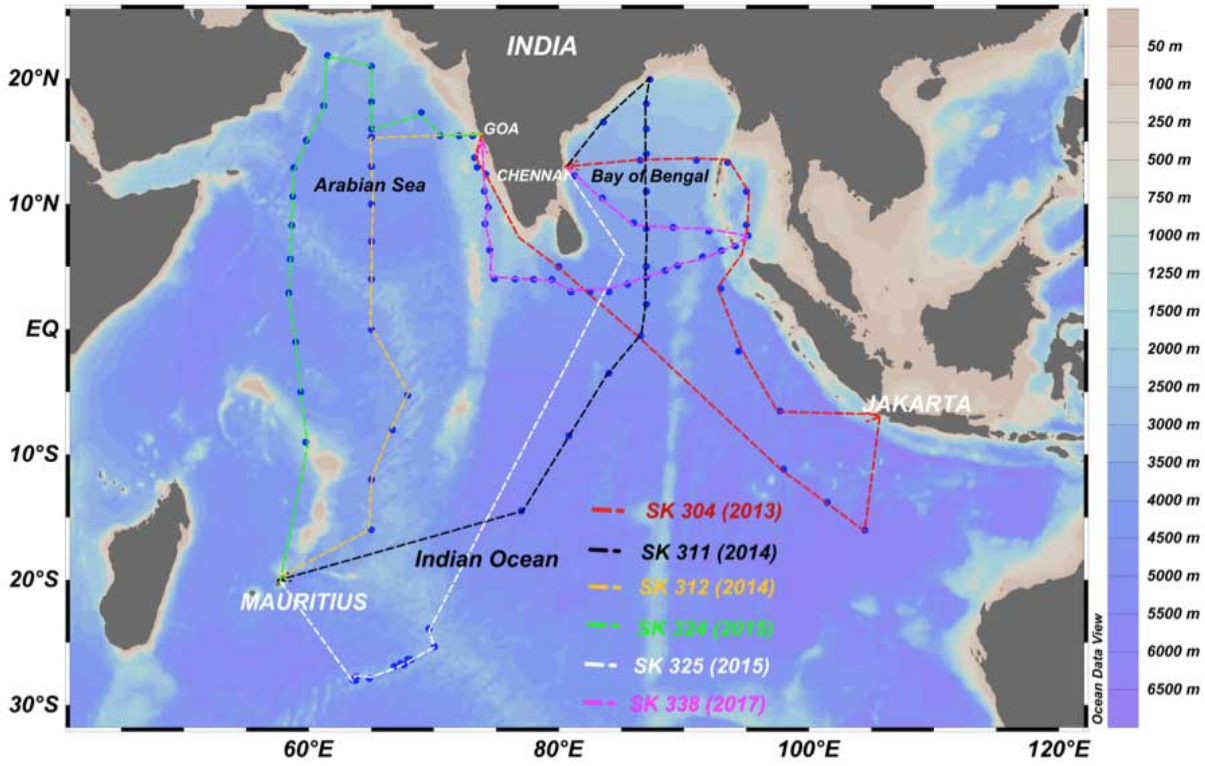

Figure 5. *Various sections sampled for GEOTRACES studies in the Indian Ocean.*

Dissolved Al measurement in Indian Ocean

Several profiles of dissolved Al in the Indian Ocean were measured. Impact of riverine input alongwith from particulates is visible in the surface Bay of Bengal, the Andaman Sea and in the Arabian Sea (Figure 6).

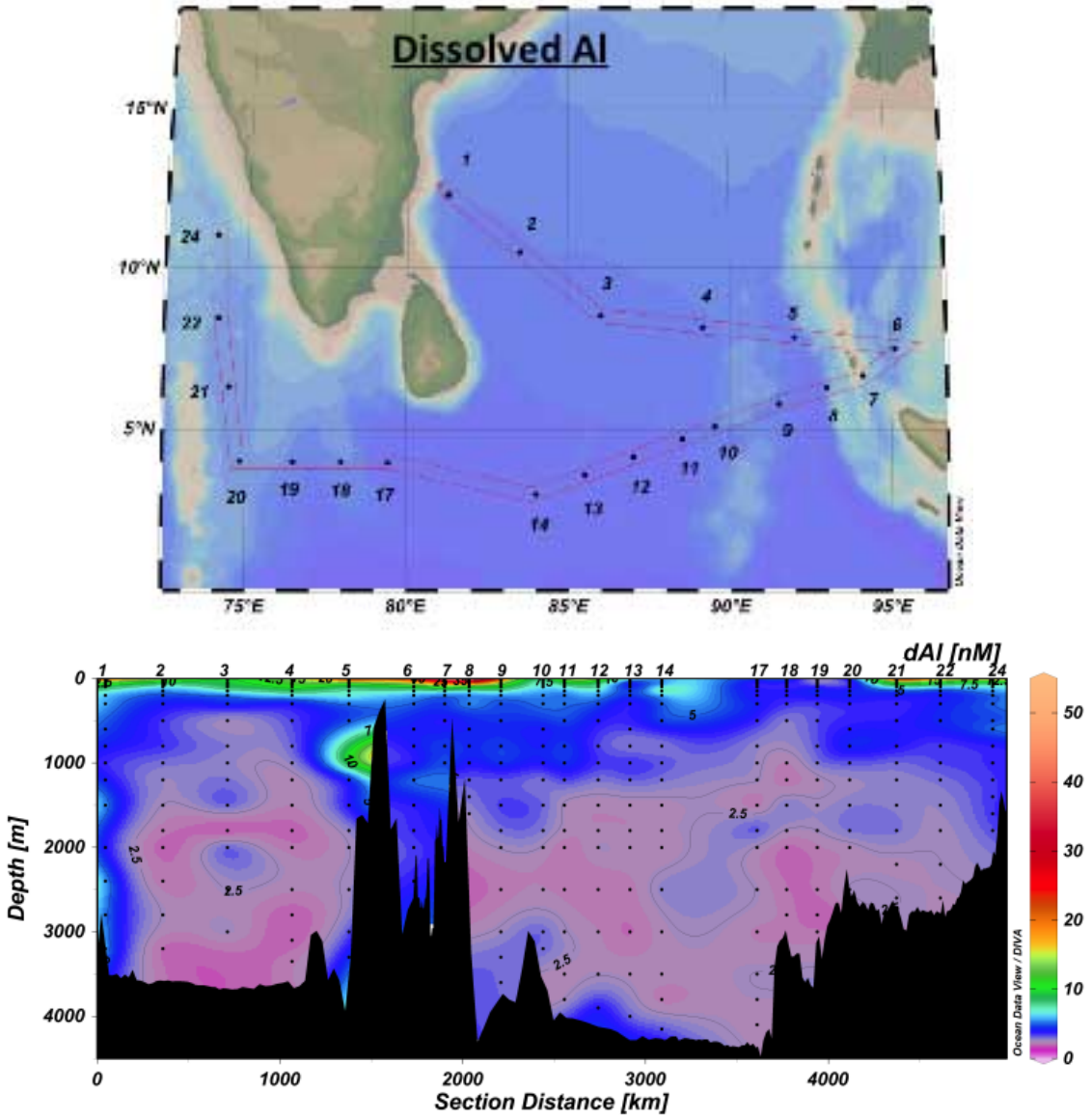

Figure 6. *Dissolved Al in the Indian Ocean*

Submitted by Vineet Goswami (Vineet.Goswami@colostate.edu) and Sunil Kumar Singh

New scientific results

- Radium Quartet in the North East Atlantic: Further measurements of the Radium quartet were undertaken during CV17038 along the western Irish continental shelf and 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 for ^{223}Ra and ^{224}Ra have indicated new potential ground water sources along the Irish coast. Samples taken in 2015-2017 now have been analysed for in-growth of ^{224}Ra from ^{228}Th and ^{228}Ra and indicate rapid scavenging of ^{228}Th from the water column and a gradual decrease in ^{228}Ra across the shelf towards the open Atlantic. At the shelf edge however ^{228}Th is closer to unity with ^{228}Ra. There is no significant ^{227}Ac present in the water column in this region.

Cruises

- Biogeochemical (Nutrients) and optical measurements (CDOM/FDOM) during Western European Shelf Pelagic Acoustic Survey (WESPAS). Expedition on the Celtic Explorer (6 June - 21 July, 2017, CE17009 & CE17011, Galway to Galway). (iCRAG project)
- Biogeochemical (Radium isotopes, Nutrients) and optical measurements (CDOM/FDOM, light profiles) along the south west coast of Ireland. Expedition on the Celtic Voyager (October 17-24, 2017, CV17038, Galway to Galway). PhD student Monica Mullins (iCRAG@NUI Galway) was the Chief Scientist) with participants from Trinity College Dublin also onboard. (iCRAG project)
- NUI Galway and the Marine Institute (Ireland) in collaboration with Dalhousie University (Canada), Exeter University (U.K.), GEOMAR (Germany) and W.H.O.I. (USA) carried out a resurvey of the A02 line for GO-Ship using the Irish vessel *RV Celtic Explorer* (April – May 2017). Prof. Peter Croot (NUI Galway) was Chief Scientist and Dr Evin McGovern (Marine Institute) was the principal investigator. This was the first time that an Irish research vessel was used for a major physical and chemical oceanographic research survey, it is hoped in the future to be able to carry out a dedicated GEOTRACES related research expedition using the same vessel.
- Prof. Peter Croot (NUI Galway) was a participant on an expedition to Isla Madre de Dios (funded by FONDECYT, Chile) in Chilean Patagonia on the *RV Forrest* as part of the "Landsea interaction effects on the local carbon cycle of the western Patagonian Archipielago Interior Sea" study (CONICYT) with Dr Rodrigo Torres and Dr Brian Reid from Centro de Investigación de Ecosistemas de la Patagonia (CIEP) in Coyhaique, Chile.

New projects and/or funding

- SCOR Ireland – at the end of 2017, Ireland become a member of SCOR with the initial national committed being comprised of Fiona Grant (Marine Institute), Eleanor O'Rourke (Marine Institute), Brian Ward (NUI Galway) and Peter Croot (NUI Galway). The committee will be expanded during 2018 and more activities are planned.

- Marine Institute of Ireland Infrastructure funding – purchase of a SeaFast system for analysis of trace metals in seawater (awarded to Peter Croot, NUI Galway).
- Marine Institute of Ireland Infrastructure funding – purchase of a Membrane Inlet Mass Spectrometer (MIMS) for the analysis of climate relevant gases in seawater (awarded to Peter Croot, NUI Galway).

GEOTRACES workshops and meetings

- Prof Peter Croot (NUI Galway) was a lecturer at the GEOTRACES Summer school in Brest, France (20-26 August 2017)

Other activities

- Synchrotron work on marine aerosols and particles at ALS in Berkeley, USA and ESRF in Grenoble, France.
- NUI Galway hosted a joint SMART/POGO Atlantic Ocean Climate School in Galway in Sept 2017. This summer school was attended by 30 international students from all around the world.

New publications (published or in press)

- Echeveste, P., Croot, P. and von Dassow, P., 2018. Differences in the sensitivity to Cu and ligand production of coastal vs offshore strains of Emiliania huxleyi. Science of The Total Environment, 625: 1673-1680.
- Ibanhez, J.S.P. and Rocha, C., 2017. Kinetics of inorganic nitrogen turnover in a sandy seepage face on a subterranean estuary. Applied Geochemistry, 87: 108-121.
- Jiang, S., Kavanagh, M. and Rocha, C., 2017. EVALUATION OF THE SUITABILITY OF VACUTAINERS FOR STORAGE OF NUTRIENT AND DISSOLVED ORGANIC CARBON ANALYTES IN WATER SAMPLES. Biology and Environment-Proceedings of the Royal Irish Academy, 117B(1): 33-46.
- Lefevre, N. et al., 2017. A source of CO2 to the atmosphere throughout the year in the Maranhense continental shelf (2 degrees 30 ' S, Brazil). Continental Shelf Research, 141: 38-50.
- Oppelt, A., Corre, M.L. and Rocha, C., 2017. Biogeochemical analysis of the calcification patterns of cold-water corals Madrepora oculata and Lophelia pertusa along contact surfaces with calcified tubes of the symbiotic polychaete Eunice norvegica: Evaluation of a 'mucus' calcification hypothesis. Deep-Sea Research Part I-Oceanographic Research Papers, 127: 90-104.
- Wieczorek, A.M., Doyle, T.K. and Croot, P.L., 2017. Microplastic Prey? An Assay to Investigate Microplastic Uptake by Heterotrophic Nanoflagellates, Fate and Impact of Microplastics in Marine Ecosystems. Elsevier, pp. 73-74.
- Wieczorek, A.M. et al., 2018. Frequency of Microplastics in Mesopelagic Fishes from the Northwest Atlantic. Frontiers in Marine Science, 5(39).

Presentations in international conferences

- Croot P, Heller M, Nicholas S & Wuttig K. Goldschmidt 2017: Paris, France. August 25-29 2017. Keynote speaker: The role of Reactive Intermediates in Biogeochemistry.
- Croot P, Nicholas S, Grassie A, Wieczorek A, Heller M, Klockgether G, Lavik G & Ferdelman T. Goldschmidt 2017: Paris, France. August 25-29 2017. Scavenging of Hydroxide Dominated Elements: Insights from Dissolved Titanium in the South Pacific Gyre and Southern Ocean
- Heller,MI, Wuttig K & Croot PL. Goldschmidt 2017: Paris, France. August 25-29 2017. Invited: Decomposition of Superoxide (O_2^-) Across the Mauritanian Shelf
- Nicholas S, Grassie A, Wieczorek A, Mullins M, Daly E & Croot P, Goldschmidt 2017: Paris, France. August 25-29 2017. Tracing Submarine Groundwater Discharge to Coastal Waters on the Irish Shelf and the North East Atlantic with the Ra Quartet
- Croot P. IUPAC 2017: Sao Paulo, Brazil. July 7-13, 2017. (Keynote speaker Energy, Water and Environmental Sciences – GEOTRACES Session: "*The importance of kinetics and redox reactions on the speciation of trace elements in Marine Biogeochemical Cycles*"

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

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN ISRAEL

May 1st, 2017 to March 30th, 2018

This report summarizes GEOTRACES related activities between May 2017 and April 2018 in Israel. It further includes 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.

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

Research

- ***Sediment traps***: Torfstein's 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
- ***Dust***: Two dust samplers are deployed continuously at the Interuniversity Institute (IUI) for Marine Sciences of Eilat.
- ***Seawater***: Red Sea deep seawater profiles are sampled regularly and analyzed for trace element concentrations, Pb isotopic compositions and $^{230}Th/^{232}Th$ ratios.
- During the reporting period, Torfstein's research group includes: two postdocs (Daniel Palchan, David Weinstein), a PhD student (Natalie Tchernichovsky), 4 MSc students (Tal Ben-Altabet, Gil Lapid, Merav Gilboa, Ortal Sava), and a lab technician (Barak Yarden).

Funding

- Funding is provided by the Israel Science Foundation (PI Torfstein).

Meetings

- Results of work on modern dust time series and their coupling with downcore late Quaternary sediment records in the Red Sea was presented at the PAGES OSM Zaragoza, Spain and at the Goldschmidt meeting Paris, France.
- MSc student Ortal Sava presented the history of Late Quaternary export production in the Red Sea in the Israel Geological Society annual meeting
- MSc student Tal Ben-Altabet participated in the GEOTRACES summer school in Brest, France (August, 2017), where he presented his work on temporal and vertical dynamics of

trace element distributions in seawater across dust storm events and water column overturning

Related publications:

- Torfstein A. and Kienast S.S. (2018) No correlation between atmospheric dust and surface chlorophyll-a in the oligotrophic Gulf of Aqaba, northern Red Sea. Journal of Geophysical Research - biogeosciences, 123, doi.org/10.1002/2017JG004063.
- Torfstein A., Teutsch N., Tirosh O., Shaked Y., Rivlin T., Zipori A., Stein M., Lazar B. and Erel Y. (2017) Chemical characterization of atmospheric dust from a weekly time series in the north Red Sea between 2006-2010. Geochimica et Cosmochimica Acta 211, 373-393.
- Steiner Z., Lazar B., Torfstein A. and Erez Y. (2017) Testing how variations in water column productivity affect trace metal accumulation in marine sediments: the Gulf of Aqaba, Red Sea. Chemical Geology 473, 40-49.

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

Workshops and meetings

- Yeala Shaked participated in the GEOTRACES SSC meeting in Salvador.
- Yeala Shaked presented her synthesis paper on availability of iron to phytoplankton in the ocean using GEOTRACES data during the SCOR FeMIP meeting and ASLO meeting in Portland.

Research

- Y. Shaked spent her sabbatical at UBC with Maita Maldonado during 2016-2017, jointly revisiting and seeking for unifying approaches to evaluate the in situ availability of oceanic dissolved Fe to natural phytoplankton.
- Her research group with 2 PhD students (Nivi Kessler, Siyuan Wang), a post-doc (Sunbhajit Basu), and a research technician (Murielle Dray) continue investigating the bioavailability of dust and mineral iron to cyanobacteria. The study of dust as a source of iron to Trichodesmium is conducted with various international collaborators, including Satish Myneni from Princeton (Synchrotron analysis of bio-induced transformations of dust), Rhona Stuart from Livermore National Laboratories (Fe uptake from dust using Nano-Sims), and Martha Gledhill from GeoMar (siderophore identification with Orbitrap mass spectrometer).

Funding

- Funding is provided by the Israeli Science Foundation research grant (PI Y. Shaked):

"Bioavailability of particulate Fe to planktonic cyanobacteria", and by the German-Israeli Foundation for Scientific Research and Development (GIF) research grant (PIS Y. Shaked, M. Gledhill and E. Achterberg): "Dust iron utilization by natural Trichodesmium colonies"

Related publications in 2017-2018

- Torfstein A, Teutsch N, Tirosh O, Shaked Y, Rivlin T, Zipori A, Stein M, Lazar B, and Y. Erel. 2017. Chemical characterization of atmospheric dust from a weekly time series in the north Red Sea between 2006 and 2010, Geochimica et Cosmochimica Acta, 211; 373-393.
- Basu S and Y. Shaked. Mineral iron utilization by natural and cultured Trichodesmium and associated bacteria, Limnology and Oceanography, In Press.

3. 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.

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

New scientific results

We reported detailed dissolved Zn zonal section across the North Pacific (~47°N) at GP02. Our data revealed values of Zn* were strongly positive in the intermediate waters of both the western and the central subarctic North Pacific. The high Zn* in the intermediate water suggest that intermediate water masses play an important role in the decoupling of dissolved Zn and silicate in the subarctic North Pacific. (Kim et al., Global Biogeochemical Cycles, 2017).

New publications

Sixteen papers have been published as shown below:

- Aoyama, M., Y. Hamajima, Y. Inomata, Y. Kumamoto, E. Oka, T. Tsubono and D. Tsumune (2018): Radiocaesium derived from the TEPCO Fukushima accident in the North Pacific Ocean: surface transport processes until 2017. *Journal of Environmental Radioactivity*, 189, 93-102.
- Che, H. and J. Zhang (2018): Water Mass Analysis and End-Member Mixing Contribution Using Coupled Radiogenic Nd Isotopes and Nd Concentrations: Interaction Between Marginal Seas and the Northwestern Pacific. *Geophysical Research Letters*, 45, 2388-2395.
- Gamo, T. and K. Shitashima (2018): Chemical characteristics of hadal waters in the Izu-Ogasawara Trench of the western Pacific Ocean. *Proceedings of Japan Academy Series B Physical and Biological Sciences*, 94, 45-55.
- Kaizer, J., M. Aoyama, Y. Kumamoto, M. Molnar, L. Palcsu and P. P. Povinec (2018): Tritium and radiocarbon in the western North Pacific waters: post-Fukushima situation. Journal of Environmental Radioactivity, 184-185, 83-94.
- Kambayashi, S., J. Zhang, and H. Narita (2017): Spatial assessment of radiocaesium in the largest lagoon in Fukushima after the TEPCO Fukushima Dai-ichi Nuclear Power Station accident. Marine pollution bulletin, 122, 344 – 352.
- Kim, T., H. Obata, J. Nishioka, T. Gamo (2017): Distribution of dissolved zinc in the western and central subarctic Pacific. Global Biogeochemical Cycles, 31, 1454-1468.
- Kitamura, M., M. C. Honda, Y. Hamajima, Y. Kumamoto, M. Aoyama, H. Kawakami, T. Aono, M. Fukuda and Y. Mino (2017): Temporal changes in radiocesium contamination derived from the Fukushima Dai-ichi Nuclear Power Plant accident in oceanic zooplankton in the western North Pacific. Journal of Environmental Radioactivity, 172, 163-172.
- Mashio, A. S., H. Obata, and T. Gamo (2017): Dissolved platinum concentrations in coastal seawater: Boso to Sanriku, Japan. Archives of Environmental Contamination and Toxicology, 73, 240-246.
- Nakanowatari, T., T. Nakamura, K. Uchimoto, J. Nishioka, H. Mitsudera and M. Wakatsuchi (2017): Importance of Ekman transport and gyre circulation change on

seasonal variation of surface dissolved iron in the western subarctic North Pacific, Journal of Geophysical Research- Ocean, 122, 4364-4391.

- Nishioka, J. and H. Obata (2017): Dissolved iron distribution in the western and central subarctic Pacific - HNLC water formation and biogeochemical processes -. Limnology and Oceanography, 62, 2004–2022.
- Obata, H., J. Nishioka, T. Kim, K. Norisuye, S. Takeda, Y. Wakuta and T. Gamo (2017): Dissolved iron and zinc in Sagami Bay and the Izu-Ogasawara Trench. Journal of Oceanography, 73, 333-344.
- Otosaka, S. (2017): Processes affecting long-term changes in 137Cs concentration in surface sediments off Fukushima. Journal of Oceanography, 73, 559-570.
- Takahata, N., Y. Tomonaga, Y. Kumamoto, M. Yamada, Y. Sano (2018): Direct tritium emissions to the ocean from the Fukushima Dai-ichi nuclear accident. Geochemical Journal, 52, 211-217.
- Takano, S., M. Tanimizu, T. Hirata, K.-C. Shin, Y. Fukami, K. Suzuki, Y. Sohrin (2017): A simple and rapid method for isotopic analysis of nickel, copper, and zinc in seawater using chelating extraction and anion exchange. Analytica Chimica Acta, 967, 1-11.
- Yoshimura, T., J. Nishioka, H. Ogawa, A. Tsuda (2018): Dynamics of particulate and dissolved organic and inorganic phosphorus during the peak and declining phase of an iron-induced phytoplankton bloom in the eastern subarctic Pacific, Journal of Marine Systems, 177, 1-7.
- Zheng, L., T. Minami, S. Takano, H. Minami and Y. Sohrin (2017): Distribution and stoichiometry of Al, Mn, Fe, Co, Ni, Cu, Zn, Cd, and Pb in seawater around the Juan de Fuca Ridge. Journal of Oceanography, 73, 669-685.

Meetings

- We had a national GEOTRACES session during annual meeting of Geochemical Society of Japan 2017 in September 13 - 15, 2017, for pursuing scientific discussion on recent Japanese GEOTRACES studies (22 papers were presented). This annual meeting was held at Tokyo Institute of Technology, Tokyo.
- During Goldschmidt Conference 2017, several GEOTRACES-related sessions were held. More than 11 papers were presented by Japanese scientists during the Goldschmidt Conference 2017 as listed below.
    - Aoyama, M., Y. Hamajima, Y. Inomata, Y. Kumamoto, E. Oka, T. Tsubono and D. Tsumune. Radiocaesium derived from FNPP1 Accident in the North Pacific Ocean as tracer of transfer processes in layers of surface, STMW, and CMW. Goldschmidt Conference 2017, Paris (France), 13 – 18 August, 2017.
    - Hara, T., H. Tazoe, H. Obata and T. Gamo. Distributions of Nd isotopic composition and REE concentrations in surface seawater in the North Pacific Ocean. Goldschmidt Conference 2017, Paris (France), 13 – 18 August, 2017.
    - Kim, T., H. Obata, H. Ogawa and T. Gamo. Tracing the subarctic North Pacific intermediate water by using decouple of dissolved zinc and silicate. Goldschmidt Conference 2017, Paris (France), 13 – 18 August, 2017.

- Maki, K., J. Nishioka, H. Obata, Y. Kondo, I. Yasuda and H. Saito. Iron distribution and supply along the Kuroshio current in the North Pacific, Goldschmidt Conference 2017, Paris (France), 13 – 18 August, 2017.
- Mashio, A. S., H. Obata and T. Gamo. Distributions and biogeochemical cycles of platinum in seawaters at coastal areas around Japan. Goldschmidt Conference 2017, Paris (France), 13 – 18 August, 2017.
- Nakaguchi, Y., Y. Ikeda, N Oku, R. Taniura, M. Tsujisaka, L. Zheng, T. Minami and Y. Sohrin, Distributions and atmospheric input of bioactive trace metals in the East China Sea, Goldschmidt Conference 2017, Paris (France), 13 – 18 August, 2017.
- Otosaka, S., M. Fukuda and T. Aono. Behavior of radiocesium at sediment-water interface off Fukushima. Goldschmidt Conference 2017, Paris (France), 13 – 18 August, 2017.
- Tazoe, H., H. Obata, T. Gamo and J. Nishioka. Latitudinal variations of neodymium isotopic composition in seawater along 160th meridian east in the western North Pacific. Goldschmidt Conference 2017, Paris (France), 13 – 18 August, 2017.
- Tsujisaka, M., S. Takano, T. Hirata, M. Murayama and Y. Sohrin, Estimation of the paleoenvironment based on the concentration and isotope ratio of molybdenum and tungsten in the Japan Sea sediment. Goldschmidt Conference 2017, Paris (France), 13 – 18 August, 2017.
- Zhang, J., S. Kambayashi and B. Zhang. Significance of submarine groundwater discharge on material transportation from land to ocean: Under long term climate change and environmental accident. Goldschmidt Conference 2017, Paris (France), 13 – 18 August, 2017.
- Zheng, L., T. Minami, S. Takano, Y. Sohrin, Dissolved and labile particulate trace metal (Al, Mn, Fe, Co, Ni, Cu, Cd, and Pb) distributions in seawater along 160°W in the North Pacific. Goldschmidt Conference 2017, Paris (France), 13 – 18 August, 2017.

- During Ocean Sciences Meeting 2018, more than 7 papers were presented by Japanese scientists in several GEOTRACES-related sessions as listed below.

  - Evans, L. K., J. Nishioka, M. Yamamoto- Kawai, B. Williams and S. Zimmermann. Distribution of Dissolved and Labile Particulate Trace Metals Associated with Ice Structure in Arctic Sea Ice, Ocean Sciences Meeting 2018, Portland (USA), 11 – 16 February, 2018.
  - Misumi, K., D. Tsumune, T. Tsubono, M. C. Long, K. Lindsay, J. K. Moore, Contribution of marginal sea sediment on iron cycling in the North Pacific, Ocean Sciences Meeting 2018, Portland (USA), 11 – 16 February, 2018.
  - Nishioka, J., Y. Yamashita, H. Obata, K. Ono, I. Yasuda, A. Scherbinin, and Y. N. Volkov. Iron distribution in the East Kamchatka Current and its influence to the NPIW. Ocean Sciences Meeting 2018, Portland (USA), 11 – 16 February, 2018.

- Obata, H., T. Kim, T. Gamo and J. Nishioka. Dissolved zinc, phosphate and silicate in the intermediate waters of the North Pacific and South Atlantic. Ocean Sciences Meeting 2018, Portland (USA), 11 – 16 February, 2018.
- Oka, A., H. Obata, and H. Tazoe. Global distribution of rare earth elements simulated by an ocean general circulation model. Ocean Sciences Meeting 2018, Portland (USA), 11 – 16 February, 2018.
- Takeuchi, A., K. Marumoto, and H. Obata. Vertical distributions of dissolved gaseous mercury (DGM) concentrations in the sub-Arctic Pacific Ocean (GEOTRACES-Japan). Ocean Sciences Meeting 2018, Portland (USA), 11 – 16 February, 2018.
- Yamashita, Y., J. Nishioka, H. Obata and H. Ogawa. Distribution of allochthonous humic-like fluorescent dissolved organic matter in the western North Pacific. Ocean Sciences Meeting 2018, Portland (USA), 11 – 16 February, 2018.

- There were more presentations in the Oceanographic Society of Japan, Japan Geoscience Union etc.

Cruise

- One GEOTRACES-related cruise in subtropical northwestern Pacific (GP02) was conducted to take clean seawater samples for trace element analyses. KH-17-3 cruise by R/V Hakuho-Maru (June 23 – August 9, 2017; PI: Hajime Obata).

Others

- A new nine-country* Working Group entitled "A framework for cooperative studies in the Western Pacific Marginal Seas: Energy and materials exchange between land and open ocean" (PI, Jing Zhang; 2017-2020), was established by the IOC Sub-Commission for the Western Pacific (WESTPAC) in 2017. Its task is to build up a framework for interdisciplinary and joint studies of the marginal seas environment. (*Japan, China, Indonesia, Korea, Malaysia, Philippines, Russia, Thailand, USA)

Submitted by Hajime Obata (obata@aori.u-tokyo.ac.jp).

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN KUWAIT

May 1st, 2017 to March 30th, 2018

Major progress

- Kuwait Institute for Scientific Research (KISR) State of Kuwait started the construction of new research vessel (55 m) in Spain. This research vessel will play an important role for future research projects and strong collaboration with Geotraces to explore trace metal distribution and their isotopes using clean techniques in the Arabian Gulf, Sea of Oman and the Arabian Sea.
- Completed 4 transects in 3 seasons in Kuwait waters for the first time investigating the distribution of trace metals in Kuwait's waters.

New Scientific Results

Completed project titled 'Assessment of Dissolved Trace Metals Distribution in Kuwait Waters' revealed important findings in terms of trace metal distribution in Kuwait waters using a clean techniques using proven well-tested methodology i.e., adsorptive cathodic stripping voltammetry (Ad-CSV) and flow injection analyzer (FIA) and multivariate statistical approach. A new manuscript has been accepted for publication at Marine pollution pollutant. A full detail of the paper and the major findings is stated below. Also, distribution of total organic carbon in Kuwait waters and the long term implications for the Oxygen Minimum Zone of the Arabian Sea is recently published. A full detail of the manuscript is given in the new publication list section.

Major findings of the recent trace metal research project

- Dissolved trace metals were analyzed for the first time using clean analytical techniques from the NW Arabian Gulf on a spatial and seasonal basis.
- Nutrient-trace metal interactions and its synergistic effect on phytoplankton standing stock was investigated using multivariate statistical approach – A first of its kind study from the Arabian Gulf.
- Multivariate analyses revealed marked spatial and seasonal disparity in water quality in the NW Arabian Gulf, off Kuwait
- Based on correlation analysis, supply and demand of macronutrients and total dissolved trace metals were proposed for phytoplankton community in the Kuwait Bay and offshore waters on a seasonal basis.
- Labile trace metal concentrations calculated from C: trace metal stoichiometry yielded comparable results with outcomes from correlation analysis on supply and demand scenario.

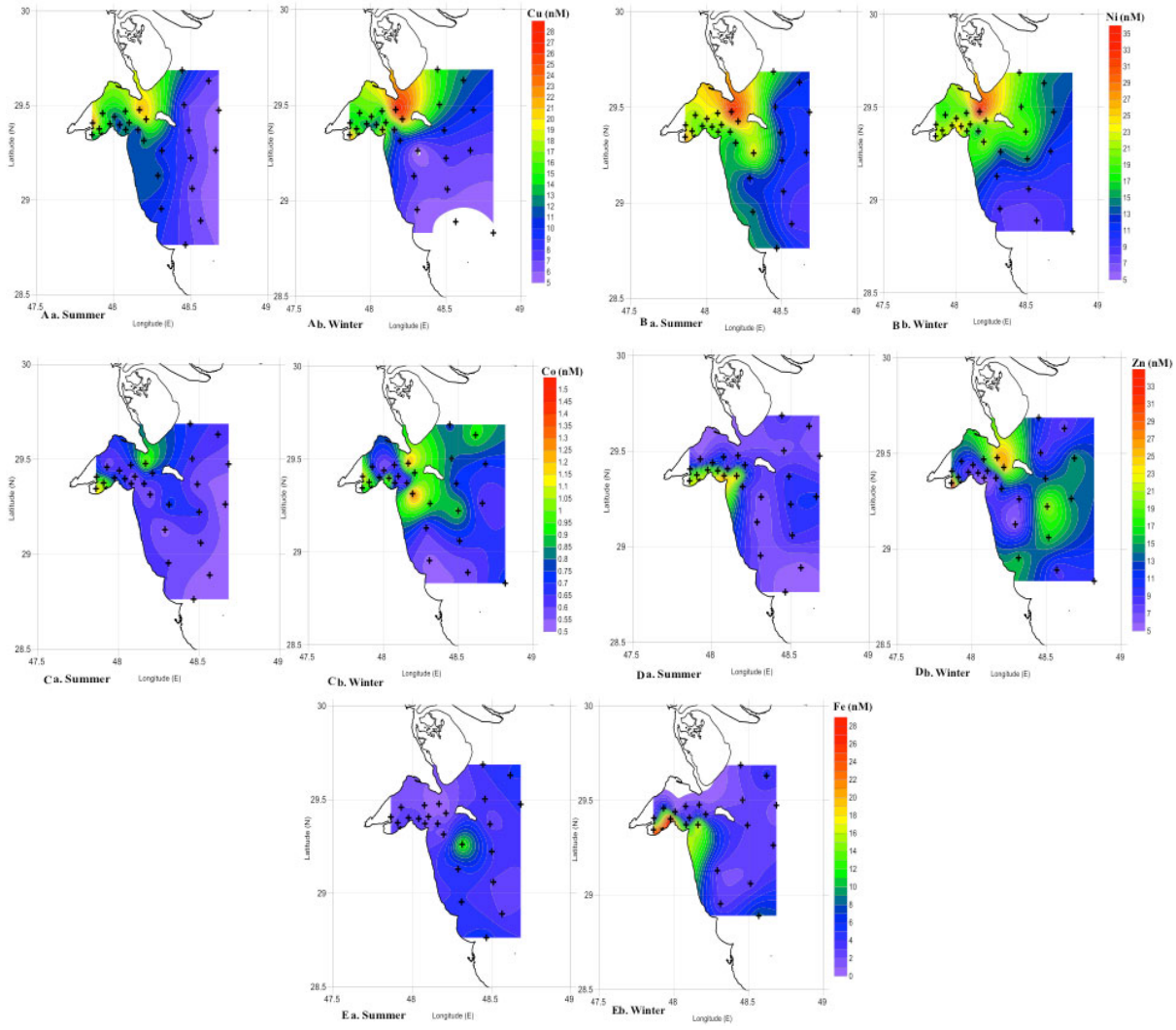

Figure 7. *Trace metal distribution in Kuwait water in summer and winter : Cu (Aa.Summer & Ab. Winter), Ni (Ba. Summer & Bb. Winter), Co (Ca. Summer & Cb.Winter), Zn (Da. Summer & Db.Winter) and Fe (Ea. Summer & Eb. Winter)*

Future Projects

- **Project Title**: Effect of mineral dust on ocean productivity and biogeochemistry of the northern Arabian Gulf.

  Objective: To identify the sources and to assess the effect of mineral dust fluxes on biogeochemical processes in the northern Arabian Gulf.

  The above project will be completed in collaboration with NIO, India.

- Similar transects conducted in the completed project will be repeated soon to update the database.

- Speciation measurements will be conducted soon to enhance our understanding on trace metal cycling and its correlation to phytoplankton in Kuwait waters.

- Development of a new sampling technique; in situ pumping system.

Other Activities

- Two training courses were conducted for regional and international researchers on trace metals and nutrients;
    - The Measurements of Trace Metals (Cu, Ni, Co & Fe) in Seawater using Adsorptive Cathodic Stripping Voltammetry (AdCSV) & Flow Injection Analyzer (FIA) (Introductory)
    - The Measurements of Nutrients in Seawater
- Conducted trainings for university students during KISR summer training programs. Students were introduced to clean sampling and analysis. The title of the projects is stated below;
    - Distribution of Dissolved Trace Metals (Copper &Iron) in Kuwait's Waters; Correlation to Phytoplankton Biomass
    - Dissolved iron in Kuwait waters and biological relationship.

New Publications

- Turki Al-Said, RakheshMadhusoodhanan, TapuspongPokavanich, Faiza Al-Yamani, Razia Kedila, Aws Al-Ghunaim, Ali Al-Hashem. 2017. Environmental characterization of a semiarid hyper saline system based on dissolved trace metal-macronutrient synergy: A multivariate spatio-temporal approach. *Marine Pollution Bulletin* http://dx.doi.org/10.1016/j.marpolbul.2017.10.009
- Faiza Al-Yamani, Takahiro Yamamoto, Turki Al-Said, Aws Al-Ghunaim. 2017. Dynamic hydrographic variations in Northwestern Arabian Gulf over the past three decades: Temporal shifts and trends derived from long-term monitoring data. *Marine Pollution Bulletin* 122 (488-499) http://dx.doi.org/10.1016/j.marpolbul.2017.06.056
- Turki Al-Said, Aws Al-Ghunaim, Durvasula V. SubbaRao, Faiza Al-Yamani, Kholood Al-Rifaie, Ali Al-Baz. 2017. Salinity-driven decadal changes in phytoplankton community in the NW Arabian Gulf of Kuwait. *Environmental Monitoring and Assessment*, 189:268 http://dx.doi.10.1007/s10661-017-5969-4
- Turki Al-Said, S.W.A. Naqvi, Faiza Al-Yamani, Alexandr Goncharov, and Loreta Fernandes. 2018. High Total Organic Carbon and Hypoxia in the Water Column of the Arabian Gulf: Implications for the Oxygen Minimum Zone of the Arabian Sea. *Marine Pollution Bulletin* 129 (35-42).

Published Conference Paper

- Turki Al-Said, Rakhesh Madhusoodhanan, Aws Al-Ghunaim, Faiza Al-Yamani, Raziya Kedila, Loreta Fernandes and Walid Al-Zakri. 2018. The Effect of Water Quality including Trace metals on Sargassum in the semiarid waters off Kuwait, NW Arabian Gulf. KISR 14473. ASLO conference, Portland, USA 11-16/02/2018.

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

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN THE NETHERLANDS

May 1st, 2017 to March 30th, 2018

New scientific results

Progress is being made with the interpretation and publication of results from cruises GA02 and GA04N. A process study was done aboard the research icebreaker Araon in collaboration with the Korean Polar Research Institute, where 19 stations were sampled in the Amundsen Sea and Antarctic Circumpolar Current. Additionally, three bio-assays were performed to test the effects of temperature and iron additions. Samples are currently being transported and will be analysed over the coming year(s). Additionally, water column samples were collected at 2 stations on a cruise in the Gulf of Mexico with RV Pelagia from March 12 – April 4, 2018. St Maarten – Nassau. Benthic flux measurements with landers and pore water sampling was carried out at the same stations. Analyses of Fe and other elements are planned (flow injection for Fe, SEAFAST-ICP-MS analyses)

New publications (published or in press)

- Slagter, H.A., Reader, H,.E., Rijkenberg, M.J.A., Rutgers van der Loeff, M., de Baar, H.J.W., Gerringa, L.J.A.,2017. Fe speciation is related to terrestrial dissolved organic matter in the Arctic Ocean. Marine Chemistry 197, 11–25. http://dx.doi.org/10.1016/j.marchem.2017.10.005
- Gerringa, L.J.A., Slagter, H.A., Bown, J., van Haren, H., Laan, P., de Baar, H.J.W., Rijkenberg, M.J.A., 2017. Dissolved Fe and Fe-binding dissolved organic ligands in the Mediterranean Sea. Marine Chemistry, 194: 100–113. http://dx.doi.org/10.1016/j.marchem.2017.05.012
- Middag, R., van Heuven, S.M.A.C., de Baar, H.J.W., Bruland, K.W., in press. The relationship between cadmium and phosphate in the Atlantic Ocean unravelled. Accepted for publication in *Earth and planetary science letters*.
- Rusiecka, D., Gledhill, M., Milne, A., Achterberg, E.P., Annett, A.L., Atkinson, S., Birchill J. Karstensen, A., Lohan, M., Mariez, C., Middag, R., Rolison, J.M., Tanhua, T., Ussher, S., Connelly, D., 2018. Anthropogenic signatures of lead in the Northeast Atlantic. *Geophysical Research Letters*, 45.
- Rolison, J.M., Stirling, C.H., Middag, R., Gault-Ringold, M., George, E., Rijkenberg, M.J.A., 2018. Iron isotope fractionation during pyrite formation in a sulfidic Precambrian ocean analogue. *Earth and planetary science letters* 488, 1-13.
- de Baar, H.J.W., van Heuven, S.M.A.C., Abouchami, W., Xue, Z., Galer, S.J.G., Rehkämper, M., Middag, R., van Ooijen, J., 2017. Interactions of dissolved CO2 with cadmium isotopes in the Southern Ocean. *Marine Chemistry* 195, 105-121.
- Rijkenberg, MJA, Slagter, HA, Rutgers van der Loeff, M, van Ooijen,J , Gerringa, LJA, 2018. Sources of dissolved Fe in the deep and upper Arctic Ocean with a focus on Fe limitation in the Nansen Basin. Front. Mar. Sci. 5:88.doi: 10.3389/fmars.2018.00088.
- Rosati G, Heimbürger LE, Melaku Canu D, Lagane C, Laffont L, Rijkenberg MJA, Gerringa LJA, Solidoro C, Gencarelli CN, Hedgecock IM, De Baar HJW, Sonke JE.

Methylmercury in the Black Sea: insights into the Hg cycle from data and models Global Biogeochemical Cycles,32. Doi.org/ 10.1002/2017GB005700.

- Dijkstra, N., P. Kraal, Seguret, M.J.M., Flores, M.R, Gonzalez, S., M.J.A. Rijkenberg, Slomp, C.P. (2018) Phosphorus dynamics in and below the redoxcline in the Black Sea and implications for phosphorus burial. Geochimica et Cosmochimica Acta 222: 685-703 Submitted.
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Cruises

- ANA08B, Amundsen Sea cruise Antarctica aboard the R.V. Araon from December 18th 2017 till February 11th 2018.

Meetings

- Séguret M, Lenstra W, Hermans M, Dijkstra N, Kuzminov A, Severmann S, Rijkenberg M, Laan P & Slomp C. Trace Metal Dynamics in the Water Column along a Shelf-To-Basin Transect in the Black Sea. Poster presentation. Goldschmidt conference, Paris, August 13-18, 2017.
- Hermans M, Lenstra W, van Helmond NAGM, Egger M, Jilbert T, Witbaard R, Gustafsson E, Gustafsson BG, Conley DJ & Slomp CP Impact of Natural Reoxygenation on the Sediment Geochemistry in a Euxinic Baltic Sea Basin Oral presentation. Goldschmidt conference, Paris, August 13-18, 2017.
- Lenstra W, Seguret M, Hermans M, Witbaard R, Kraal P, Kuzminov A, Severmann S, Teaca A, Behrends T, Dijkstra N & Slomp C. The Shelf-To-Basin Iron Shuttle in the Black Sea Revisited. Oral presentation. Goldschmidt conference, Paris, August 13-18, 2017

Submitted by Rob Middag (rob.middag@nioz.nl).

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN THE NEW ZEALAND

May 1st, 2017 to March 30th, 2018

New Scientific Results

GEOTRACES GA04N Black Sea and Mediterranean Sea Expedition. The GEOTRACES (GA04N) expedition to the Black Sea in 2013 provided an opportunity to examine the biogeochemical cycling of a suite of trace elements and their isotopes 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 formed the basis of the PhD research programmes of completed graduate students John Rolison and Ejin George, and were presented as part of a keynote address at the 2017 Goldschmidt Conference in Paris, France. The U and Fe isotope datasets have been published in *GCA* and *EPSL*, respectively, and a manuscript detailing the Cd isotope systematics of this region is currently being prepared.

We have also obtained Fe and Cd isotope datasets for surface water samples collected during the Mediterranean legs of the GA04N expedition. Zinc isotope results for surface waters are in progress, following extensive method development. This will be followed by a Fe, Zn and Cd isotope investigation of water samples collected from depth profiles in the Mediterranean Sea. Together, these datasets will provide important information on the biogeochemical cycling of Fe, Zn and Cd in the oceans, and will provide additional insight on the modifying influence of atmospheric and anthropogenic inputs, as the Mediterranean Sea receives the largest flux of atmospheric deposition of any modern marine basin, is strongly impacted by anthropogenic activity, and experiences overturning circulation analogous to the global ocean but on shorter timescales.

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 formed the basis of the PhD research of graduate student Ejin George, who successfully defended his thesis in May 2017. The Cd isotope and Cd concentration datasets for the GP13 expedition were submitted to the 2017 International Data Product and several manuscripts are in final draft form.

An inter-calibration exercise involving a crossover station along the GP13 transect has also been conducted and shows excellent agreement between different laboratories. This work is currently being prepared for publication.

GEOTRACES GPpr08 (Leg 2, Phantastic II) Ross Sea, Antarctica Expedition. Water samples collected in 2013/2014 during Leg 2 of the GEOTRACES GPpr08 (Phantastic II) Expedition have provided an opportunity to investigate the biogeochemical cycling of a suite of bioactive trace elements, with emphasis on Fe and Fe stable isotopes, in the High Nutrient Low Chlorophyll (HNLC) region adjacent to the West Antarctic Peninsula, with a primary

objective of elucidating the sources of Fe to this oceanic region. The concentrations of a suite of ca. 20 elements was obtained in 2017 for the majority of water samples collected during the Phantastic II cruise by University of Otago PhD student Kyyas Seyitmuhammedov (primary supervisor: Claudine Stirling), while visiting offshore-supervisor Rob Middag at NIOZ, The Netherlands. The remaining samples are scheduled to be analysed for their elemental concentrations at the University of Otago in mid-2018. The Fe stable isotope composition of a selection of these samples will be determined by MC-ICPMS at the University of Otago in late-2018 using double-spike protocols.

New Publications

- J.M. Rolison, C.H. Stirling, R. Middag, M. Gault-Ringold, E. George, M.J.A. Rijkenberg (2018). Iron isotope fractionation during pyrite formation in a sulfidic Precambrian ocean. *Earth Planet. Sci. Lett.* 488, 1-13.
- J.M. Rolison, C.H. Stirling, R. Middag, M.J.A. Rijkenberg (2017). Uranium stable isotope fractionation in the Black Sea: Calibration of the $^{238}U/^{235}U$ paleoredox proxy. *Geochim. Cosmochim. Acta*. 203, 69-88.

PhD Theses

- Ejin George – University of Otago (primary supervisor: Claudine Stirling). Title: 'Marine biogeochemical cycling of cadmium and its isotopes: Studies of the South Pacific Ocean, Mediterranean Sea and Black Sea'. PhD defended: May 2017; PhD conferred: December 2017.

Meetings

- C.H. Stirling, J.M. Rolison, E. George, R. Middag, M.O. Clarkson, S.K. Gangl (2017). Metal isotope tracers of the redox and productivity states of the past oceans: Refining modern calibrations. *Invited Keynote Address*, 2017 *Goldschmidt Conference*, Paris, France, August 2017.

Submitted by Claudine Stirling (cstirling@chemistry.otago.ac.nz).

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN NORWAY

May 1st, 2017 to March 30th, 2018

Publications

- Marco van Hulten et al. at the Geophysical Institute, University of Bergen published a paper in Biogeosciences on the distibition on manganese in the West Atlantic Ocean. They fitted data from GEOTRACES GA02 transect to the first global ocean circulation model for Mn.
- Marco van Hulten, Rob Middag, Jean-Claude Dutay, Hein de Baar, Matthieu Roy-Barman, Marion Gehlen, Alessandro Tagliabue, and Andreas Sterl Manganese in the west Atlantic Ocean in the context of the first global ocean circulation model of manganese Biogeosciences, 14, 1123-1152, https://doi.org/10.5194/bg-14-1123-2017, 2017
- Marci van Hulten et al. also have a paper in review in Geoscientific Model Development journal on scavenging and circulation of thorium-230 and protactinium-231 in the ocean:
- Marco van Hulten, M., Dutay, J.-C., and Roy-Barman, M.: A global scavenging and circulation ocean model of thorium-230 and protactinium-231 with realistic particle dynamics (NEMO–ProThorP 0.1), Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2017-274, in review, 2017.
- And finally, Christoph Heinze from the same institute have also submitted a paper Biogeosciences discussions on the potential of using ^{230}Th for detection of ocean acidification impacts: https://www.biogeosciences-discuss.net/bg-2017-305/

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

New scientific results

Geochemical proxies in bottom sediments

• The first data on partition of about twenty chemical elements (including rock-forming elements and heavy metals) in long columns of bottom sediments (up to 460 cm) from Northern Atlantic Ocean have been obtained. Down the core, a rhythmic alternation of high and low concentrations of rock-forming Al, Fe, Si and Ca was recorded that was caused by change in sedimentary material supply in dependence on conditions of sedimentation in glacial and interglacial periods (Figure 8). Variations in the Al, Fe, Si, V, Cr, Zn, Zr, and Ti vertical distribution were in the opposite order with the Ca changes (main element of carbonate foraminifera-coccolithophorid sediments). On the other hand, synchronous Ca and Sr variation was recorded down the core ($R^2 = 0.79$) which was opposite to Si/Al ratio. The Sr/Ca ratio could serve a geochemical proxy of climate change: glacial periods ($\delta^{18}O$) are characterized by minimal Sr/Ca values, interglacial - by high Sr/Ca, Rb/Sr ratios [Wien et al., 2005]. According to our data, the variation relationship of Sr/Ca in sediments St. 3378 correspond to MIS 1–6 [**Novichkova et al., 2017; Demina et al., 2017**].

• New micropalaeontological and geochemical data were obtained from the eastern part of the Kara Sea. Core AMK-5240 was formed during the Holocen at the central part of the Voronin Trough. The bottom of the Voronin Trough, further north is covered with diamicton and has numerous erosional bedforms, indicating a streamlined flow of grounded ice along the trough after Last Glacial Maximum [LGM; Polyak et al., 2008]. The core section is represented by silty clay with carbonate content from 0 to 8%. The amount of biogenic material (opal, $CaCO_3$ and organic matter) varies from 0.6 to 1.8% (Figure 9). According to our reconstructions, the period of 11–12 ky BP is characterized by the increased influence of the pra-Yenisei river. In this period, CD-ratio (ratio between freshwater and marine species) and Si/Al, Ti/Al (as indicator of terrigenous coarse-grained sediment) rise up. The optimum Holocene conditions is reconstructed for the period of 9–11 ky. The "warm-water" North Atlantic dinocyst species were appeared and C_{org} was increased more than 1.5% [**Novichkova et al., 2018**].

Suspended particulate matter and trapped material

• The role of zooplankton in the vertical mass flux in the Kara and Laptev seas was studied during cruise 63th of the RV *Akademik Mstislav Keldysh* in August–October 2015. Mass fluxes were estimated using sediment trap samples. The maximum values of the total vertical flux (19600 $mg \cdot m^{-2} \cdot day^{-1}$) and particulate organic carbon (POC) flux (464 $mgC \cdot m^{-2} \cdot day^{-1}$) were measured close to the Lena River Delta in the Laptev Sea. In the Kara Sea, the total flux (80–2700 $mg \cdot m^{-2} \cdot day^{-1}$) and the POC flux (17–130 $mgC \cdot m^{-2} \cdot day^{-1}$) were substantially higher than the estimates published earlier. The fecal pellet flux varied from 2 to 92 $mgC \cdot m^{-2} \cdot day^{-1}$ and made up 4–190% of the total organic carbon flux. The mineral composition of fecal pellets largely mirrored that of suspended particulate matter. Clay minerals in the fecal pellets were more abundant than in particulate matter in the areas with noticeable freshwater impact. The flux of zooplankton carcasses varied from 0.1 to 66.4 $mgC \cdot m^{-2} \cdot day^{-1}$ and made up 0.2–72% of total POC flux. The results are discussed in relation to the abundance and composition of zooplankton, the concentration and composition of suspended particulate matter, hydrophysical conditions, and methods of sample preparation for analysis [**Dritz et al., 2017**].

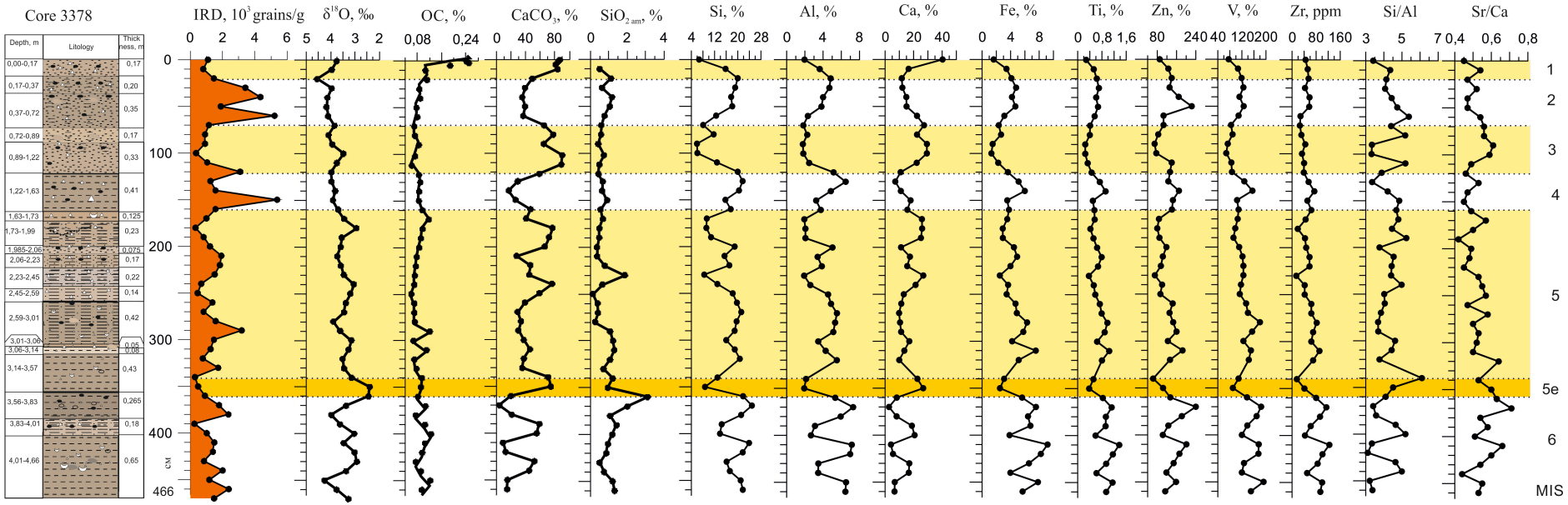

Figure 8. *Geochemical proxies in AI-3378 sediment core at the Snorry Drift (2192 m depth), eastern slope of the Reykjanes Ridge, North Atlantic, 49th cruise of RV Akademik Ioffe. Yellow is marked by warm marine isotope stages, dark yellow – the warmest one (Holocene MIS 5e) [Novichkova et al., 2017; Demina et al., 2017]. IRD – ice-rafted debris; MIS – marine isotope stage.*

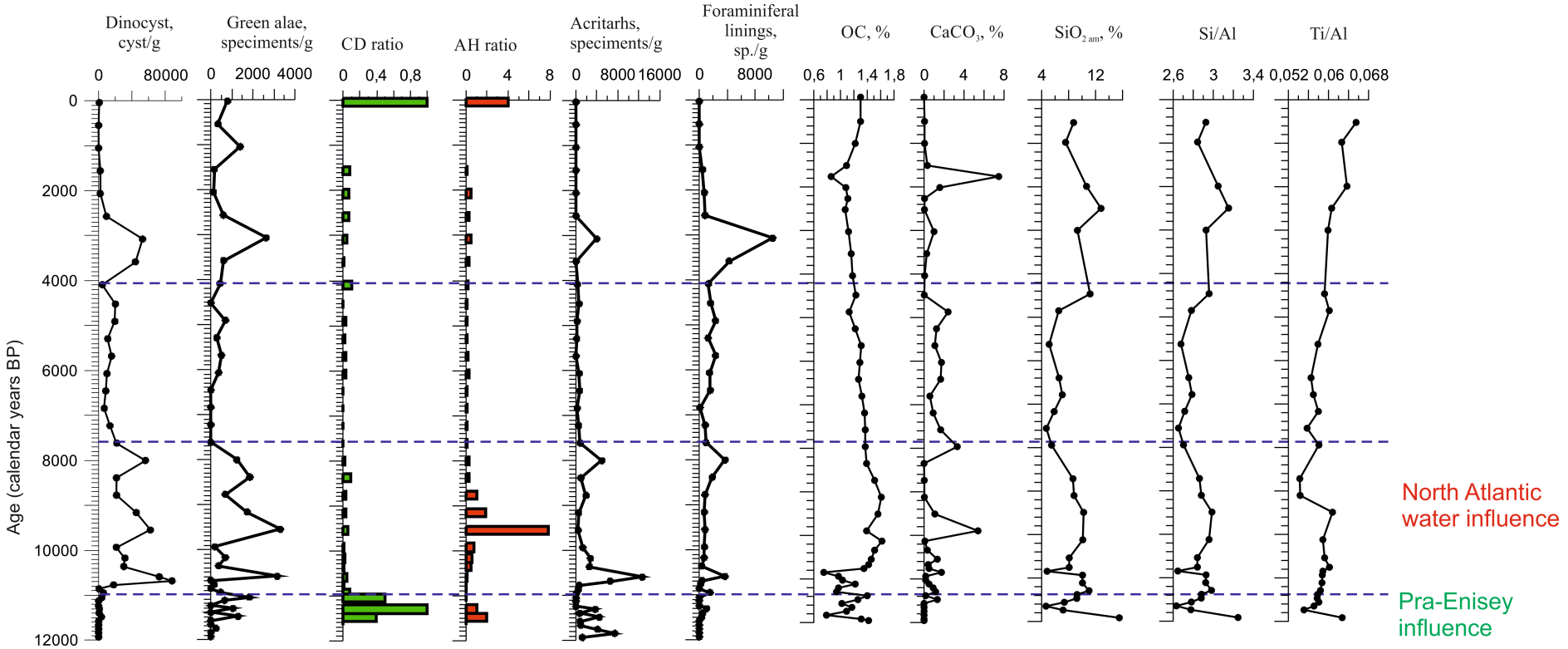

Figure 9. *Micropalaeontological and geochemical proxies in AMK-5240 sediment core collected in the Voronin Trough, eastern part of the Kara Sea [Novichkova et al., 2018, in press], 63th cruise of RV Akademik Mstislav Keldysh.*

• Role of zooplankton in the organic matter flux was studied in the Kara and Laptev seas using sediment traps in the course of cruise 63th of the RV *Academic Mstislav Keldysh* research vessel in August–October 2015. The values of the total flux and that of organic matter were at least an order of magnitude higher than those obtained before the 2000s. A hypothesis is proposed on an increasing influence of the river runoff on the Kara Sea area under climatic changes. Zooplankton contribution into C_{org} flux varied broadly, averaging 50%. The highest flux values and contribution of zooplankton in them (up to 96%) were recorded in the frontal (gradient) zones [**Pasternak et al., 2017**].

• In studying the sedimentary process in the White Sea, we managed to combine short-term expeditions on the stations with stationary continuous year-round study of the environment throughout the water column (surface–bottom): by moorings – automatic deep observatories for sedimentation (ADOS) with simultaneous study of bottom sediments, i.e., to study the data from the natural environment and climate recorder in the range from a few years (AGOS) to hundreds and thousands of years ago to the present (Figure 10).

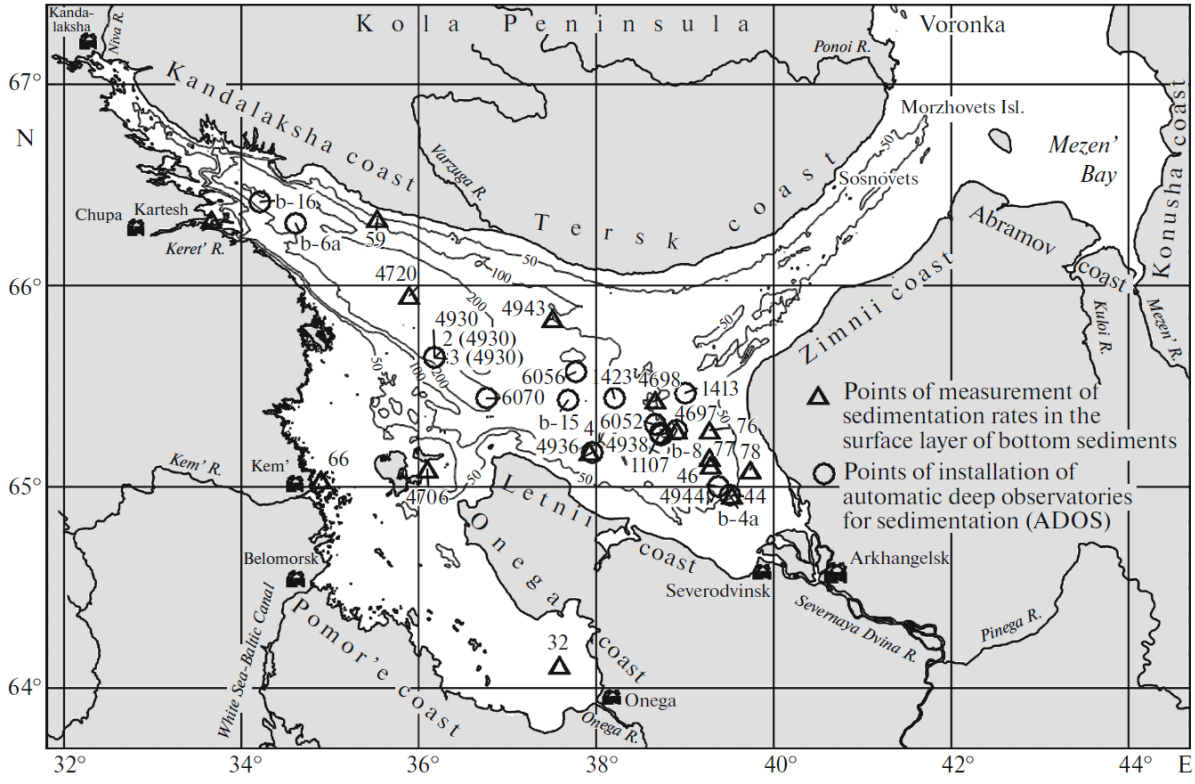

Figure 10. *Location of all-year moorings (ADOS) with the points of analysis of fluxes (absolute mass) in the surface layer of bottom sediments in the White Sea (the sedimentation rates by ^{210}Pb and ^{137}Cs are recalculated into absolute mass [Novigatsky et al., 2018].*

Our data on the long-term monitoring of the concentration of suspension (Figure 11a) and flux of the particulate sedimentary material (Figure 11b) clearly indicate stable year-round nepheloid layers in the White Sea. In addition, the scheme (Figure 11b) shows the area of ultrarapid sedimentation of the marginal filter of the Severnaya Dvina River, which is clearly observed in the water column (Stations b-4a and 1413), as well as in the surface layer of bottom sediments (Stations 44 and 78).

The quantitative transition of particulate forms of sedimentary material into the concentrated forms follows a linear dependence with the local maximum in the deep nepheloid layer. Areas of ultrarapid sedimentation, namely marginal filters (Severnaya Dvina

River and others), are distinguished. The long-term data on the concentration of the suspension and fluxes of particulate sedimentary material clearly distinguish the stable year-round nepheloid layers as well [**Novigatsky et al., 2018**].

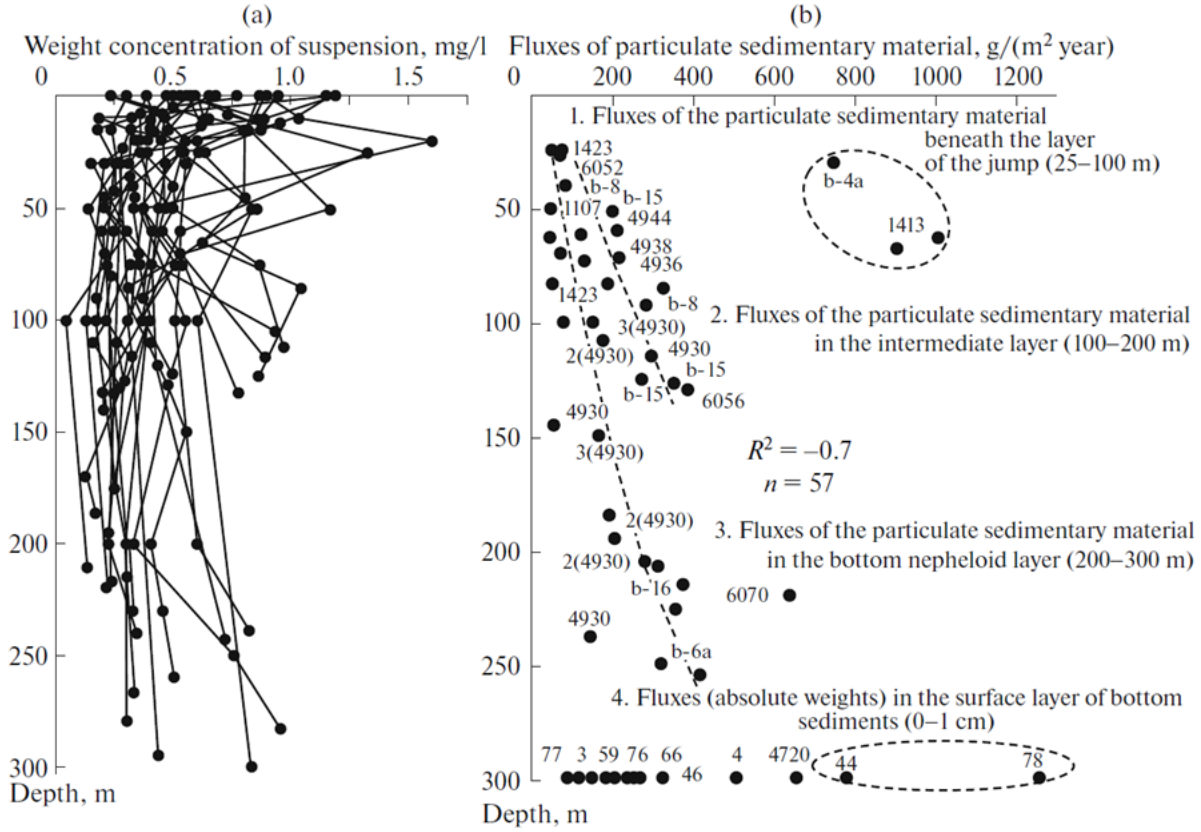

Figure 11. *Data of long-term studies in the White Sea: (a) vertical distribution of mass concentration of suspended particulate matter; (b) linear dependence of vertical fluxes of sedimentary material on the depth (ADOS data). Dashed lines show the area of avalanche sedimentation (alluvial fan) for the Severnaya Dvina River [Novigatsky et al., 2018].*

• Investigations of the suspended particulate matter along the latitudinal transect 59°30' N from Great Britain to Greenland were carried out in the 49th cruise of the RV *Academik Ioffe*. The concentrations of suspended matter along the transect were low, increasing from 0.24 to 1.07 mg/L in the surface layer (0–5 m), from 0.24 to 0.99 mg/L in the pycnocline (thermocline) zone and appreciably decreasing to the bottom layer, from 0.10 to 0.56 mg/L. The isotopic composition of the organic carbon of the suspended matter was determined in 18 samples. The values of $\delta^{13}C\text{-}C_{org}$ vary from –17 to –24.6‰. Judging by the chlorophyll *a* content, isotopic composition and remoteness of water masses from the coast, the carbon of the suspended particulate matter is mainly represented by autochthonous organic matter of phytoplankton origin. The presence of the suspended particulate matter with a heavy isotopic composition in the surface layer of the water column can serve as a proof of the current processes of phytoplankton blooming. In this case, the differences in the intensity of these processes can be observed, creating a mosaic picture of blooming even within a distance of 150 miles [**Politova et al., 2018**].

Dissolved metals and biogenic elements

• A detailed depth concentration profiles across the redox zone and the upper part of anoxic zone of the Black sea were obtained for dissolved molybdenum, vanadium and tungsten (Figure 12). Both dissolved (<0.45 μm) and sum of dissolved and particulate fractions were examined for this elements. In the redox zone with a hydrogen sulfide content of ~7 μM, the molybdenum drastically decreases, probably due to scavenging of Mo(VI) in form of thiomolybdate ion on sinking particles of sulfides with subsequent reduction to Mo(IV). The concentrations of V and W are influenced by their scavenging onto Mn oxyhydroxides which are present in the oxygen deficiency zone. Reductive dissolution of Mn oxyhydroxides in the upper part of the anoxic zone leads to the increase in V and W concentrations. It is shown that particulate fraction of the studied elements is too small to significantly affect their bulk concentrations. The release of vanadium into dissolved state due to the Mn (and Fe) oxyhydroxides dissolution is about 70–75%, and 25–30% is scavenged onto precipitated sulfide particles. Tungsten completely returned into solution after dissolution of manganese oxyhydroxides, as evidenced by its strong correlation with the dissolved Mn. Based on the concentrations of these elements, their budget in the Black Sea was calculated [**Rimskaya-Korsakova et al., *in press***].

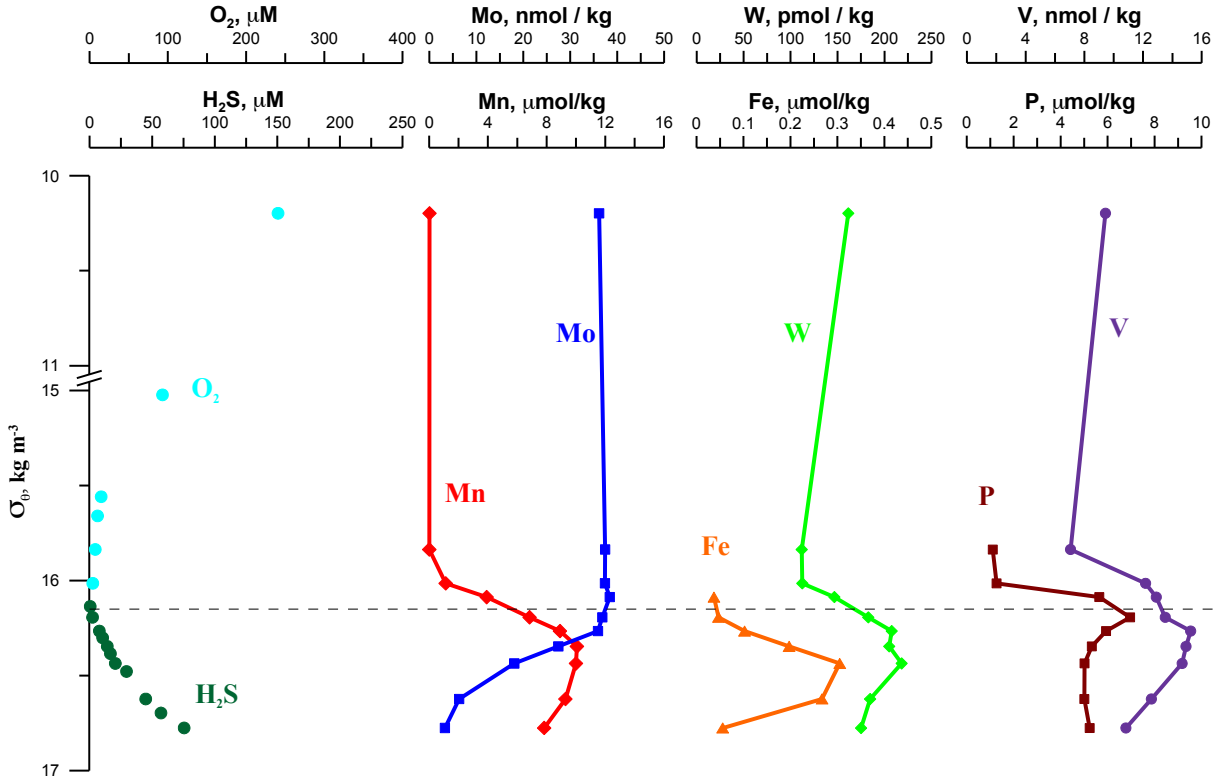

Figure 12. *Detailed depth profiles of Mn, Mo, W, Fe, V and P concentration across the redox zone and the upper part of anoxic zone of the Black Sea [Rimskaya-Korsakova et al., in press].*

• The results of the first two years of work in the frames of the project "Observatory –the Marginal Filter of Severnaya Dvina River" (the White Sea, Arctic) are presented. The main aim of this project is the regular investigations of sedimentological, geochemical and biological processes in the marginal filter zone of the Severnaya Dvina River in its lower flow and its marginal filter (MF). The MF is the river – sea mixing zone which is the natural trap for all kinds of dissolved and particulate material on its way from continent to sea or ocean. This paper is devoted to the results of determination of the dissolved mineral forms of N, P and Si.

The samples of surface water were taken every month during two years in two points – in the Arkhangelsk city (Yacht-club) and in the port Economya. In the MF the samples were taken two times in a year – in spring immediately after the ice coming off and in the period of low water in August. Water was filtered through the Nuclepore filters at the day of sampling and the nutrient elements were determined by the generally accepted methods.

The results show that concentrations of nitrites, nitrates, phosphates and silica are greatly changed in seasons and between years. The ratios between maximum and minimum concentrations during two years of observations were in a range 11–16 for NO_2-N, PO_4-P and Si, and especially great for NO_3-N– up to 620. A comparison with the typical for World Rivers concentrations have shown that concentrations of nitrites and phosphates were in 2–3 times higher than global ones, concentrations of nitrates were close to global level and silica only was approximately in 1.4 times lower the global concentration. The correlation between molar ratios of N/P, Si/P and Si/N (Redfield ratios) have shown that N only was the limiting factor for normal activity of phytoplankton in the ecosystem of the lower flow of the river. The concentrations of the elements in the MF zone were determined in the whole range of salinity from river waters up to sea waters. It was found that at high water in spring the time of water existence in MF was much lower than in period of low water. This time was not enough for normal development of biochemical processes which provided influence on the concentrations and forms of elements in the MF zone. At low water in August the dependences of the concentrations from salinity begun to be more complicated and variable. The works in the frames of this project are continued [**Gordeev et al., 2018**].

Aerosols, snow and black carbon

• In order to better understand the chemical composition of snow and its impact on surface water hydrochemistry in the poorly studied catchment area of the Kara Sea in the Western Siberia Lowland (WSL), the surface layer of snow was analyzed [Shevchenko et al., 2017]. Sampled were collected in February 2014 across a 1700 km latitudinal gradient from Tomsk to Ob River estuary (ca. 56.5 to 68° N). We aimed at assessing the latitudinal effect on both dissolved and particulate forms of elements in snow and quantifying the impact of atmospheric input to element storage and export fluxes in inland waters of the WSL (Figure 13). The concentration of dissolved + colloidal (< 0.45 μm) Fe, Co, Cu, As and La increased by a factor of 2 to 5 north of 63° N compared to southern regions. The pH and dissolved Ca, Mg, Sr, Mo and U in snow water increased with the rise in concentrations of particulate fraction (PF). Principal component analyses of major and trace element concentrations in both dissolved and particulate fractions revealed two factors not linked to the latitude. A hierarchical cluster analysis yielded several groups of elements that originated from alumino-silicate mineral matrix, carbonate minerals and marine aerosols or belonging to volatile atmospheric heavy metals, labile elements from weatherable minerals and nutrients. The main sources of mineral components in PF are desert and semi-desert regions of central Asia. Therefore, the present study demonstrates significant and previously underestimated atmospheric input of many major and trace elements to their riverine fluxes during spring floods. A broader impact of this result is that current estimations of river water fluxes response to climate warming in high latitudes may be unwarranted without detailed analysis of winter precipitation [**Shevchenko et al., 2017**].

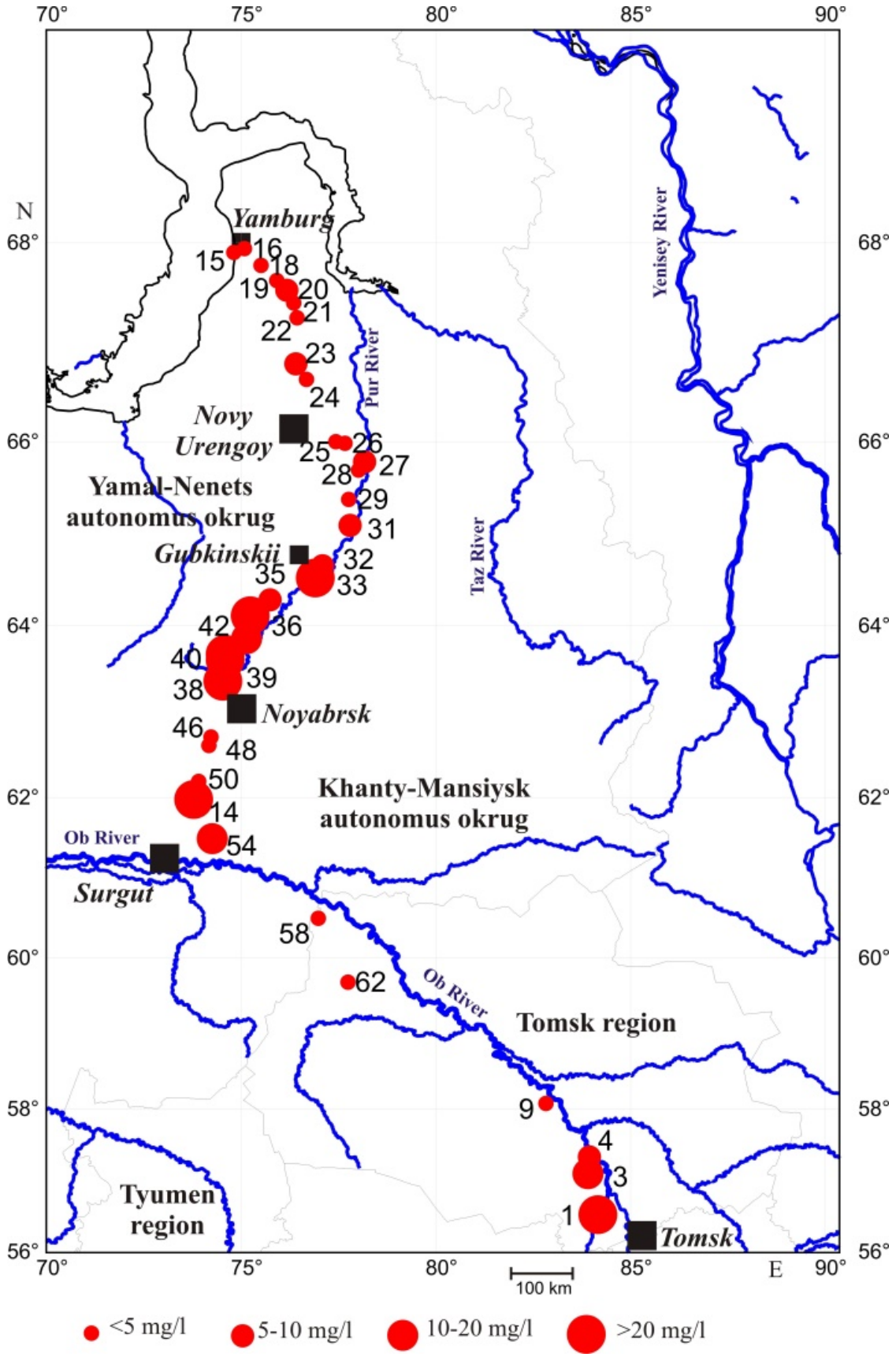

Figure 13. *Particulate matter concentration in melted snow (mg/l) from Tomsk city to Ob River estuary [Shevchenko et al., 2017].*

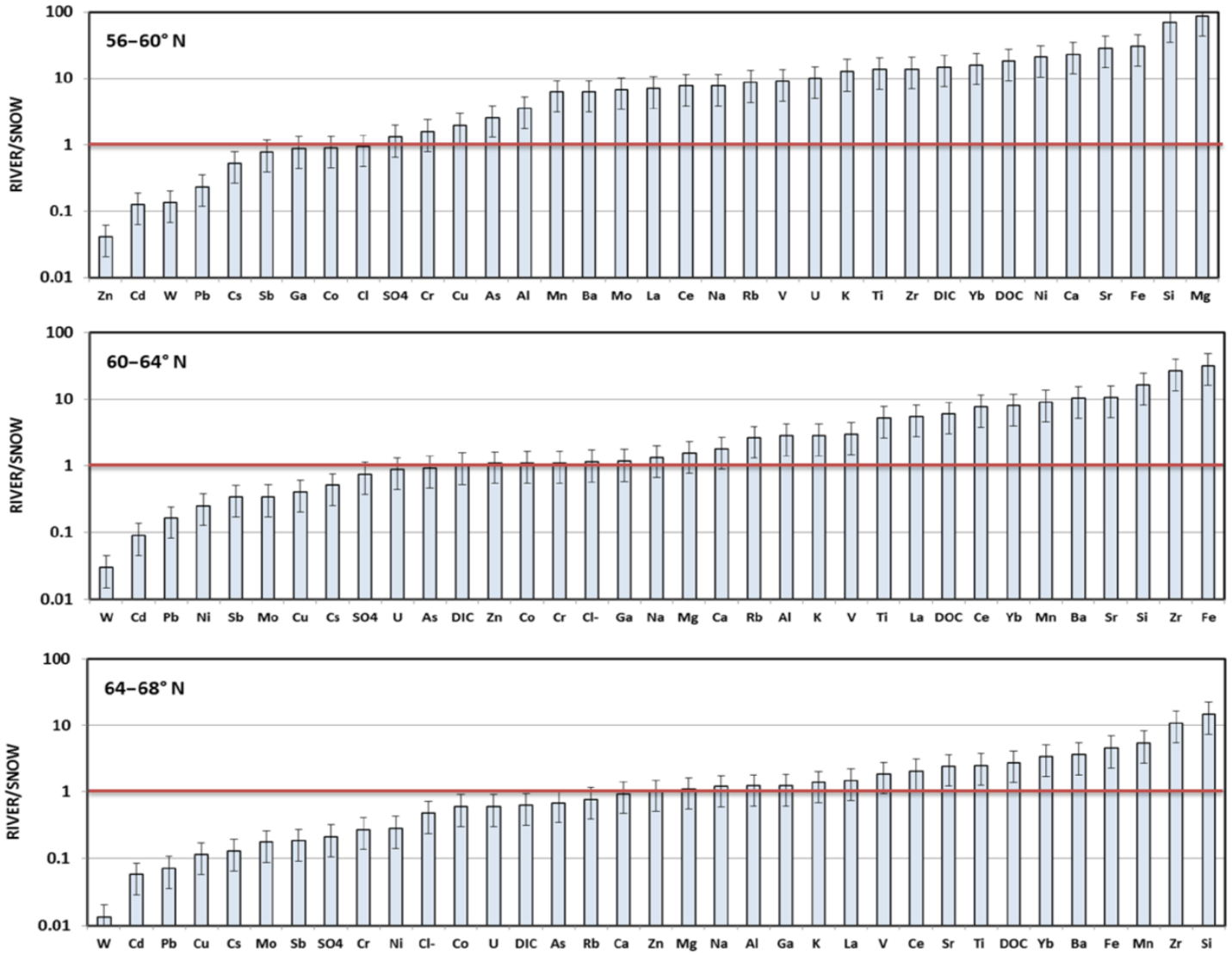

Figure 14. *The ratio of mean dissolved flux of rivers in 3 latitudinal zones in the Ob' River catchment to the stock of snow dissolved fraction [Shevchenko et al., 2017].*

• Almost all-around-year sampling of aerosols is being carried out over the northwestern coast of the Kandalaksha Bay (White Sea, Arctic). High-volume aerosol sampler is equipped with impactor allowing to collect aerosols of two size fractions: 2.5–10 and <2.5 μm. Trace elemental composition of both aerosol fractions was studied using ICP-MS with Agillent 7500. Almost all elements concentration is an order of magnitude larger in coarser aerosols than in PM2.5 in summer aerosols. The highest portion of concentrations related to fine aerosols is obtained for Bi, Cd, Pb. Content of lithogenic elements (Sr, Rb, La etc.) in fine matter (PM2.5) was up to 7–8%. Relative enrichment for V, Cu, Ni, Cd, Pb, Bi related to Earth's crust in fine fraction was 2–10 times higher than that in coarser fraction (Figure 14) [**Starodymova et al., 2018**].

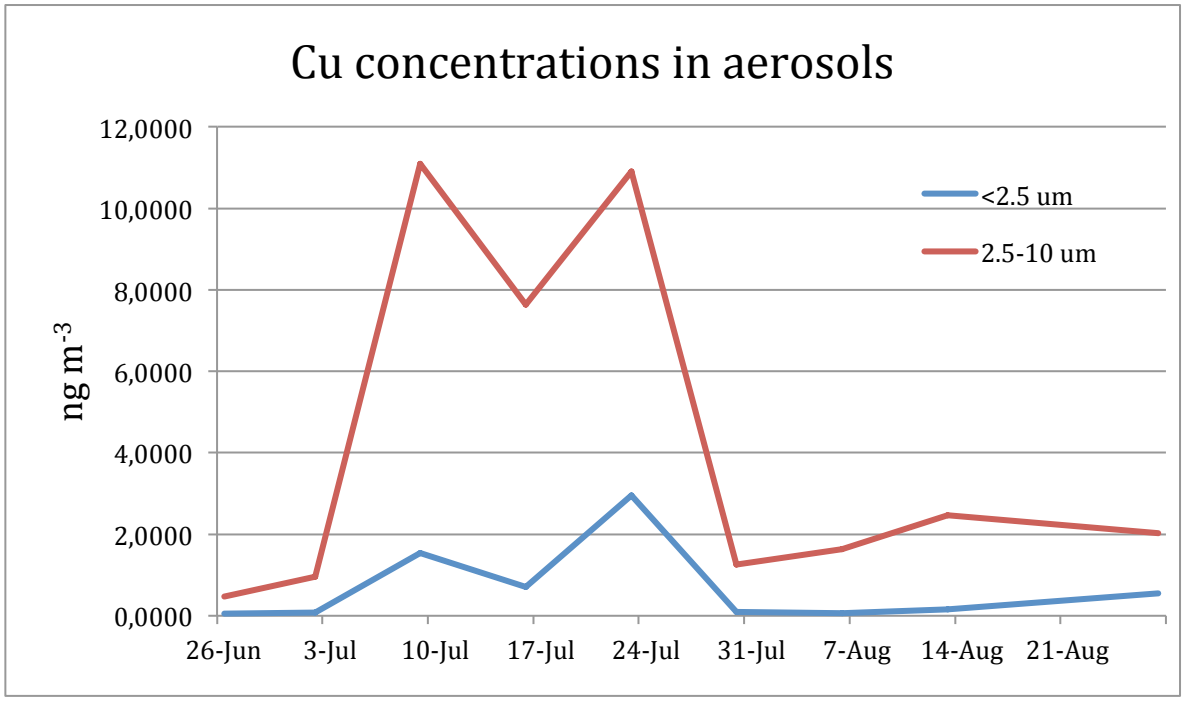

Figure 14. *Concentration of Cu in aerosols in the coastal area of the Kandalaksha Bay (White Sea, Arctic), collected in summer 2016 [Starodymova et al., 2018].*

• Short-lived climate forcers have been proven important both for the climate and human health. In particular, black carbon (BC) is an important climate forcer both as an aerosol and when deposited on snow and ice surface because of its strong light absorption. Results of measurements of elemental carbon (EC; a measurement-based definition of BC) in snow collected in catchment areas of the western Russia Arctic seas (western Siberia and northwestern European Russia) during 2014, 2015 and 2016, have been summarized together with colleagues from Norwegian Institute of Air Research (NILU) [Evangeliou et al., 2018]. The Russian Arctic is of great interest to the scientific community due to the large uncertainty of emission sources there. We have determined the major contributing sources of BC in snow in western Siberia and northwestern European Russia using a Lagrangian atmospheric transport model. For the first time, we use a recently developed feature that calculates deposition in backward (so-called retroplume) simulations allowing estimation of the specific locations of sources that contribute to the deposited mass. EC concentrations in snow from western Siberia and northwestern European Russia were highly variable depending on the sampling location. In the northwestern European Russia the major sources were transportation activities and domestic combustion in Finland [**Evangeliou et al., 2018**].

• The data on the distribution of atmospheric black carbon (BC) in the marine boundary layer of the North Atlantic and Baltic, North, Norwegian, Barents, White, Kara, Laptev and East Siberian seas from the 68th and 69th research cruises of the RV *Akademik Mstislav Keldysh* since June 25 to September 30, 2017 are processed and interpreted. During some parts of the cruises, air masses arrived from 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 (mainly in the area of the Baltic and North seas) and regions with gas flaring (the Kara Sea region) 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 [**Shevchenko et al., 2017**].

• We examine the decadal (2001–2010) regularities in the processes of distant transport of air masses and heavy metals (HM) to five locations in the North of the European territory of Russia. The spatial and seasonal differences in these processes are considered. We use the back trajectories statistical method for the transport of air masses, and a model description of the distant transport of HM on submicron aerosol particles. The study revealed the most significant sources of HM metals in different seasons for different regions, namely the industrial centers of Murmansk and Arkhangelsk oblasts, as well as the more distant Sverdlovsk, Leningrad and Vologda oblasts, and the cities of Kirov, Perm and Norilsk. The mean indicators of anthropogenic environmental pollution in the background areas of Murmansk and Arkhangelsk oblasts at a large distance from the emission sources. The estimates obtained for lead and cadmium are in a reasonable agreement with available measurements. It is shown that it is only with high winter-summer ratios of anthropogenic HM concentration (higher than 170, which corresponds to about 50% of cases) that anthropogenic impacts on the environment in a warm season can be neglected in the areas under consideration. Otherwise 14 to 45% of the anthropogenic annual flow of HM from the atmosphere can be deposited on the snow-free surface of soils and water bodies. It is found that a combination of the effectivenesses of sources and sinks during the distant transport of HM leads to uneven pollution of the territory under consideration, and this must be taken into account when selecting so-called background (low-pollution) areas separately for each pollutant involved [**Vinogradova et al., 2017b**].

• Interannual variations in the level of anthropogenic contamination of the surface air in the northern areas of Russia are studied, which are related to a change in the direction of air mass transport. To estimate the state of anthropogenic environmental contamination in the north of Russia, concentrations of seven chemical elements (Pb, Cd, As, Zn, Ni, Cr, and Cu), conventionally called *heavy metals* (HMs) below, were calculated in the surface air of the sites under study (**Fig. 9**). The transport of air and heavy metals to four sites located on territories of nature reserves on the coast of the Arctic Ocean (from the Kola Peninsula to a delta of the Lena River) in winter (January) and summer (July) is analyzed for 2000–2013. Indices of atmospheric circulation and data on the emission of pollutants into the atmosphere in cities and regions of Russia are involved in the analysis. Concentrations of seven heavy metals in the surface air are evaluated in the Arctic regions under study and their interannual, spatial, and seasonal variations are discussed. A strong interannual variability of atmospheric circulation differently influences the variations in the atmosphere contamination with different anthropogenic heavy metals in various areas of the north of Russia. The concentration ratios of heavy metals under study are different for each site in different years. The interannual and seasonal variations in the contamination level have maximum values for heavy metals arriving from most distant sources. Thus, the results of measuring the content of

anthropogenic contaminants in the air of reference areas during one season or even one year should not serve a basis for long-term conclusions and forecasts. It would be also unjustified to make general conclusions on the contamination level of the environment from observation results for only one contaminant and/or only at a single site [**Vinogradova et al., 2017a**].

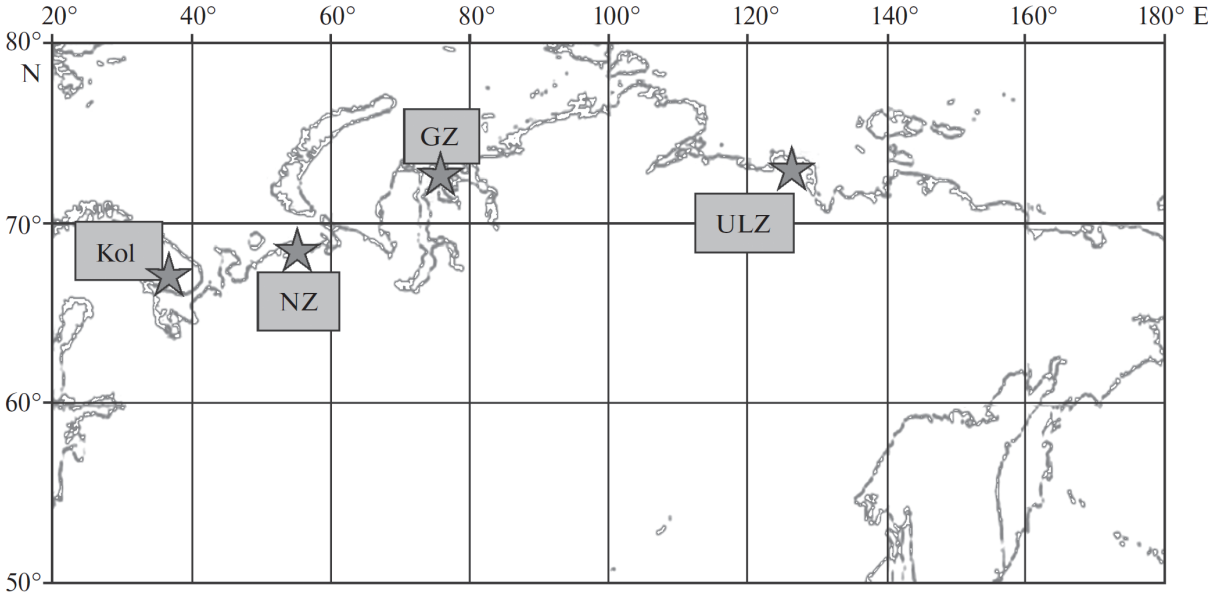

Fig. 9. Location of research sites of anthropogenic contamination of the surface air on the coast of the Arctic Ocean [Vinogradova et al., 2017a]. Kol – Kola Peninsula, NZ – Nenets Nature Reserve, GZ – Gydan Nature Reserve, ULZ – Ust-Lenski Nature Reserve [Vinogradova et al., 2017a].

• The first data on the concentrations, fluxes, and mineral and chemical compositions of aerosols from the near-water surface layer of the Caspian Sea are studied. It is shown that the aerosol fluxes onto the sea surface are comparable to the fluxes of a lithogenic substance in a water column. The mineral and chemical compositions of aerosols depend on the carrying air masses that pass through different regions. The coefficients of enrichment of aerosols with chemical elements relative to the upper lithosphere and their correlation relationships are studied [**Lisitzin et al., 2018**].

Isotopic proxies, methane and biogeochemical processes

• The data on the isotopic composition of particulate organic carbon ($\delta^{13}C_{POC}$) in the Caspian Sea water in summer–autumn 2008, 2010, 2012, and 2013 are first studied. These data allowed as to reveal the predominant genesis of organic carbon in suspended particulate matter of the active seawater layer (from 0 to 40 m). The $\delta^{13}C_{POC}$ = –27‰ (PDB) and $\delta^{13}C_{POC}$ = –20.5‰ (PDB) values were taken as the reference data for terrigenous and planktonogenic organic matter, respectively. Seasonal (early summer, late summer, and autumn) variations in the composition of suspended particulate matter in the active sea layer were revealed. A shift of $\delta^{13}C_{POC}$ towards greater values was seen in autumn (with a slight outburst in the development (bloom) of phytoplankton) in comparison with summer (with large accumulations and an extraordinary phytoplankton bloom confined to the thermocline area). The seasonal dynamics of autochthonous and allochthonous components in the suspended particulate matter of the Middle and Southern Caspian Sea was studied with the use of data on the concentration of particulate matter and chlorophyll *a*, the phytoplankton biomass and the POC content [**Kravchishina et al., 2018**].

• An area of cold methane seeps at the bottom of the Laptev Sea was investigated. High rates of methane oxidation were revealed in the sediments and in the water column. Anaerobic methane oxidation carried out by the ANME-2 a/b consortium was coupled to sulfate reduction. Bacteria of the genera *Sulfurovum* and *Arcobacter* were the agents of the sulfur cycle. Methane unconsumed in the sediments diffused into the near-bottom water, where it was oxidized by methanotrophic bacteria. Methanotrophic activity was essential for development of symbiotrophic tubeworms of the upper sediment layers, which were responsible for the process of bioturbation [**Savvichev et al., 2018**].

• Integrated studies on the hydrochemistry and water column rates of microbial processes in the eastern part of the Black Sea along a standard 100-miles transect off Gelendzhik city from the coast to the central part of the sea at water depths of 100–2170 m show that a series of warm winters and the absence of intense convective winter mixing resulted in a relatively low content of suspended particulate matter (SPM), particulate organic carbon (POC), and nutrients in the water column in March 2009. The relatively high SPM concentrations and the presence of isotopically light POC at the offshore station are indicative of the supply of terrigenous material from land and low contributions of phytoplanktonic organic matter to the composition of SPM. This may explain the low rates of biogeochemical processes in the water column near the coast. The surface layer at deep-water stations is dominated by isotopically heavy phytoplanktonic organic matter. This suggests that the supply of terrigenous material from land was insufficient in offshore deep-water areas. Therefore, warm winters and insufficient nutrient supply do not prevent photosynthesis in the photic layer of the deep-water zone, which generates organic substrates for heterotrophic aquatic communities. The results of isotopic analysis of POC, measurements of the rates biogeochemical processes, and the hydrochemical characteristics of the water column can be used to determine the nature and seasonal variability of the POC composition.

In the anaerobic zone of the water column, below the redox zone, the methane concentration increased irregularly to a depth of 600 m and remained constantly high below this depth. The increase in methane concentrations is associated with the acceleration of methane production and supply of methane from the bottom by diffuse leakage and/or seepage.

In the aerobic zone, the rate of methane production was highest in the surface layer of the water column with a high C_{org} content. In the anaerobic zone, the highest rates of methane production are confined to the upper boundary of the redox zone, where the largest amount of dead phytoplanktonic organic matter precipitates out of the photic layer [**Rusanov et al., 2018**].

New publications (published or in press)

- Demina L.L. and Galkin S.V. (2018) Bioaccumulation of Trace Elements in Organisms of Benthic Biocenoses in Oceanic Oxidized and Reduced Environments: Similarities and Differences. *Geochemistry Intern.*, No 6 (in press).
- Demina L.L. and Galkin S.V. (2018) Ecology of the bottom fauna and bioaccumulation of trace metals along the Lena River – Laptev Sea transect. *Environmental Earth Sciences.* V. 77, No 43. https://doi.org/10.1007/s12665-018-7231-y
- Demina L.L., Budko D.F., Lisitsyn A.P., Novigatsky A.N. (2018) The first data on geochemical fractions of heavy metals in vertical fluxes of dispersed sedimentary matter in the White Sea. *Doklady Earth. Sci.* V. 480, No 3 (in press).

- Demina L.L., Budko D.F., Solomatina A.S. (2017) X-ray fluorescence analysis for lithological geochemical studies of bottom sediments. *Geology of Seas and Oceans. Proceedings of XXII International Conference on Marine Geology*. Moscow, November 20 – 24, 2017. V. I. P. 63–67. http://geoschool.ocean.ru/index.php
- Drits A.V., M.D. Kravchishina, A.F. Pasternak, A.N. Novigatsky, O.M. Dara, and M.V. Flint (2017) Role of Zooplankton in the Vertical Mass Flux in the Kara and Laptev Seas in Fall. *Oceanology*. V. 57. No 6. P. 841–854. doi: 10.7868/S0030157417060089
- Evangeliou N., Popovicheva O.B., Shevchenko V.P., Yttri K.-E., Eckhardt S., Pokrovsky O.S., Eleftheradis K., Stohl A. (2017) Black carbon in the Russian Arctic. Using a dispersion model to track the origin of black carbon in snow and atmosphere. *Report Series in Aerosol Science.* No. 201. Proceedings of the 3rd Pan-Eurasian Experiment (PEEX) Conference and the 7th PEEX Meeting / H.K. Lappalainen, P. Haapanala, A. Borisova, S. Chalov, N. Kasimov, S. Zilitinkevich, M. Kulmala (eds.). P. 106–111.
- Evangeliou N., Shevchenko V.P., Yttri K.E., Eckhardt S., Sollum E., Pokrovsky O.S., Kobelev V.O., Korobov V.B., Lobanov A.A., Starodymova D.P., Vorobiev S.N., Thompson R., Stohl A. (2018) Origin of elemental carbon in snow from western Siberia and northwestern European Russia during winter–spring 2014, 2015 and 2016. *Atmospheric Chemistry and Physics*. V. 18. P. 963–977.
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- Kabanov D.M., Zenkova P.N., Lisitzin A.P., Lubo-Ktcybxtyrj K.E., Panchenko M.V., Radionov V.F., Sakerin S.M., Sidorova O.R., Terpugova S.A., Shevchenko V.P. (2017) Peculiarities of spatial-temporal variability of the aerosol optical depth of the atmosphere over Kara and Barents Seas in 2016. *Proceedings of SPIE 10466, 23rd International Symposium on Atmospheric and Ocean Optics: Atmospheric Physics*, 1046622G (30 November 2017); doi:10.1117/12.2284298.
- Kravchishina M.D., A.A. Klyuvitkin, L.A. Pautova, N.V. Politova, and A.Yu. Lein (2018) Stable Isotopic Composition of Particulate Organic Carbon in the Caspian Sea. *Oceanology*. 2018. V. 58. No. 1. P. 45–56. doi: 10.1134/S0001437018010083
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- Rusanov I.I., A.Yu. Lein, P.N. Makkaveev, A A. Klyuvitkin, M.D. Kravchishina, M.V. Ivanov, and M.V. Flint (2018) Seasonal Dynamics of Biogeochemical Processes in the Water Column of the Northeastern Black Sea. *Oceanology*. V. 58. No. 1. P. 57–70. doi: 10.1134/S0001437017060133
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- Shevchenko V.P., Kopeikin V.M., Evangeliou N., Lisitzin A.P., Novigaqtsky A.N., Starodymova D.P., Stohl A., Thompson R., Zakharova E.V. (2017) Atmospheric black carbon over the North Atlantic and Russian Arctic seas in summer–autumn time, 2015–2016. *Report Series in Aerosol Science.* No. 201. Proceedings of the 3rd Pan-Eurasian Experiment (PEEX) Conference and the 7th PEEX Meeting / H.K. Lappalainen, P. Haapanala, A. Borisova, S. Chalov, N. Kasimov, S. Zilitinkevich, M. Kulmala (eds.). P. 441–443.
- Shevchenko V.P., Pokrovsky O.S., Vorobyev S.N., Krickov I.V., Manasypov R.M., Politova N.V., Kopysov S.G., Dara O.M., Auda Y., Shirokova L.S., Kolesnichenko L.G., Zemtsov V.A., Kirpotin S.N. (2017) Impact of snow deposition on major and trace element concentration and elementary fluxes in surface waters of the Western Siberian Lowland across a 1700 km latitudinal gradient. *Hydrology and Earth System Sciences.* V. 21. P. 5725–5746.
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- Vinogradova A.A., Ivanova Yu.A. (2017a) Heavy Metals in the Atmosphere over the Northern Coast of Eurasia: Interannual Variations in Winter and Summer. *Izvestiya, Atmospheric and Oceanic Physics.* V. 53. No. 7. P. 711–718. doi: 10.1134/S000143381707009X
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Presentations in international conferences

- The 3rd PEEX Science Conference and 7th PEEX Meeting, IIASA Workshop (Moscow, 19–22 September, 2017). https://www.atm.helsinki.fi/peex/index.php/3rd-sci-conf-programme
  Shevchenko V.P., Kopeikin V.M., Evangeliou N., Lisitzin A.P., Novigaqtsky A.N., Starodymova D.P., Stohl A., Thompson R., Zakharova E.V. Atmospheric black carbon over the North Atlantic and Russian Arctic seas in summer–autumn time, 2015–2016. Poster.

Cruises GEOTRACES-related

• The 68th cruise of RV *Akademik Mstislav Keldysh* became a continuation of the long-term research program of IO RAS in two main directions: 15-year hydrophysical monitoring in the North Atlantic at 59.5° N (a contribution to the Russian CLIVAR and WORLD OCEAN Research Programmes); a comprehensive study of the sedimentation system of the North Atlantic and the Arctic bordering it, resumed in 2015 and conducted on a regular basis to the present. Principal Scientist of the cruise was Ph.D. Marina Kravchishina (IO RAS). The cruise was divided into two parts: i) interdisciplinary studies in the North Atlantic along 59.5° N (29 June – 16 July 2017); ii) a linked study of the conditions and processes of sedimentation (resent and past) with an assessment of the vertical fluxes of suspended matter and pollutants in the Norwegian Sea and Barents Sea (July 18 – August 19, 2017) (Figure 16). The researches in the expedition will contribute to the study of key processes occurring in the interaction area of the North Atlantic and the European part of the Arctic.

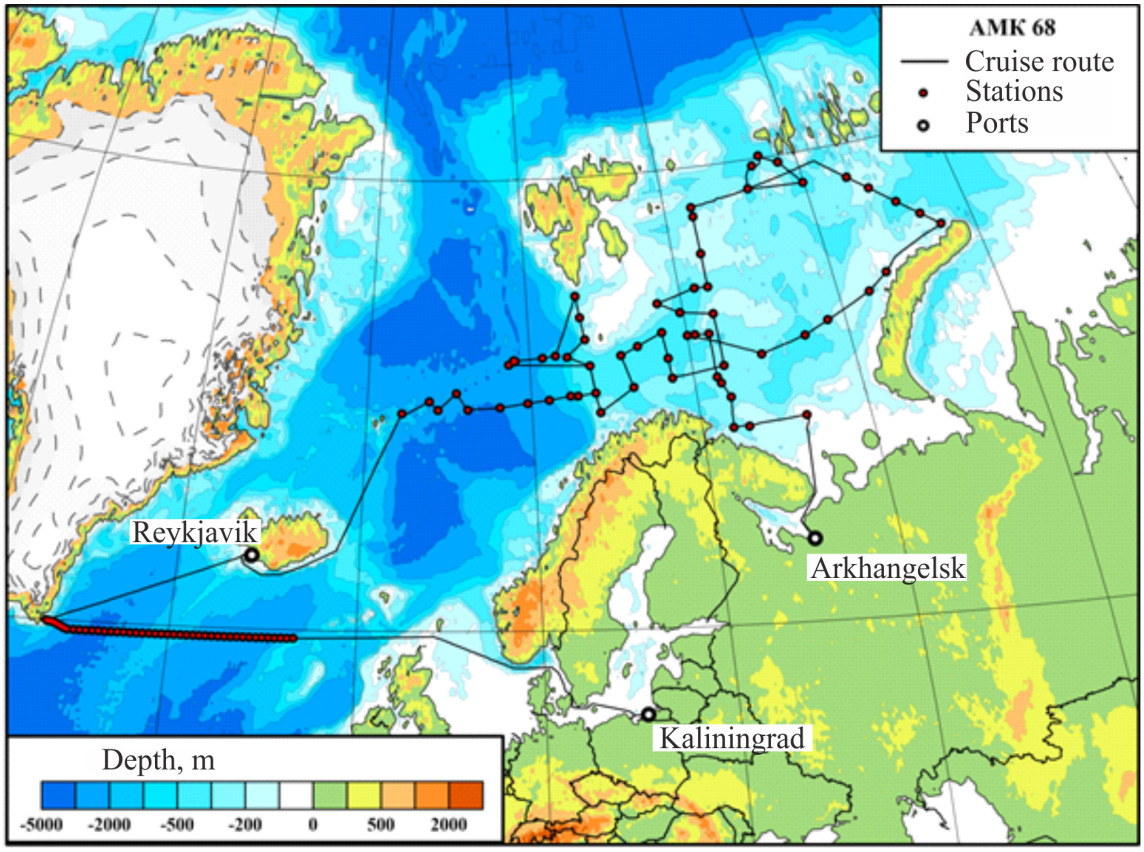

Figure 16. *The route of the 68th cruise of RV Akademik Mstislav Keldysh (from Kaliningrad to Arkhangelsk), June–August 2017: North Atlantic 59.5° N, Norwegian Sea, Barents Sea.*

• The 69th cruise of RV *Academik Mstislav Keldysh*, from August–October 2017, Principal Scientist was Prof. Mikhail Flint (IO RAS) (Figure 17). The main goal of the researches was multidisciplinary studying of the Siberian Arctic ecosystems: Kara Sea, Laptev Sea and East-Siberian Sea.

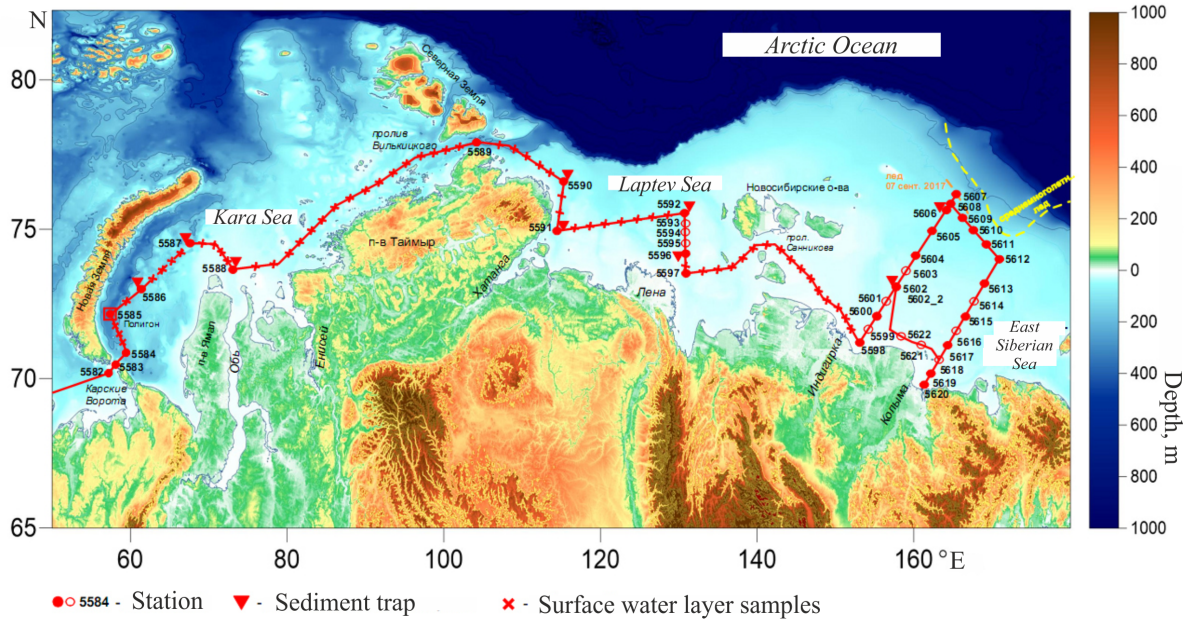

Figure 17. *The route and sampling sites of the 69th cruise of RV Akademik Mstislav Keldysh, June–August 2017: Kara, Laptev and East-Siberian seas.*

• The 101th cruise to the Black Sea of the RV *Professor Vodyanitsky*, December 2017. Principal Scientist of geological researches was Ph.D. Alexey Klyuvitkin (IO RAS) (Figure 18). The related studies of suspended particulate matter trapped material and upper sediment layer for revealing the sedimentation processes and early diagenesis.

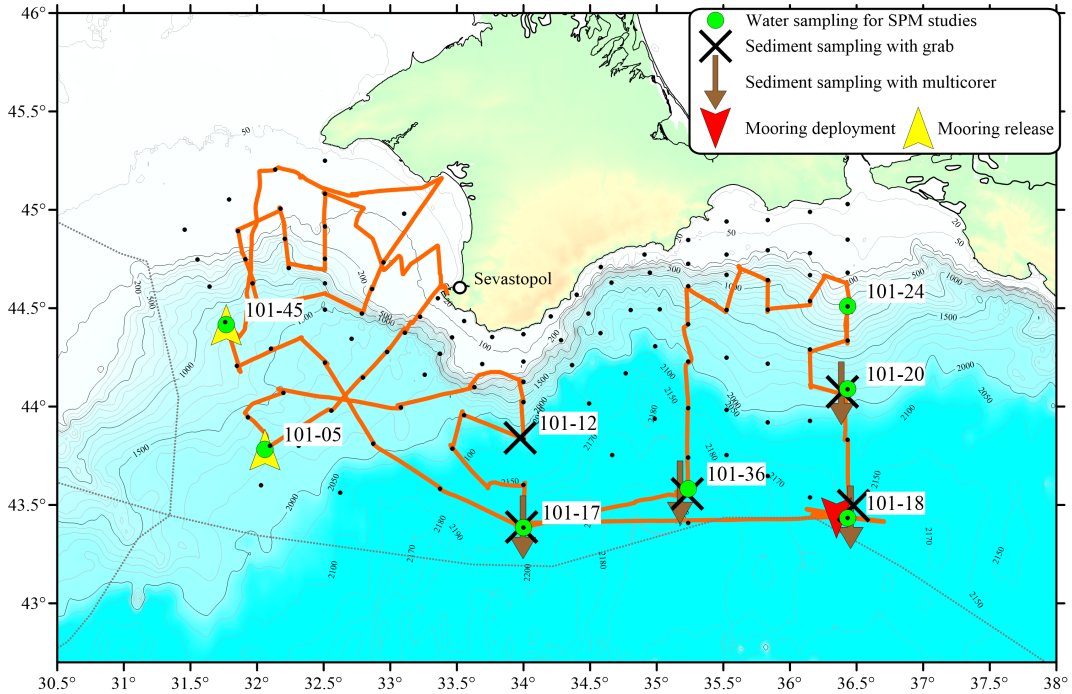

Figure 18. *The route of the 101th cruise of RV Professor Vodyanitsky and sampling sites in the Black Sea, December 2017.*

Outreach activities

• Obukhov Institute of Atmospheric Physics, Russian Academy of Sciences (IAP RAS) is involved in GEOTRACES-related activities in Russia on aerosol researches in Arctic.

Other activities

- Black carbon researches are conducted by Shirshov Institute of Oceanology, Russian Academy of Sciences (IO RAS) together with Norwegian Institute of Air Research in the frame of activity of AMAP expert group on short-living climate forcers (SLCF).
- IO RAS collaborated with University of Southern Mississippi in studying of barium geochemistry in water and bottom sediments. The samples were collected in the Barents Sea.
- IO RAS collaborated with Institute for Chemistry and Biology of the Marine Environment (ICBM, University of Oldenburg) in studying neodymium isotopes in bottom sediments collected in the Barents Sea.
- IO RAS and Geosciences Environment Toulouse (University of Toulouse) conduct joint researches of trace metals in snow, lichens and river suspended matter in Arctic.
- IO RAS cooperated in organic geochemistry research and radiocarbon dating of sediment cores from the Norwegian Sea with Institute of Ocean Research (Peking University).

Submitted by Marina Kravchishina (kravchishina@ocean.ru).

New scientific results

- Most of research was oriented to study Hg and its species cycling. An overview of the previous research on Hg abundance, distribution and speciation in environmental compartments in the Adriatic Sea revealed that Hg concentrations in seawater decreased during past decades due to the closure of industries that released Hg to the coastal environments. A decreasing gradient in Hg concentrations from the northern to the southern Adriatic indicates that the presence of legacy mercury still contributes to Hg in seawater. Concentrations of Hg in plankton and mussels follow the spatial and temporal trends observed in water, however, concentrations in fish do not follow these trends indicating the complexity of MMHg formation and accumulation in fish. In order to better understand the interaction between Hg species and the abundance and composition of microbial community in the central Adriatic Sea, more precisely in the transect from Hg contaminated coastal environment in Kaštela Bay to the Island of Vis, monthly sampling was performed over two years period in collaboration with the Institute of Oceanography and Fisheries in Split and the research vessel Bios Dva. Mercury analysis included total mercury (THg), dissolved gaseous mercury (DGM), and total methylated mercury (MeHg). Microbial structure analysis included high and low nucleic acid bacteria, nanoflagellates, picoeukaryoes, Prochlorococcus, and Synechococcus. Physico-chemical properties of seawater were also measured. The results revealed that Hg methylation in seawater is a metabolism-dependent transformation promoted by the heterotrophic activity of low nucleic acid bacteria under the absence of probable phosphorus limitation. Under these conditions, MeHg was also related to nutrients and Prochlorococcus, whose decay promotes heterotrophic activity. DGM was related with heterotrophic bacteria, autotrophic picoplankton and chlorophyll a, indicating biotic DGM production that is not metabolically dependent. MMHg biomagnification from microseston to mesozooplankton was observed through the significant increase of corresponding bioaccumulation factors. Results revealed that Hg uptake by plankton might be enhanced under phosphorous-limitation conditions.
- In an effort to study seasonal Hg transformation mechanisms and underlying processes in the coastal marine ecosystem of the Gulf of Trieste (northern Adriatic Sea), we have successfully applied the ^{197}Hg radiotracer technique in series of incubation experiments. This area is characterized by continuous Hg input from the Soča/Isonzo River as a consequence of nearly 500 years of activity at the Idrija Mine (W Slovenia). During our study, Hg methylation in the marine water column could not be detected, suggesting that sediments are the principal methylation site and the source of MeHg to the water column. Conversely, the water column showed a pronounced Hg reduction potential, mostly of photochemical origin, suggesting that the Gulf of Trieste is a source of Hg^0 to the atmosphere. However, the high Hg reduction potential observed in autumn was most likely related to a phytoplankton (diatom) autumn bloom, indicated by high Chl concentrations measured during that period. We hypothesize that the microbial reduction was either linked to the expression of *mer* genes or, a consequence of non-specific redox reactions. Variations in bacterioplankton community fingerprints (as determined by Denaturing Gradient Gel Electrophoresis) suggested that community structure had little influence on microbial Hg reduction potential.

- In an effort to understand the atmospheric cycling and seasonal depositional characteristics of Hg, wet deposition samples were collected for approximately 5 years at 17 selected GMOS monitoring sites located in the Northern and Southern hemispheres in the framework of the Global Mercury Observation System (GMOS) project. These data set provides a new insight into baseline concentrations of THg concentrations in precipitation worldwide, particularly in regions such as the Southern Hemisphere and tropical areas where wet deposition as well as atmospheric Hg species were not investigated before, opening the way for future and additional simultaneous measurements across the GMOS network as well as new findings in future modeling studies.
- A Bayesian Network (BN) approach that integrates relevant biological and physical-chemical variables across spatial (two water layers) and temporal scales to identify the main contributing microbial mechanisms regulating POC accumulation in the northern Adriatic Sea was developed. Three scenario tests (diatom, nanoflagellate and dinoflagellate blooms) using the BN predicted diatom blooms to produce high chlorophyll a at the water surface while nanoflagellate blooms were predicted to occur also at lower depths (>5 m) in the water column and to produce lower chlorophyll concentrations. A sensitivity analysis using all available data identified the variables with the greatest influence on POC accumulation being the enzymes, which highlights the importance of microbial community interactions. However, the incorporation of experimental and field data changed the sensitivity of the model nodes ≥25% in the BN and therefore, is an important consideration when combining manipulated data sets in data limited conditions.
- We aimed at directly demonstrating the sulfur-oxidizing, chemoautotrophic nature of the symbionts and at investigating putative carbon transfer from the symbiont to the ciliate host. We performed pulse-chase incubations with ^{14}C- and ^{13}C-labeled bicarbonate under varying environmental conditions. A combination of tissue autoradiography and nanoscale secondary ion mass spectrometry coupled with transmission electron microscopy was used to follow the fate of the radioactive and stable isotopes of carbon, respectively. We show that symbiont cells fix substantial amounts of inorganic carbon in the presence of sulfide, but also (to a lesser degree) in the absence of sulfide by utilizing internally stored sulfur. Isotope labeling patterns point to translocation of organic carbon to the host through both release of these compounds and digestion of symbiont cells. The latter mechanism is also supported by ultracytochemical detection of acid phosphatase in lysosomes and in food vacuoles of ciliate cells. Fluorescence in situ hybridization of freshly collected ciliates revealed that the vast majority of ingested microbial cells were ectosymbionts.

New publications (published or in press)

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Organization and editing of Special issues related to marine science

- HORVAT, Milena, KNOERY, Joel, GÅRDFELDT, Katarina, SPROVIERI, Francesca. Introduction to the special issue in the marine Environment: editorial. Marine Chemistry, ISSN 0304-4203. [Print ed.], 2017, vol. 193, str. 1-2, doi: 10.1016/j.marchem.2017.05.005.

- FAGANELI, Jadran, OGRINC, Nives. Introduction to the Special issue on the 22nd International Symposium on Environmental Biogeochemistry Sponsored by the International Society for Environmental Biogeochemistry (ISEB. Geomicrobiology journal, ISSN 0149-0451, vol. 34, no. 7, str. 577-578, doi: 10.1080/01490451.2017.1328944.

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Invited presentations at Universities

- OGRINC, Nives. Carbon cycling and its isotopes in the environment: invited talk, Hokaiddo University, 17. November 2017, Sapporo, Japan.
- OGRINC, Nives. Carbon cycling and its isotopes in the environment: invited talk, Università di Parma, Dipartimento di Scienze Matematiche, Fisiche e Informatiche, 27 marzo, 2018, Parma.
- OGRINC, Nives. Carbonate system in different aquatic sediments: stable isotope approach : invited talk, Università di Parma, Dipartimento di Scienze Matematiche, Fisiche e Informatiche, 26 marzo, 2018, Parma.

New projects and/or funding

- In May 2017 new national project entitled (2017-2020): Stable isotopes in the study of the impact of increasing CO2 levels on C and Hg cycling in coastal waters was approved. The project coordinating by JSI deals with deals with the use of stable isotopes to better understand the origin and processes of C and Hg in relation to increasing levels of atmospheric CO2 in the coastal marine ecosystem.
- Two new projects in the EU framework EURAMET/EMPIR were approved (2017-2020): SIRS -Metrology for Stable Isotope Reference Standards started in June 2017 dealing with the development of new reference material of CO2 and N2O for stable isotope measurements in air and MercOx - Metrology for oxidised mercury, which is coordinated by JSI started in October 2017. MercOx is dealing with the use of new analytical approaches including stable isotopes of Hg to study transport, fate and sources of Hg in the environment and also in marine systems.
- ERA Planet programme (EU H2020; 2017-2021), where JSI participates in two sub-projects (STRAND 1 SMURBS – Smart Urban Solutions for air quality, disasters and city growth; STRAND 3 – IGosp - Integrated Global Observing Systems for Persistent Pollutants), both started in September 2017. IGosp is also related to marine environment since it is dealing with Integrating remote and in-situ observations of persistent pollutant concentrations with ancillary data regarding meteorology and the composition of the atmosphere.
- TC interregional project INT7019 “Supporting a Global Ocean Acidification Observing Network towards Increased Involvement of Developing States”, where Slovenia is taking an active part is still going on. 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.
- European Carbon Dioxide Capture and Storage Laboratory Infrastructure (ECCSEL) project entitled: “Stable isotopes as a tool for monitoring the influence of CO2 emissions on marine microalgae”. The main objective of the project is to investigate the possibility of the use of stable carbon isotopes as effective early warning tracers of CO2 migration in engineered CO2 storage sites. The proposed approach was used for tracing the origin, migration and fate of natural CO2 in the real-world situations at a site where natural CO2 is leaking from the sea floor, such as at the Natural Laboratory of Panarea.

PhD theses

- ŽIVKOVIĆ Igor. Seasonal changes in mercury speciation and the composition of the microbial community in the seawater in the central Adriatic Sea, doctoral dissertation. The PhD was successfully defended on April 25, 2018.

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

New scientific results

In 2017, we focused on trace metal distribution and associated community structures in summer and winter along the Good Hope Line (Atlantic) and along the WOCE I06 transect (Indian Ocean):

- PhD student Jean Loock investigated the change in Cd and Mn depth distribution along the Good Hope Line in austral summer and winter 2015 (Loock et al., submitted). Hydrothermal activity was indicated at 54 °S that will be further investigated in future. These trace metals were also measured along the I06 transect in winter 2017 (Figure 19; unpublished).

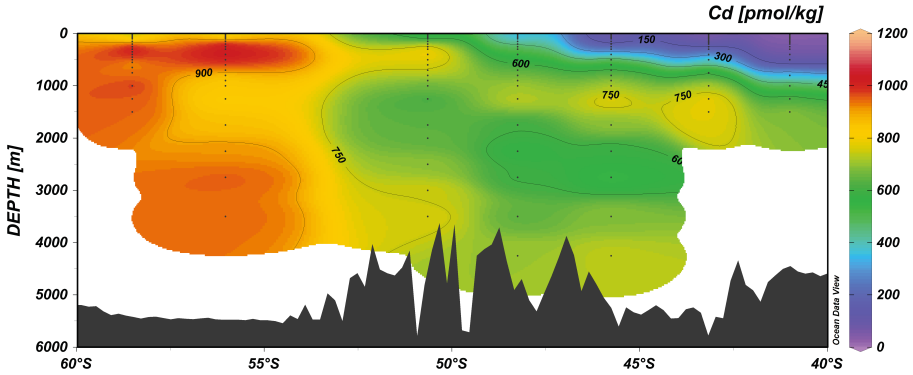


***Figure 19**. Distribution of dissolved cadmium along the I06 transect (Indian Ocean) in austral winter (July 2017)*

- PhD student Ryan Cloete measured dissolved Cu, Zn and Ni along the same transects. He noticed strong seasonality in the Cu and Zn concentrations in the mixed layer, with average winter concentrations exceeding summer values by 0.2 nM for Cu and 0.9 nM for Zn (Cloete et al., submitted). These trace metals were also measured along the I06 transect in winter 2017 (Figure 20; unpublished).

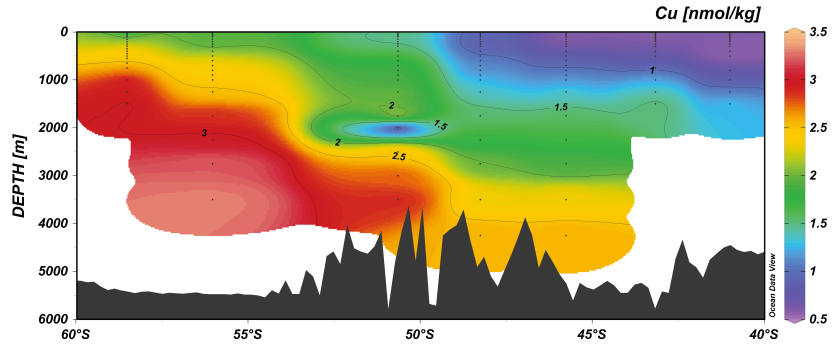


***Figure 20.** Distribution of dissolved copper along the I06 transect (Indian Ocean) in austral winter (July 2017)*

- MSc students Ian Weir and Johan Viljoen looked at changes in the community structure (Figure 3; unpublished) with changes in macronutrients and bioactive trace metals in the surface ocean along the Good Hope Line (Atlantic sector of the Southern Ocean). Statistical analyses indicated that 65% of the variability in the community structure along the Good Hope Line could be explained by only three factors. Three factors (not necessarily the same) also explained 98% of the variability in the trace metal distribution. Interestingly, out of all bioactive trace metals, the variability of iron (along the surface transect) was the least related to total chl-a and phytoplankton community structure. MSc

student J. Viljoen furthermore examined the change in phytoplankton community structure upon iron and light addition in on-board bottle incubations in the Atlantic sector of the Southern Ocean (Good Hope Line). Two experiments were conducted one at 46 °S and one at 65 °S. The community at 46 °S was more diverse than the community at 65 °S. However, at 46 °S, major shifts in the community composition occurred under higher light, rather than after iron addition. At 65 °S, in contrast, a shift occurred upon iron addition, independent of the light level, i.e. even under low light conditions (Viljoen et al., submitted).

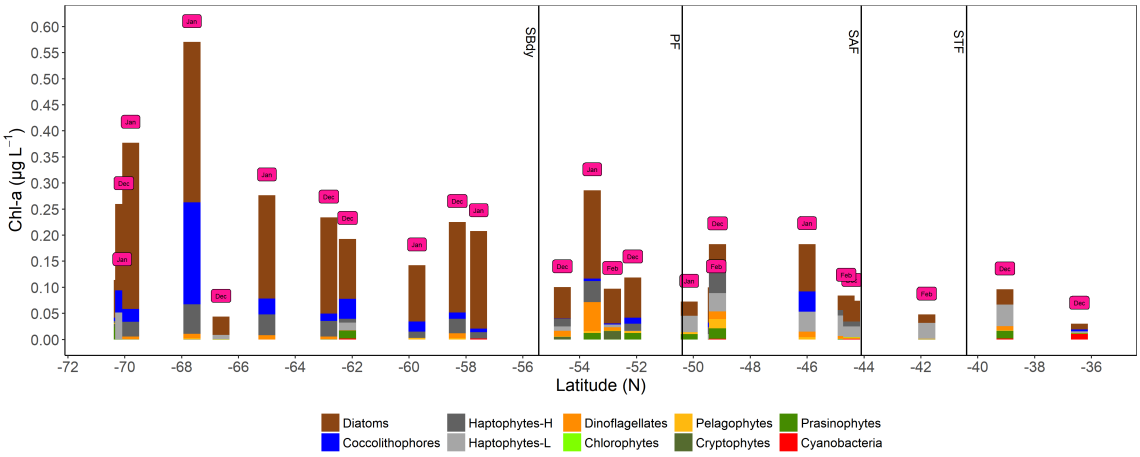


Figure 21. *Phytoplankton community structure in surface waters along the Good Hope Line (Atlantic Southern Ocean) in summer 2015.*

Cruises

Winter Cruise 2017 along the WOCE I06 transect (Indian Ocean) GEOTRACES related activities: The first key objective was to determine the trace metal (Fe, Cu, Zn, Mn, Ni, Cd, Co and Pb) and Rare Earth Element (lanthanide series, La through Lu) concentrations. The teams collected various samples to assess the partitioning of these elements between the total, dissolved, particulate and soluble fractions as well as to assess what influence the ligands have on these interactions. Physical (salinity and temperature) and biological (macronutrients, phytoplankton & bacterial abundance and composition) data were collected to further constrain the biogeochemical cycling of these elements. Other key objectives consisted in quantifying the inputs of hydrothermally derived trace elements (specifically Fe, Cu, Zn and REE's) into the deep waters of the Southern Ocean. Samples were also taken for determination of stable isotopes of Cu, Zn, Fe and Si. This should allow to better constrain what are the controlling factors on metal speciation once ejected into the ocean and how does this affect bioavailability. We also deployed our two McLane pumps successfully during this cruise and we attempted to collect dust samples. The latter was hindered by extreme tail winds throughout most of the winter cruise.

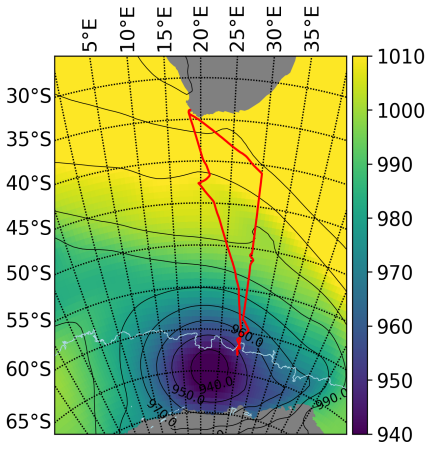


Figure 22. *Cruise track of the Winter 2017 expedition (red line) overlain to the 04/07/2017 mean sea level pressure from ERA-Interim reanalyses (shading and contours) and 15% sea ice concentration from AMSR2 (light blue line). From Vichi et al. (2017; Cruise Report)*

New projects and/or funding

- Roychoudhury AN (2018-2020) Distribution and Speciation of Bioactive Trace Elements in Southern Ocean, NRF SANAP, R 1,820,000
- Roychoudhury AN (2017-2019) TraceEx: Establishment of Center of excellence in Trace and experimental Biogeochemistry, Donor funding, R 17 Million
- Roychoudhury AN (2017-2019) Nanoparticles at Air-Sea interface. NRF Competitive Rated Researcher Grant, R 1,550,000
- Fietz S (2018-2020) South African National Antarctic Programme (SNA170506229934) Shifts in phytoplankton and microbial community composition and functional diversity related to trace metal cycling; R914,000
- Fietz S, Lloyd J (2018-2020) South African bilateral programme, SA-Iran (IRSA170718254901) Carbonic anhydrases from marine microbes and phytoplankton for enzymatic remediation of cadmium-contaminated water resources; R242,950
- Fietz S, Lloyd J, Makhalanyane T (2018-2020) South African bilateral programme, SA-Mexico (MESA170607237905) Exploiting microbes for remediation of pollution in oceans; R2,284,200
- Ryan-Keogh T, Mtshali T (2018-2020) Seasonal evolution of biogeochemical Fe cycle in the Southern Ocean. NRF SANAP

Outreach activities

- Team blog: https://southernoceanfe.wordpress.com/
- Team's facebook page: https://www.facebook.com/Environmental-Geochemistry-at-Stellenbosch-University-135430226505633/

New publications (published or in press)

- Ryan-Keogh TJ, Thomalla SJ, Mtshali TN, Little H (2017) Modelled estimates of spatial variability of iron stress in the Atlantic sector of the Southern Ocean, Biogeosciences, 14: 3883-3897, doi: 10.5194/bg-14-3883-2017.
- Das SK, Routh J, Roychoudhury AN, Veldhuis MJW, Ismail HE. (2017) Connecting pigment composition and dissolved trace elements to phytoplankton population in the southern Benguela Upwelling zone (St. Helena Bay). J Marine Systems 176, 13-23
- Von der Heyden BP, Roychoudhury AN, Tyliszczak T, Myneni SCB (2017) Investigating nanoscale mineral compositions: Iron L3-edge spectroscopic evaluation of iron oxide and oxy-hydroxide coordination. American Mineralogist 102, 674-685.

PhD & MSc theses

- KI Kangueehi, Trace metal concentrations and dissolution characteristics of dust emitted from known sources in southern Africa (MSc thesis, Dec 2017)

Presentations in international conferences

- S.M. Smart, S.E. Fawcett, H. Ren, R. Schiebel, M.A. Weigand, A.N. Roychoudhury, G.H. Haug, D.M. Sigman. Ground-truthing the Foraminifera-bound Nitrogen isotope paleo-proxy in the modern Southern Ocean, Ocean Science Meeting, Portland, USA, February 2018.
- Roychoudhury An, R. Cloete, J. Loock, T.Mtshali, S. Fietz. Bioactive trace elements (Cu, Zn, Cd and Co) in the Southern Ocean. Goldschmidt, Paris, August 2017
- Kangueehi K, S. Fietz, A. N. Roychoudhury, F. D. Eckardt, J. Von Holdt. Dust transport pathways and bioavailability of dust emissions from southern Africa. Goldschmidt, Paris, August 2017

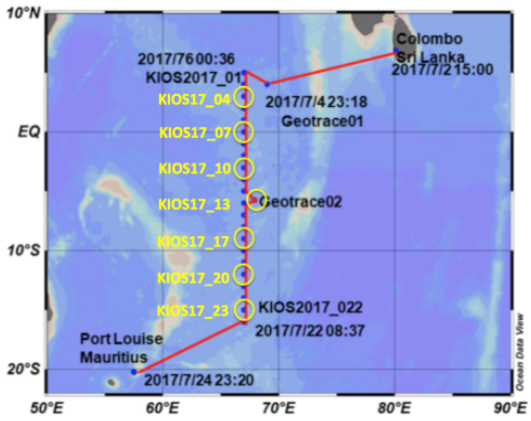
Submitted by Susanne Fietz (sfietz@sun.ac.za)

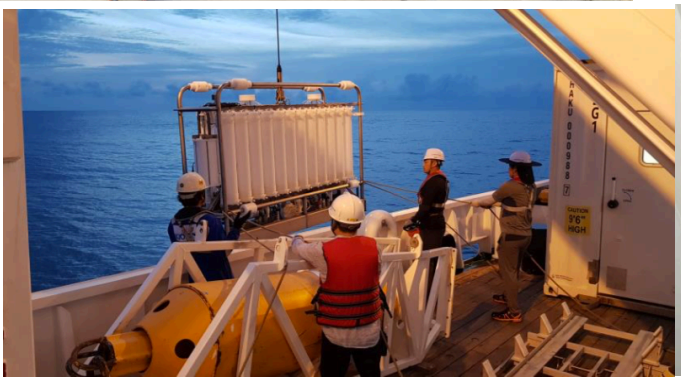
ANNUAL REPORT ON GEOTRACES ACTIVITIES IN SOUTH KOREA

May 1st, 2017 to March 30th, 2018

Cruises

- Korea Institute of Ocean Science and Technology (KIOST) have conducted 1st yr Indian Ocean section cruise covering 5N to 16S (1 degree int.) in 67E (July 2 – 24). Scientists in KIOST successfully collected the clean seawater samples for trace metal analyzes at 7 stations (3 degree interval, 112 for dissolved- and 56 for particulate samples) in this cruise, including 1 GEOTRACES crossover station (5° 16', 67° 54' in GI02 cruise). Together with the trace Elements, on-board measurements of radioactive Th-234 tracer also was done in this cruise (at the same station with TE clean sampling)





New projects and/or funding

- KIOST begins 3-years Indian Ocean Project (2017-2019), focusing on "Understanding the circulation and internal cycling in Indian Ocean in accordance with variability of Indian Ocean Dipole Mode". The first open ocean TEIs study from KIOST and South Korea will be conducted as part of this project in Indian Ocean, until 2019.

Other activities

- Korean new Research vessel, R/V *Isabu,* just launched in 2016 (~6,000 t) is equipped the Pristine trace metal clean sampler composing titanium frame and 24 × 12L PVDF sampler with Urethane coated Kevlar wire (10,000 m) and clean-room containers. Through the deep sea test cruise in Pacific (near Mariana Trench), and first Indian Ocean expedition, KIOST researchers setup the this sampler.

- At the same time, the KIOST headquarter and whole campus moved to new campus in Busan city in Nov-Dec, 2017. In new research building in Busan Campus, new clean laboratory is built. In this laboratory, the TEI-related instruments (new seaFAST ICP-MS, existing MC- and Q-ICP-MS, and new 2 FIA systems) will be newly installed in 2018. KIOST scientist is expecting that this can be the good chance to initialize the open ocean TEI study in the South Korea

Submitted by Dr. Intae Kim (ikim@kiost.ac.kr).

GEOTRACES related articles

- Cho H-M, Kim G, Kwon E-Y, Moosdorf N, Garcia-Orellana J, Santos I R (2018) Submarine groundwater discharge as a major source of nutrients to the global ocean. Scientific Reports 8 (1); 2439.76

- Montiel D, Dimova N, Andreo B, Prieto J, Garcia-Orellana J, Rodellas V (2018). Assessing submarine groundwater discharge (SGD) and nitrate fluxes in highly heterogeneous coastal karst aquifers: challenges and solutions. Journal of Hydrology 557, 222 – 242.

- Gdaniec S, Roy-Barman M, Foliot L, Thil F, Dapoigny A, Burckel P, Garcia-Orellana J, Masqué P, Mörth CM, Andersson PS (2018). Thorium and Protactinium isotopes as tracers of marine particle fluxes and deep water circulation in the Mediterranean Sea. Marine Chemistry 199, 12 – 23.

- Krall L, Trezzi G, Garcia-Orellana J, Rodellas V, Mörth CM, Andersson P. (2017). Submarine groundwater discharge at Forsmark, Gulf of Bothnia, provided by Ra isotopes. Marine Chemistry 196, 162 – 172.

- Andreo B, Barberá JA, Mudarra M, Marín AI, Garcia-Orellana J, Rodellas V, Pérez Ramos I (2018). A multi-method approach for groundwater resource assessment in coastal carbonate (karst) aquifers: the case study of Sierra Almijara (southern Spain). Hydrology Journal 26 (1), 41 – 56

- Cerdà-Domènech M, Rodellas V, Folch A, Garcia-Orellana J (2017). Constraining the temporal variation of Ra isotopes and Rn in the groundwater endmember: Implications on the derived SGD estimates. Science of the Total Environment 595, 849 – 857

- Castrillejo M, Casacuberta N, Christl M, Garcia-Orellana J, Vockenhuber C, Synal H-A, Masqué P (2017). Anthropogenic 236U and 129I in the Mediterranean Sea: first comprehensive distribution and constrain of their sources. Science of the Total Environment 593-594, 745 – 759.

- Trezzi G., Garcia-Orellana J, Rodellas V, Masqué P, Garcia-Solsona E, Andersson P. (2017) Assessing the role of submarine groundwater discharge as a source of Sr to the Mediterranean Sea. Geochimica et Cosmochimica Acta 200, 42 – 54.

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- Santana-Gonzalez, C., Santana-Casiano, J. M., González-Dávila, M., Fraile-Nuez, E. Emissions of Fe(II) and its kinetic of oxidation at Tagoro submarine volcano, El Hierro.

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- Samperio-Ramos, G., Santana-Casiano, J.M., González-Dávila, M. Variability in the production of organic ligands, by Synechococcus PCC 7002, under different iron scenarios. Journal of Oceanography. 2017. https://doi.org/10.1007/s10872-017-0457-6.

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- Samperio-Ramos, G., González-Dávila, M., Santana-Casiano, J. M. Impact on the Fe redox cycling of organic ligands released by Synechococcus PCC 7002, under different iron fertilization scenarios. Modeling approach. Journal of Marine Systems. 2018. https://doi.org/10.1016/j.jmarsys.2018.01.009.

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- Laglera L. M., Tovar-Sánchez A., Iversen M.H., Gonzalez H.E., Naik H., Mangesh G., Assmy P., Klaas C., Mazzocchi G., Montresor M., Naqvi S.W.A., Smetacek V., Wolf-Gladrow D.A. Iron partitioning during LOHAFEX: Copepod grazing as a major driver for iron recycling in the Southern Ocean. Marine Chemistry, 196, 148-161.DOI: 10.1016/j.marchem.2017.08.011, 2017.

- Scarlett Trimborn, Tina Brenneis, Clara J. M. Hoppe, Luis M. Laglera, Louiza Norman, Juan Santos-Echeandía,Christian Völkner, Dieter Wolf-Gladrow, Christel S. Hassler. Iron sources alter the response of Southern Ocean phytoplankton to ocean acidification. Marine Ecology Progress Series 578: 35-50. 2017.

- João Canário, Juan Santos-Echeandia, Ana Padeiro, Eduardo Amaro, Volker Strass, Dieter Wolf-Gladrow, Christine Klaas, Sharyn Ossebaar, Boris Koch, Luis M. Laglera. Mercury and methylmercury in the West Southern Ocean: Results from Eddy Pump - ANTXXVIII/3 cruise. Deep Sea Research Part II: Topical Studies in Oceanography. 138, 74-85. 2017.

- Wee Cheah, Mariana A Soppa, Sonja Wiegmann, Sharyn Ossebaar, Luis M. Laglera, Volker Strass, Juan Santos-Echeandía, Mario Hoppema, Dieter Wolf-Gladrow, Astrid Bracher. Importance of deep mixing and silicic acid in regulating phytoplankton biomass and community in the iron limited Antarctic Polar Front region in summer. Deep Sea Research Part II: Topical Studies in Oceanography. 138, 52-62. 2017.

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- Damien J. Cabanes, Louiza Norman, Juan Santos-Echeandía, Morten H. Iversen, Scarlett Trimborn, Luis M. Laglera, Christel S. Hassler. First evaluation of the role of salp fecal pellets on iron biogeochemistry. Frontiers in Marine Science. 3, article number 289, 2017.

- Brito, P., Prego, R., Mil-Homens, M., Caçador, I., Caetano, M., 2018. Sources and distribution of yttrium and rare earth elements in surface sediments from Tagus estuary, Portugal. Science of the Total Environment, 621: 317-325.

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- Álvarez-Vázquez, M.A., Caetano, M., Álvarez-Iglesias, P., Pedrosa-García, M.C., Calvo, S., De Uña-Álvarez, E., Quintana, B., Vale, C., Prego, R., 2017. Natural and Anthropocene fluxes of trace elements in estuarine sediments of Galician Rias. Estuarine, coastal and Shelf Science, 198: 329-342.

- lvarez-Vázquez, M.A., Prego, R., Caetano, M., De Uña-Álvarez, E., Doval, M., Calvo, S., Vale, C., 2017. Contributions of trace elements to the sea by small uncontaminated rivers: effects of a water reservoir and a wastewater treatment plant. Chemosphere, 178: 173-186.

- Cobelo-García, A., Morán, P., Almécija, C., Caballero, P., 2017. Historical record of trace elements (1983–2007) in scales from Atlantic salmon (Salmo salar): Study of past metal contamination from a copper mine (Ulla River, NW Iberian Peninsula). Chemosphere, 188, pp. 18-24.

- Cobelo-García, A., Filella, M., 2017. Electroanalytical techniques for the quantification of technology-critical elements in environmental science. Current Opinion in Electrochemistry, 3, pp. 78-90.

- Monteiro, C.E., Cobelo-Garcia, A., Caetano, M., Correia dos Santos, M.M., 2017. Improved voltammetric method for simultaneous determination of Pt and Rh using second derivative signal transformation – application to environmental samples. Talanta, 175, pp. 1-8.

Books and Chapters

- González, A.G., Pokrovsky, O.S., Santana-Casiano, J.M., González-Dávila, M., 2017. Bioadsorption of Heavy Metals. In: Prospects and Challenges in Algal Biotechnology. Tripathi B., Kumar D. (eds.). Springer, Singapore. Pages 233-255. (CL). https://doi.org/10.1007/978-981-10-1950-0_8
- Rico, M., González, A.G., Santana-Casiano, J.M., González-Dávila, M.,Pérez-Almeida, N., Suárez de Tángil, M., 2017. Production of Primary and Secondary Metabolites Using Algae. In: Prospects and Challenges in Algal Biotechnology. Tripathi B., Kumar D. (eds.). Springer, Singapore. Pages 311-326. (CL). https://doi.org/10.1007/978-981-10-1950-0_12

Meetings

- Laiz, A. Teles-Machado, S. Plecha, A. Cobelo, D. Sánchez-Quiles, D. Roque-Atienza, E. González-Ortegón, A. Peliz and A. Tovar-Sánchez. Transport of trace metals within the Gulf of Cadiz and the Mediterranean Sea. VI International Symposium of Marine Sciences, Vigo: 20-22 Junio, 2018, Spain (Oral communication).
- E. González-Ortegón, D. Sánchez-Quiles, I. Laiz, A. Cobelo, M. Casas-Ruíz, L. Barbero, A. Tovar-Sánchez. Metal distribution in the main estuaries of the Gulf of Cadiz. VI International Symposium of Marine Sciences, Vigo: 20-22 June, 2018, Spain (Poster communication).
- Tovar-Sánchez, C. Buonocore, D. Roque, J. Blasco. The Marine Strategy Framework Directive: Unattainable Goal for Trace Meatls. The XIX Iberian Marine Chemistry Seminary (SIQUIMAR). Vigo: 20-22 June, 2018, Spain (Poster communication).
- D. Sánchez-Quiles; F. Delgadillo-Hinojosa; M. Lucila-Lares; A. Tovar-Sánchez; M. Ángel Huerta-Díaz; E. Vanesa Torres-Delgado; E. Gutiérrez-Mejía; S. Sañudo-Wilhelmy. The remote origin of dissolved lead in the water column of the Gulf of Mexico. The Iberian Marine Chemistry Seminary (SIQUIMAR). Vigo (Spain), 20-22th June 2018.
- Luis M. Laglera. New analytical developments in cathodic polarography for the determination and characterization of trace metal complexation by natural ligands in seawater. 5º Encuentro Brasileño sobre Especiación Química. EspeQBrasil 2017. Águas de Lindóia/Sao Paulo, Brasil, 2017. Invited talk
- G. González, J. M. Santana Casiano, N. Pérez-Almeida, M. González-Dávila. The effect of Cu on the Fe redox cycle: The role of reactive oxygen species. **Goldschmidt**. Paris, 13-18 August, 2017.
- J.M. Santana-Casiano, M. González-Dávila, C. Santana-González, E. Fraile-Nuez. Changes in the redox and acid-base properties of the seawater due to the hydrothermal emissions of the Tagoro submarine volcano. **Goldschmidt**. Paris, 13-18 August, 2017.
- J. M. Santana-Casiano, M. González-Dávila**,** D. González-Santana**,** A. G. González**,** S. Gladyshev, A. Sokov. Ocean Acidification and Water Masses Carbonate Buffer Capacity along the 59.5ºN in the Irminger Sea. **Ocean Science Meeting**. Portland, Oregon, 11-16 February 2018
- Caroli xa Santana-González, Juana Magdalena Santana-Casiano, and Melchor González-Dávila. TdFe(II) emissions in the degassing phase of Tagoro submarine volcano and its correlation with the decrease of pH. **EGU General Assembly**. Vienna, Austria, 8-13 April 2018

GEOTRACES related projects

- Title: *Mesoscale and Sub-mesoscale processes in the Strait of Gibraltar: The Trafalgar-Alborán connection. MEGAN*.
  IP: Carlos M. García Jiménez (UCA)
  Founded by: MINECO *CTM2013-49048-C2-1-R*.
  Period: 1/1/2014 - 31/12/2017

- Title: *Effect of the ocean acidification and warming in the biogeochemical cycle of Fe in the Norh Atlanti*c.
  IP: J. Magdalena Santana Casiano, Melchor González Dávila
  Founded by: Ministerio de Economía y Competitivodad. CTM2014-53342-P
  Period: 2015-2017

- Title: *Effects of ocean acidification, temperature and organic matter on Fe(II) persistence in the Atlantic Ocean*.
  IP: J. Magdalena Santana Casiano, Melchor González Dávila
  Founded by: Ministerio de Economía y Competitividad. CTM2017-83476-P
  Period: 2018-2020

PhD Thesis

- Miguel Ángel Álvarez Vázquez (Dr. Ricardo Prego, director; Dra. De Uña-Álvarez codirectora). Natural and anthropogenic changes and sedimentary imprint of biogeochemical discharges in the river-ria system. Univ. de Vigo (Campus del Mar), 13 de julio de 2017. Sobresaliente cum Laude.
- Guillermo Samperio Ramos. Biogeochemical Cycle of Fe in acidified marine environments. 2017. QUIMA-IOCAG, Universidad de Las Palmas de Gran Canaria
- Maxi Castrillejo. Sources and distribution of artificial radionuclides in the oceans: from Fukushima to the Mediterranean Sea. Universitat Autònoma de Barcelona. Facultad / Escuela: Facultad de Ciencias. September 22, 2017

MS Thesis

- Cira Buonocore. Master in Chemical oceanography. Title: Dissolved metal concentration in the Spanish coasts. Detection limits and effects, an open question. Cádiz, 11 December -2017
- Marcia Isabel Cadena Aizaga. The role of humic acids on the iron speciation and the competitive effect with copper in seawater. 2017. QUIMA-IOCAG Universidad de Las Palmas de Gran Canaria

Teaching

- Master´s Degree in Oceanography. Chemical Reactivity of the Oceans
  Professor: Dr. Antonio Tovar-Sánchez
  Facultad de Ciencias del Mar, University of Cádiz and University of Las Palmas de Gran Canaria (Spain). Academic years: 2017-18

Other activities

- GEOTRACES summer school 2019: CEIMAR, UCA and ICMAN (CSIC) agree to host a new edition of the GEOTRACES Summer school in Cádiz.

Cruises

- PACETIME – Mediterranean Sea. On board of the R/V Pourquoi pas? (France) this campaign was carried out in May-June 2017. Water samples (depth water profiles) were collected at 15 stations along the Mediterranean Sea (IP: Cecile Guieu). (Figure 22)
- VULCANA1015. Vulcanología Canaria Submarina. Organized by Instituto Español de Oceanografía. From March 28th to April 9th, 2017 in the South of La Palma and in the area of the submarine volcano of El Hierro.
- XIXIMI-06. – Gulf of Mexico. On board of the R/V Justo Sierra (Mexico) this campaign was carried out from August 18 to September 7th 2017. Water samples (depth water profiles) were collected at 43 stations along the Gulf of Mexico (IP: Francisco Delgadillo-Hinojosa). (Figure 23)

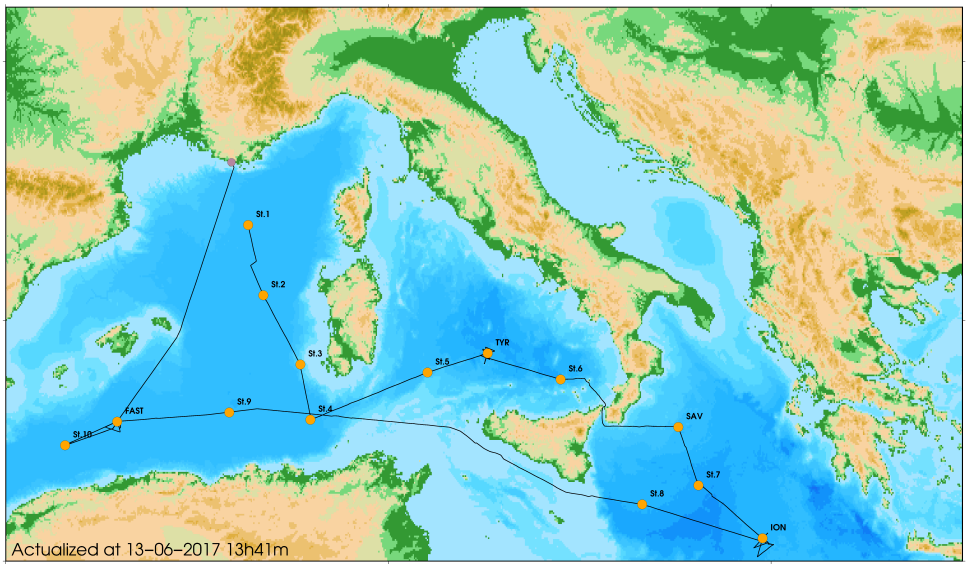


Figure 22. *PACETIME stations.*

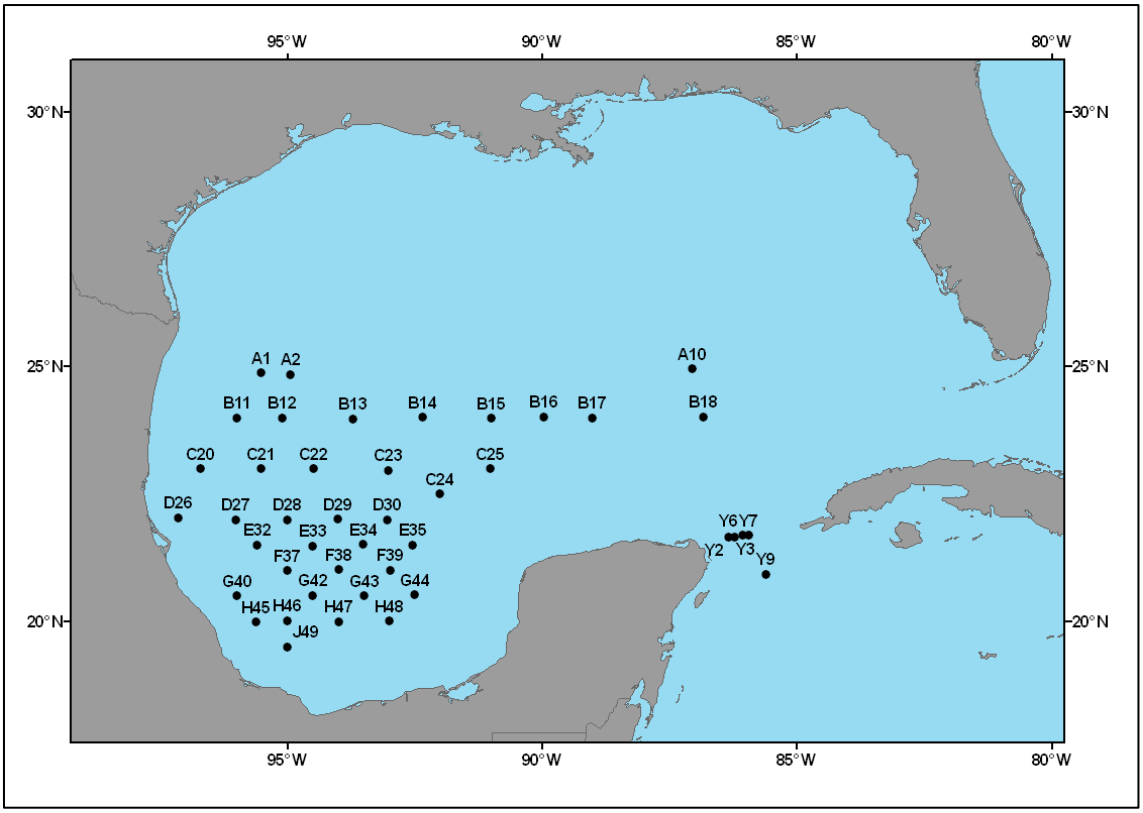


Figure 23. *XIXIMI-06 stations.*

Submitted by Antonio Tovar-Sánchez (a.tovar@csic.es)

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN SWEDEN

May 1st, 2017 to March 30th, 2018

New scientific results

- Data on ^{232}Th, ^{230}Th and ^{231}Pa from the Arctic Ocean (*R/V Polarstern* 2015 cruise ARK XXIX/3, PS94) are evaluated and reported at meetings during 2017.

Intercalibration

- Participated in analyses of duplicate samples for Nd isotopes from the Arctic Ocean (*R/V Polarstern* 2015 cruise ARK XXIX/3, PS94).

New publications (published or in press)

- Gdaniec S., Roy-Barman M., Foliot L., Thil F., Dapoigny A., Burckel P., Garcia-Orellana J., Masque P., Mörth C.-M. and Andersson P.S. (2018) Thorium and Protactinium isotopes as tracers of marine particle fluxes and deep water circulation in the Mediterranean Sea. https://doi.org/10.1016/j.marchem.2017.12.002 *Marine Chemistry*, 199, 12-23.
- Krall L., Trezzi G., Garcia-Orellana J., Rodellas V., Mörth C.-M. and Andersson P. (2017) Submarine groundwater discharge at Forsmark, Gulf of Bothnia, provided by Ra isotopes. https://doi.org/10.1016/j.marchem.2017.09.003 *Marine Chemistry*, 196, 162-172. (*This is formally not GEOTRACES but is clearly linked*)

PhD theses

- Sandra Gdaniec, PhD student at NRM/SU and also working at LSCE in Paris defended her licentiate-thesis, 19 May, 2017, with the title "231Pa and Th-isotopes as tracers of deep water ventilation and particle scavenging in the Mediterranean Sea".

Meetings

Participation in the Goldschmidt Meeting in Paris, 13-18 August, 2017. Abstracts:

- Gdaniec S., Valk O., Rutgers van der Loeff M. Roy-Barman M., Andersson P.S. (2017). ^{231}Pa and ^{230}Th in the Barents Sea and the Nansen basin: implications for shelf-basin interactions and changes in particle flux Goldschmidt Conference, August 2017, Paris. Session: *Cycles of Trace Elements and Isotopes in the Ocean: GEOTRACES and Beyond*

- Roy-Barman M., Gdaniec S., Foliot L., Thil F., Burckel P., Andersson P., Mörth C.-M., Masque P. and Garcia-Orellana J. (2017) Influence of Deep Water Formation and Boundary Scavenging on ^{231}Pa and ^{230}Th Distribution in the Mediterranean Sea. Goldschmidt Meeting Paris, 13-18 August 2017.

Submitted by Per Andersson (per.andersson@nrm.se).

New scientific results

- **Where, How And Which Trace Elements Are Released From Dust At The Sea Surface?**

  Alex Baker and Tim Jickells (2017, see reference below) propose to answer this question thanks to analysis of aerosols collected in the framework of the Atlantic Meridional Transect (AMT). They established the soluble concentrations of a range of trace metals (iron, aluminium, manganese, titanium, zinc, vanadium, nickel and copper) and major ions. They reveal much higher inputs to the North Atlantic Ocean compared to the South Atlantic Ocean, reflecting stronger land based emission sources in the Northern Hemisphere. Comparison of these inputs with the surface water contents of the same trace metals compiled in the GEOTRACES intermediate data product show surprising features.

  Baker, A.R. and Jickells, T.D. (2017), Progress in Oceanography.

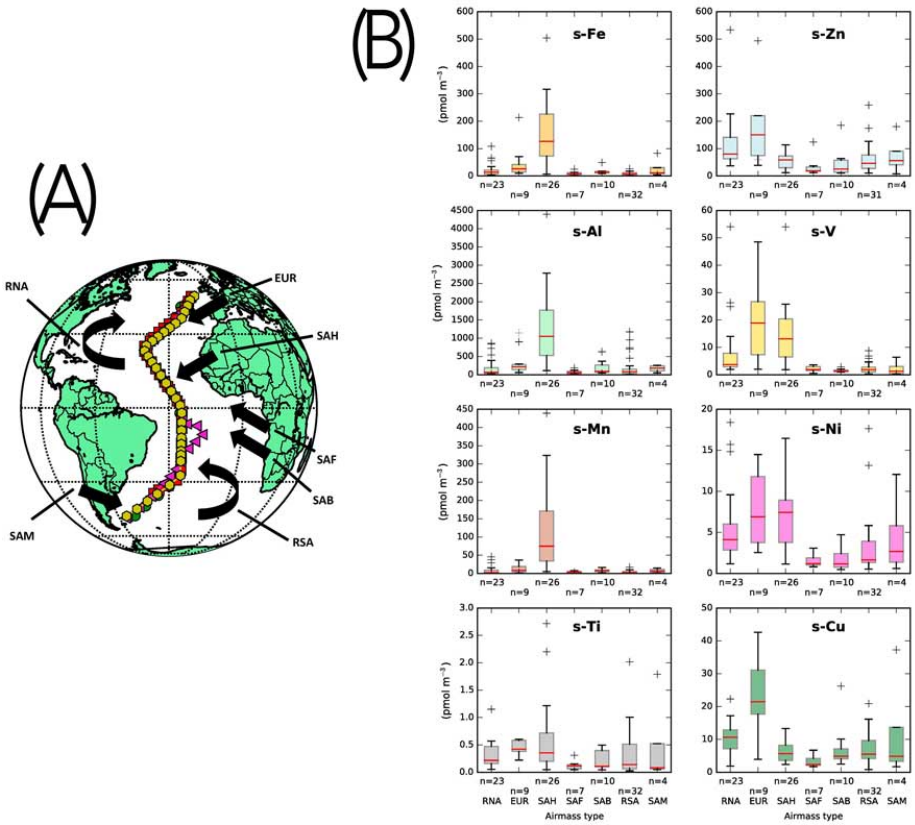


Figure 24: *(A) Approximate tracks of the AMT cruises (dots and triangles) and general flow directions of the seven major atmospheric transport routes encountered during the cruises (arrows). Abbreviations for the air transport regimes are: continental Europe (EUR), North Africa including the Sahara and Sahel: (SAH), Southern Africa impacted by biomass burning emissions (SAB), Southern Africa not impacted by biomass burning (SAF), South America (SAM), remote North or South Atlantic i.e. not crossing land for at least 5 days prior to collection (RNA and RSA respectively). (B) Box and whisker plots showing the variations in the concentrations of iron, aluminium, manganese, titanium, zinc, vanadium, nickel and copper with air transport/source type for the AMT transect. They reveal much higher inputs to the North Atlantic Ocean, reflecting stronger land based emission sources in the Northern Hemisphere.* http://www.geotraces.org/science/science-highlight/1481-trace-elements-dust

- **Barium Isotope Measurements Help Constraining the Oceanic Barium Cycle**

  Hsieh and Henderson (2017, see reference below) propose a compilation of the oceanic barium (Ba) concentrations together with its isotopic profiles measured so far. Their review covers the main oceanic basins, comparing data obtained in the North and South Atlantic, North Pacific and the Southern Oceans. Their main conclusions are: (i) near-surface Ba isotope values are controlled by basin-scale balances rather than by regional or short-term processes; (ii) isotope Ba fractionation during its removal from the surface is significant: the global Ba isotope data can be fit by mixing and removal/addition of Ba with a single isotope fractionation of 1.00058 ±0.00010; (iii) the resulting Ba isotope composition of the upper ocean waters is correlated with the fraction of Ba utilization at the basin scale; (iv) in the deep waters, it is suspected that external inputs of Ba (released by sediments or hydrothermal sources) can be traced by their specific isotopic signatures.

  Hsieh, Y-T. and Henderson, G.M. (2017), Earth and Planetary Science Letters.

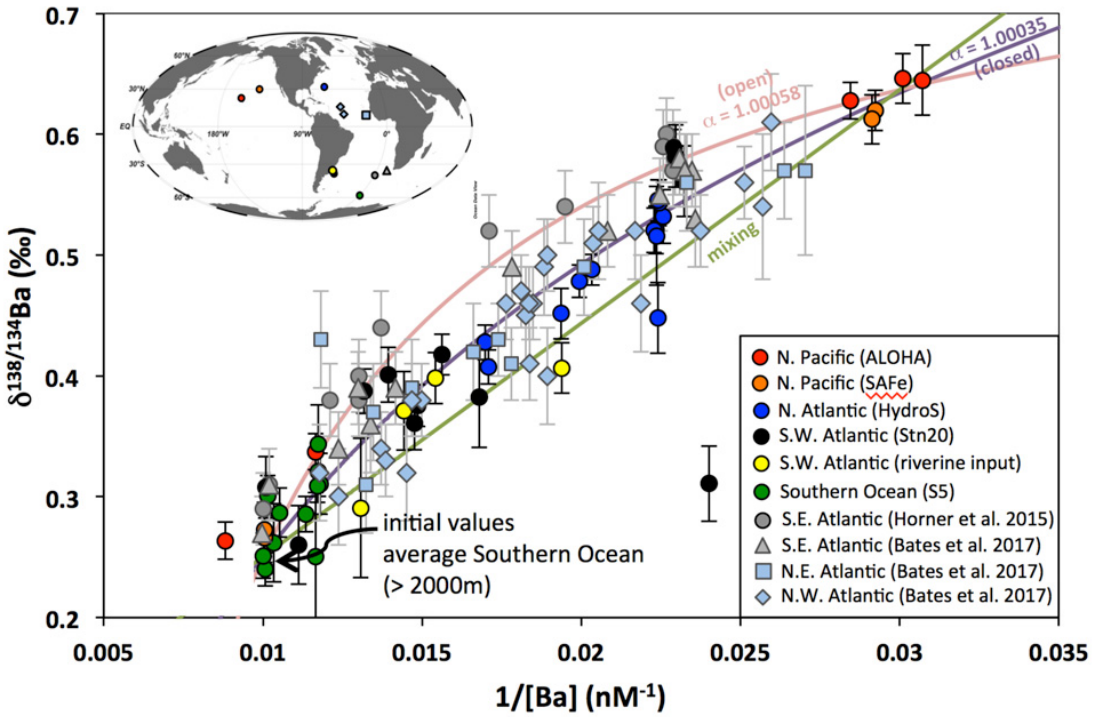


Figure 25: *Seawater Ba isotope compositions versus 1/[Ba] in the global ocean. The data are fitted with three curves generated by a steady-state (open) model, a Rayleigh fractionation (closed) model and a mixing model, each constrained using an initial composition equal to the average value in the deep Southern Ocean and a final value equal to the surface values in the Pacific Ocean. The results show that seawater Ba isotope compositions are controlled by basin-scale Ba utilization, remineralisation, and ocean mixing during the internal oceanic Ba cycle. External Ba inputs also play important roles in the oceanic Ba isotope budget. For example, riverine input introduces light Ba isotopic signatures to the surface ocean; and sediment or hydrothermal inputs may introduce heavy Ba isotopic compositions to the deep water, which have been identified with the non-conservative behaviour of Ba isotopes during the N-S Atlantic deep water mixing. Such distinct Ba isotope signatures from these sources can become useful tracers for constraining Ba inputs in the present and past ocean.*
http://www.geotraces.org/science/science-highlight/1431-barium-isotope-measurements

- **Iron plays an important role in zonal alkaline phosphate distribution in the sub-tropical North Atlantic**. This is essential for organism to use DOP as an alternative source of P as phosphate concentrations were limiting.

  New and unpublished results from the ZIPLOC cruise (see below).

- **The first 3D global ocean cobalt model shows that sediments are the major global source and that the suppression of cobalt scavenging by low oxygen and reduced bacterial activity is key in extending the residence time of externally supplied cobalt**.

  Tagliabue et al. (2018), Global Biogeochemical Cycles.

- **Analysis of the Cr isotopic composition of seawater within the oxygen minimum zone of the eastern sub-tropical Atlantic Ocean shows no evidence for reduction of Cr(VI) to Cr(III)**. While shelf waters have variable Cr isotopic compositions, intermediate and deep water masses show a rather limited range of values, so authigenic marine precipitates deposited in deep water in the open ocean have the potential to faithfully record the Cr isotopic composition of ancient seawater.

  Goring-Harford et al. (in press), Geochimica et Cosmochimica Acta.

New publications (published or in press)

- Achterberg, E.P., Steigenberger, S., Marsay, C.M., LeMoigne, F.A.C., Painter, S.C., Baker, A.R., Connelly, D.P., Moore, C.M., Tagliabue, A., Tanhua, T. (2018), Iron Biogeochemistry in the High Latitutde North Atlantic Ocean, Scientific Reports, 8, 1283, doi:10.1038/s41598-018-19472-1.
- Baker, A.R. and Jickells, T.D. (2017), Atmospheric deposition of soluble trace elements along the Atlantic Meridional Transect (AMT). Progress in Oceanography, 158, 41-51, doi:10.1016/j.pocean.2016.10.002.
- Baker, A.R., Kanakidou, M., Altieri, K.E., Daskalakis, N., Okin, G.S., Myriokefalitakis, S., Dentener, F., Uematsu, M., Sarin, M.M., Duce, R.A., Galloway, J.N., Keene, W.C., Singh, A., Zamora, L., Lamarque, J.F., Hsu, S.C., Rohekar, S.S., Prospero, J.M. (2017), Observation- and model-based estimates of particulate dry nitrogen deposition to the oceans, Atmospheric Chemistry and Physics, 17, 8189-8210, doi:10.5194/acp-17-8189-2017.
- Birchill, A.J., Milne, A., Woodward, E.M.S., Harris, C., Annett, A., Rusiecka, D., Achterberg, E.A., Gledhill, M., Ussher, S.J., Worsfold, P.J., Geibert, W., Lohan, M.C. (2017), Seasonal iron depletion in a temperature shelf sea. Geophysical Research Letters, 44(17), doi:10.1002/2017GL073881.
- Bridgestock, L., Hsieh, Y-T., Porcelli, D., Homoky, W.B., Bryan, A., Henderson, G.M. (2018), Controls on the barium isotope compositions of marine sediments, Earth and Planetary Science Letters, 481, 101-110, doi.10.1016/j.epsl.2017.10.019.
- Bridgestock, L., Rehkämper, M., van de Flierdt, T., Paul, M., Milne, A., Lohan, E., Achterberg (2018), The distribution of lead concentrations and isotope compositions in the eastern Tropical Atlantic Ocean, Geochimica et Cosmochimica Acta, 225, 36-51, doi.10.1016/j.gca.2018.01.018.

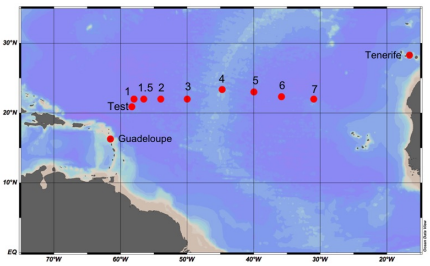
- Browning, T.J., Achterberg, E.P., Rapp, I., Engel, A., Bertrand, E.M., Tagliabue, A., Moore, C.M. (2017), Nutrient co-limitation at the boundary of an oceanic gyre, Nature, 551, 242-246, doi:10.1038/nature24063.
- de Souza, G.F., Khatiwala, S.P., Hain, M.P., Little, S.H., Vance, D. (2018), On the origin of the marine zinc-silicon correlation, Earth and Planetary Science Letters, 492, 22-34, doi:10.1016/j.epsl.2018.03.050.
- Ellwood, M.J., Bowie, A., Baker, A., Gault-Ringold, M., Hassler, C., Law, C.S., Maher, W., Marriner, A., Nodder, S., Sander, S., Stevens, C., Townsend, A., van der Merwe, P., Woodward, E.M.S., Wuttig, K., Boyd, P.W. (2018), Insights into the biogeochemical cycling of iron, nitrate and phosphate across a 5300 km South Pacific zonal section (153E-150W). Global Biogeochemical Cycles, 32, 187-207, doi: 10.1002/2017GB005736.
- Goring-Harford H.J., Klar J.K., Pearce C.R., Connelly D.P., Achterberg E.P., James R.H. (in press), Behaviour of chromium isotopes in the eastern sub-tropical Atlantic Oxygen Minimum Zone. Geochimica et Cosmochimica Acta, doi:10.1016/j.gca.2018.03.004.
- Hawco, N., Lam, P., Lee, J-M., Ohnemus, D., Noble, A., Wyatt, N.J., Lohan, M.C., Saito, M.A. (2018), Cobalt scavenging in the mesopelagic ocean and its influence on global mass balance: Synthesizing water column and sedimentary fluxes. Marine Chemistry, 201, 151-166, doi:10.1016/j.marchem.2017.09.001.
- Hopwood, M. J., Birchill, A.J., Gledhill, M., Milne, A., Achterberg, E.P. (2017), A comparison between four analytical methods for the measurement of Fe(II) at nanomolar concentrations in coastal seawater, Frontiers in Marine Science, 29, doi:10.3389/fmars.2017.00192.
- Hsieh, Y-T. and Henderson, G.M. (2017) Barium stable isotopes in the global ocean: Tracer of Ba inputs and utilization. Earth and Planetary Science Letters, 473, 269-278, doi: 10.1016/j.epsl.2017.06.024.
- John, S.G., Helgoe, J., Townsend, E., Weber, T., DeVries, T., Tagliabue, A., Moore, K., Lam, P., Marsay, C.M., Till, C. (2018), Biogeochemical cycling of Fe and Fe stable isotopes in the Eastern Tropical South Pacific. Marine Chemistry, 201, 66-76, doi:10.1016/j.marchem.2017.06.003.
- Klar, J.K., Schlosser, C., Milton, J.A., Woodward, E.M.S, Lacan, F., Parkinson, I.J., Achterberg, E.P., James, R.H. (in press), Sources of dissolved iron to oxygen minimum zone waters of the Senegalese continental margin in the tropical North Atlantic Ocean: Insights from iron isotopes, Geochimica et Cosmochima Acta, doi:10.1016/j.gca.2018.02.031.
- Klar, J.K., Homoky, W.B., Statham, P.J., Harris, E.L., Birchill, A., Woodward, E.M.S., Silburn, B., Cooper, M., James, R.H., Connelly, D.P, Chever, F., Lichtschlag, A., Graves, C. (2017), Stability of dissolved and soluable Fe(II) in shelf sediment pore waters and release to an oxic water column. Biogeochemistry, 135 (1-2), 49–67, doi:10.1007/s10533-017-0309-x.
- Little, S.H., Vance, D., McManus, J., Severmann, S., Lyons, T.W. (2017), Copper isotope signatures in modern organic rich sediments. Geochimica et Cosmochimica Acta, 212, 253-273, doi:10.1016/j.gca.2017.06.019.
- Milne, A., Schlosser, C., Wake, B., Achterberg, E.P., Chance, R., Baker, A,R, Forryan, A., Lohan, M.C. (2017), Particulate phases are key in controlling dissolved iron concentrations

in the (sub)-tropical North Atlantic, Geophysical Research Letters, 44, doi: 10.1002/2016GL072314.

- Orr, J.C., Najjar, R.G., Aumont, O., Bopp, L., Bullister, J.L., Danabasoglu, G., Doney, S.C., Dunne, J.P., Dutay, J.-C., Graven, H., Griffies, S.M., John, J.G., Joos, F., Levin, I., Lindsay, K., Matear, R.J., McKinley, G.A., Mouchet, A., Oschlies, A., Romanou, A., Schlitzer, R., Tagliabue, A., Tanhua, T., Yool, A. (2017), Biogeochemical protocols and diagnostics for the CMIP6 Ocean Model Intercomparison Project (OMIP), Geoscientifc Model Development, 10(6), 2169-2199, doi:10.5194/gmd-10-2169-2017.
- Rusieka, D., Gledhill, M., Milne, A., Achterberg, E.P., Annet, A.L. Atkinson, S., Birchill, A., Kartensen, J., Lohan, M.C., Mariez, C., Middag, R., Rolison, J.M., Tanhua, T., Ussher, S., Connelly, D. (2018), Anthropogenic signatures of lead in the Northeast Atlantic. Geophysical Research Letter, 45, 2734-2743, doi: 10.1002/2017GL076825.
- Sabadel, A.J.M., Browning, T.J., Kruimer, D., Airs, R.L., Woodward, E.M.S., Van Hale, R., Frew, R.D. (2017). Determination of picomolar dissolved free amino acids along a South Atlantic transect using reversed-phase high-performance liquid chromatography, Marine Chemistry, 196, 173-180, doi:10.1016/j.marchem.2017.09.008.
- Sherrell, R.M., Annett, A.L., Fitzsimmons, J.N., Roccanova, V.J., Meredith, M.P. (in press), A "shallow bathtub ring" of local sedimentary iron input maintains the Palmer Deep biological hotspot on the West Antarctic Peninsula shelf. Philosophical Transactions of the Royal Society A.
- Tagliabue, A., Hawco, N.J., Bundy, R.M., Landing, W.M., Milne, A., Morton, P.L., Saito, M.A. (2018), The role of external inputs and internal cycling in shaping the global ocean cobalt distribution: insights from the first cobalt biogeochemical model, Global Biogeochemical Cycles, doi: 10.1002/2017GB005830.

Cruises

- **GEOTRACES process study GApr08, ZIPLOc** (Zinc Iron Phosphorus co-limitation in the Ocean), on the *RRS James Cook* (JC150) was successfully completed (26 June - 12 August 2017; Guadeloupe to Tenerife). Chief scientist: Claire Mahaffey. GEOTRACES PIs: Claire Mahaffey, Alessandro Tagliabue and Maeve Lohan.



Bioassay experiments were conducted at seven stations involving the addition of iron, zinc and cobalt. 130 samples were collected from the trace metal clean FISH device to define zonal gradients in nutrients, trace metals, phytoplankton biomass and community structure and rates of nitrogen fixation and alkaline phosphatase activity.

Objectives:

1. Determine the prevalence of Zn and Fe limitation of alkaline phosphatase in the ocean
2. Quantify the impact of Zn-P and Fe-P co-limitation on growth, nitrogen fixation and community structure
3. Quantify the significance of Zn-P and Fe-P co-limitation over basin scales and multi-decadal time scales using PISCES model

- **GEOTRACES GA13 section cruise** on the *RRS James Cook* (JC156) was successfully completed (20 Dec 2017 – 2 Feb 2018; Southampton to Guadeloupe). Chief scientist: Alessandro Tagliabue. GEOTRACES PIs: Maeve Lohan and Alessandro Tagliabue.

New projects and/or funding

- Angela Milne and Simon Ussher (Plymouth University) won funding on the programmes **CUSTARD (‘*Carbon Uptake and Seasonal Traits in Antarctic Remineralisation Depth*’)** and **PICCOLO (‘*Processes Influencing Carbon Cycling: Observations of the lower limb of the Antarctic Overturning*’)**. Both programmes are part of the NERC strategic programme RoSES (‘*Role of the Southern Ocean in the Earth System*’). Angela and Simon will conduct dissolved and particulate iron and trace element biogeochemical measurements in the Southern Ocean on cruises during the austral summer 2020-2021.
- Amber Annett started her 5 year NERC Independent Research Fellowship in Southampton to work on ‘***Radium in Changing Environments: A novel tracer of iron fluxes at Ocean Margins***’. So far she participated in the ICY-LAB and GA13 cruises, with upcoming cruises along the western Antarctic Peninsula.
  Amber has also been awarded a visiting scholar fellowship at the Key State Laboratory of Marine Environmental Science at Xiamen University, to learn and develop the application of Ra/Th diequilibrium in sediments to calculate trace metal fluxes.
- Susan Little has has started her 5 year NERC Independent Research Fellowship at Imperial College London to work on ‘***Beyond Iron in the Ocean: Trace metal micronutrients and the carbon cycle (BIOTrace)***’. So far she has been involved with the ICY-LAB cruise, with upcoming field work in Greenland (trace metal isotopes in glacial meltwaters).

PhD theses

- Heather Jane Goring-Harford (2017). ‘*Chromium isotope behavior in natural waters*’. University of Southampton. Thesis advisor: Rachel James.
- Antony Birchill (2017). ‘*The seasonal cycling and physio-chemical speciation of iron in the Celtic and hebridean Shelf sea*.’ University of Plymouth. Thesis advisors: Maeve Lohan (DoS), Angie Milne, Simon Ussher.

Meetings

- Goldschmidt conference, Paris, August 2017
  - Yves Plancherel and Tina van de Flierdt co-convened session 10i: ‘Cycles of Trace Elements and Isotopes in the Ocean: GEOTRACES and Beyond’.
  - William Homoky co-convened session 10j: ‘Bio-Geochemical Processes Across the Sediment-Water Interface: Key Tools, New Sites and Recent Advances’.
  - Archer, C., Vance, D., Lohan, M.C., ‘Negligible Ni isotope fractionation associated with phytoplankton uptake in the South Atlantic Ocean’.
  - A. Baker, C. Yodle, E. Droste, J. Bock, L. Ganzeveld. ‘Iodine Speciation in Aerosols over the Atlantic, Indian and Pacific Oceans’.
  - A. Birchill, A. Milne, S. Ussher, P. Worsfold, M. Lohan. ‘The Physico-Chemical Speciation of Iron over an Oxic Shelf Margin’.
  - A. Bryan, A. Dickson, G. Henderson, D. Porcelli, C. Slomp, W. Homoky, F. Dowdall, S. Van DenBoorn, ‘Controls on the Cadmium-Isotope Composition of Modern Marine Sediments’.

- H. Goring-Harfor, R. James, C. Pearce, D. Connelly, J. Klar, I. Parkinson, 'On the Cr Isotopic Composition of Seawater'.
- A. Griffiths, M. Lambelet, K.Crocket, T. van de Flierdt, M. Rehkämper, R. Abell, F. Nitsche, 'Neodymium Isotopic Composition of East Antarctic Continental Shelf and Deep Water'.
- W. Homoky and A. Annett, 'Radium Isotopes Resolved Across an Ocean-Sediment interface'.
- Y-T. Hsie, L. Bridgestock, W.E. Seyfried Jr., G.M. Henderson, 'Barium Isotope Fractionation in Hydrothermal Vent Fluids: Constraints on Ba Inputs to the Ocean'.
- J. Klar, R. James, D. Gibbs, A. Lough, I. Parkinson, J. Milton, J. Hawkes, 'Evolution of the Isotopic Composition of Dissolved Iron in Hydrothermal Plumes in the Southern Ocean'.
- M. Lambelet, K. Crocket, T. van de Flierdt, L. Bridgestock, F. Deng, R. Chance, A. Backer, E. Achterberg, 'Neodymium Isotopes and Rare Earth Elements in the Tropical Atlantic Ocean: Results from the GEOTRACES GA06 Cruise'.
- S. Little, T. van de Flierdt, D. Wilson, M. Rehkämper, P. Spooner, J. Adkins, L. Robinson, 'Deep sea corals as archives of seawater Zn isotopes'.
- A. Lough, J. Klar., R.H. James, D. Connelly, W. Homoky, P.J. Statham, 'Iron isotopes track the uptake and exchange of iron across an oxic shelf sea'.
- A. Milne, T. Conway, C. Schlosser, S. John, E. Achterberg, M. Lohan, 'Iron along the GEOTRACES South Atlantic Transect GA10'.
- Y. Plancherel, C. Basak, S. Khatiwala, L. Carney, R. Anderson, G.M. Henderson. 'The Role of Scavenging on the Oceanic Distribution of 231Pa, 230Th and 10Be'.
- D. Rusiecka, E. Achterberg, M. Gledhill, D. Connelly, T. Tanhua, M. Liu, 'Anthropogenic lead as signature of Mediterranean Waters in the Depp North Atlantic'.
- T. Stichel, J. Klar, K. Crocket, R. James, P. Statham, M. Lohan, A. Milne, R. Mills. 'Limited Exchange of Neodymium Isotopes with the NE Atlantic Continental Margin'.

- PAGES 5th Open Science Meeting, Zaragoza, May 2017
  - Susan Little convened a session on 'Trace elements and their isotopes as geochemical proxies of past ocean conditions'.
  - S.H. Little., D. Vance, C. Archer, J. McManus, S. Severmann, T. Lyons, 'Copper isotopes signatures in the marine environment'.

- Advances in Marine Biogeochemistry Conference VIII (AMBIO), The Challenger Society, SAMS, September 2017
  - Susan Little delivered a keynote talk on 'Coupling and decoupling of Zn and Si in the global ocean'.
  - Luke Bridgestock delivered a keynote talk on 'Isotopic insights into the marine biogeochemical barium cycle'.
  - A. Annett, J. Fitzsimmons, R. Sherrell, 'Trace metal supply from the western Antarctic Peninsula Shelf to the open ocean'.
  - A. Birchill, A. Milne, S. Ussher, M.C. Lohan, 'Iron deficient waters over the Hebridean shelf break'.
  - J. Klar, W. Homoky, A. Lough, R.H. James, P.J. Statham, 'Stability of dissolved and soluble Fe(II) in shelf sediment porewater and release to an oxic water colum'.

- K. Kunde, N.J. Wyatt, M.C. Lohan, 'Iron and phosphorus co-limitation in the sub-tropical North Atlantic'.
- A. Lough, J. Klar, R.H. James, D. Connelly, W. Homoky, P.J. Statham, 'Iron isotopes track the uptake and exchange of iron across and oxic shelf sea'.

- Redox-Active Minerals in Natural Systems, Mineralogical Society, Manchester, June 2017
  - Susan Little delivered a keynote talk on 'Pseudo-redox control on the oceanic budget of Zn and Zn isotopes'.

- Ocean Sciences meeting, Portland, February 2018
  - Alessandro Tagliabue co-chaired sessions on 'Abiotic and Biotic Retention, Recycling, and Remineralization of Metals in the Ocean' and 'The Dawn of BioGEOTRACES: Metal-Microbe Interactions in the Ocean'.
  - C. Davis, K. Kunde, N. Wyatt, L. Wrightson, L. Johnson, M. Woodward, M. Lohan, A. Tagliabue, C. Mahaffey, 'What drives cross-basin trends in the biological production of metal-enzyme activity in the subtropical North Atlantic?'
  - A. Gourain, P. Salaun, A. Tagliabue, S.M.G. van de Berg, J. Boutorh, M. Cheize, L. Pereira Contreira, P. Lherminier, J-L. Menzel Barraqueta, H. Planquette, G. Sarthou, R. Shelley, 'Speciation of dissolved sopper in North Atlantic along the GEOTRACES GA01 section'.
  - K. Kunde, N. Wyatt, D. Gonzalez-Santana, L. Wrightson, L. Johnson, C. Davis, M. Woodward, C. Mahaffey, M. Lohan, 'Iron Biogeochemistry in the subtropical North Atlantic'.
  - C. Mahaffey, C. Davis, K. Kunde, N. Wyatt, D. Gonzalez-Santana, L. Wrightson, L. Johnson, M. Woodward, A. Tagliabue, M. Lohan, 'Influence of iron and zinc on alkaline phosphatase and biological activity in the subtropical North Atlantic during bioassay experiments'.
  - A. Milne, T. Conway, C. Schlosser, S. John, E. Achterberg, M.C. Lohan, 'Iron along the GEOTRACES South Atlantic Transect GA10'.
  - N. Wyatt, K. Kunde, C. Davis, D. Gonzalez-Santana, M. Woodward, A. Tagliabue, C. Mahaffey, M. Lohan, 'The biogeochemical cycling of zinc in the subtropical North Atlantic'.

- Geochemistry in Progress Meeting (GGRiP), St Andrews, March 2018
  - Presentations by H. Packman, A. Pegrum-Haram (Imperial College London).

Outreach activities

- Susan Little gave a 'Pint of Science' talk in London (May 2017) on 'Bloom and Bust: Glassy Diatoms and Ocean Nutrients'.
- Blog on ZIPLOC cruise via @MahaffeyLab (June-August 2017).
- Maeve Lohan and Alessandro Tagliabue explain *Intercalibration* and *Modelling* in a new video about the GEOTRACES programme ('21 Questions and Answers about GEOTRACES').

  https://www.youtube.com/watch?v=3_pC_2eeAtA&feature=youtube
- BBC South today-interview with Maeve Lohan and Alessandro Tagliabue prior to sailing on GA13 (December 2017).

- BBC Solent radio- interview with Maeve Lohan and Alessandro Tagliabue prior to sailing on GA13 (December 2017).
- Twitter @FRidge_GA13 (December 2017 – February 2018).

Other activities

- Alex Baker and Maeve Lohan taught on the 1st GEOTRACES summer school in Brest, France (August 2017). Alessandro Tagliabue and Maeve Lohan served on the scientific organizing committee.
- Will Homoky is the current Chair of the 'Advances in Marine Biogeochemistry (AMBIO)' group of the Challenger Society.
- Susan Little is a full committee member of the Geochemistry Group of the Geological and Mineralogical Society.
- Maeve Lohan (co-chair) and Tina van de Flierdt (committee member) attended two virtual Standards & Intercalibration (S&I) meetings in the the run up to the release of the IDP2017.
- Alessandro Tagliabue co-chaired the Data Management Committee (DMC).
- Maeve Lohan and Alessandro Tagliabue attended the annual DMC and SSC meeting in Brazil, the latter of which was also attended by Gideon Henderson and Tina van de Flierdt.
- Tina van de Flierdt and Amber Annett presented science highlights at the release event for IDP2017 at the Goldschmidt conference in Paris (August 2018), and Alessandro Tagliabue presented at the release at the Ocean Sciences meeting in Portland (February 2018).

Submitted by Tina van de Flierdt (tina.vandeflierdt@imperial.ac.uk).

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN UNITED STATES

May 1st, 2017 to March 30th, 2018

U.S. GEOTRACES Meetings

The US GEOTRACES Scientific Steering Committee (SSC) met on 21-22 June 2017 at the US National Science Foundation (NSF), thereby facilitating interaction with NSF program officers who oversee support of US GEOTRACES activities. The SSC reviewed progress on the two GEOTRACES sections completed most recently (GP16 in the eastern tropical South Pacific and GN01 in the western Arctic Ocean) and laid out plans for future US contributions to GEOTRACES. In particular, the SSC approved plans to complete the GEOTRACES GP17 section (Tahiti – Antarctica – Chile). The SSC also agreed to partner with the Ocean Carbon and Biogeochemistry program in a new initiative to assess community interest for a joint study of the biogeochemistry of the Gulf of Mexico. Additional information about this is provided below under Outreach.

Other meetings sponsored during the past year by US GEOTRACES are associated with specific GEOTRACES sections, and are discussed below under Cruise-related Activities.

Cruise-related Activities

Eastern Tropical Pacific A special issue of Marine Chemistry with results from GP16 was officially published in April, 2018< https://www.sciencedirect.com/journal/marine-chemistry/vol/201/suppl/C?dgcid=raven_sd_via_email>. The title of the issue is "The U.S.GEOTRACES Eastern Tropical Pacific Transect (GP16)". Jim Moffett of the University of Southern California served as the guest editor of the volume. A complete list of the 19 papers published in this volume is provided below. Meanwhile, additional papers describing results from the GP16 section continue to be submitted for publication, independently of the Marine Chemistry volume.

Arctic Ocean US investigators continue to analyze samples collected aboard the U.S. Coast Guard Cutter Healy (HLY1502, 9 August to 12 October, 2015, sailing out of and returning to Dutch Harbor, Alaska; Chief Scientist: David Kadko, Co-Chief Scientist: Bill Landing, Logistics Coordinator: Greg Cutter).

A total of 56 participants, representing each project involved in this section, gathered for a data workshop in Miami, Florida (23 to 26 October, 2017) to share and compare their findings. Several Arctic synthesis themes emerged from working group discussions during the workshop, including: 1) shelf-basin interaction that affects the distribution of trace elements and their isotopes (TEIs) in the halocline, 2) processes affecting TEI distributions in the seasonal ice zone, 3) residence times of TEIs in surface waters, and 4) sources of TEIs carried across the Arctic Ocean by the Transpolar Drift.

North Pacific Meridional Section Under the leadership of Greg Cutter (Chief Scientist) as well as Phoebe Lam and Karen Casciotti (co-Chief Scientists) US GEOTRACES will undertake Section GP15 (Alaska to Tahiti) later this year. Sailing aboard the R/V Roger Revelle, the cruise will depart Seattle on 18 September 2018 and conclude in Papeete Tahiti on 24 November, with a mid-cruise stop in Hilo Hawaii to permit offloading of samples, onloading of supplies and exchange of personnel. Altogether, 38 principal investigators representing 27 universities and research institutions have been funded to participate in GP15. Their projects will cover the measurement of all GEOTRACES key TEIs. In addition, the

cruise leaders are working with the BioGEOTRACES community to collect samples for as many BioGEOTRACES parameters as possible.

A workshop was held 8-9 March 2018 (Old Dominion University, Norfolk Virginia) to inform investigators about the cruise logistics and to negotiate allocation of shared samples (seawater and filtered particles). Altogether, more than 50 participants attended the meeting, representing each of the funded projects as well as the ship operators (Scripps Institution of Oceanography). Organizing and coordinating such a comprehensive program requires a tremendous effort on the part of the cruise leaders, who hold weekly teleconferences while working out the details of the cruise planning.

South Pacific Meridional Section As noted above, US GEOTRACES has initiated planning to undertake the GP17 section from Tahiti to Antarctica, completing the western Pacific meridional section. Discussion with program officers at NSF determined that the optimum time for the cruise will be roughly December 2021 to February 2022.

New Funding

Final decisions about which proposals will be funded to participate in GP15 were communicated to US GEOTRACES PIs by NSF in late 2017.

A proposal requesting three years of continuing support for the US GEOTRACES project office was submitted to NSF in February 2018. We anticipate that a decision will be received in June.

Presentation of results

Many presentations of US GEOTRACES results were given at the 2017 Goldschmidt Conference in Paris France and at the 2018 Ocean Sciences meeting in Portland Oregon. The Goldschmidt GEOTRACES session spanned three oral sessions and included 35 oral presentations, of which a significant number were from US investigators, students, and postdocs. The editors of the journal Chemical Geology approached the lead convener (Tim Conway, University of South Florida) about putting together a special issue based on the exciting research presented during this session, which includes a mixture of synthesis and new research; several US investigators are contributing to this.

Synthesis

Two projects that grew out of the GEOTRACES synthesis workshop held at the Lamont-Doherty Earth Observatory, Palisades, New York, USA from 1-4 August, 2016, have advanced under the leadership of Christopher Hayes of the University of Southern Mississippi. The first combines inventories of selected key TEIs measured along the GA03 section together with the distributions of dissolved ^{230}Th and ^{232}Th to estimate the rate of supply of each TEI from dust, as well as its residence time in the water column. This paper has been submitted to Global Biogeochemical Cycles, reviewed, revised and resubmitted. We are awaiting a final decision on the manuscript. A second effort, also exploiting data from GA03, utilizes multiple radionuclide systems to calculate the sinking flux of particulate organic carbon as well as the particulate sinking fluxes of several key TEIs. In addition to providing estimates of sinking fluxes throughout the water column, this synthesis activity is evaluating the strengths and limitations of each radionuclide system for estimating fluxes of particles and their constituents. A manuscript describing the results of this synthesis initiative is being written under the leadership of Chris Hayes and Erin Black.

Outreach and Capacity Building Activities

US GEOTRACES co-organized and co-supported town hall meetings at the 2017 Goldschmidt Conference (Paris France) and at the 2018 Ocean Sciences meeting (Portland Oregon, USA) to inform the research community about the release of the latest GEOTRACES data product, IDP2017.

US GEOTRACES investigators had a strong presence at the first GEOTRACES summer school in Brest France 20-26 August 2017, training the next generation of GEOTRACERS. US lecturers included Bob Anderson, Greg Cutter, Phoebe Lam, Kristen Buck and Paul Field, out of 17 total. Approximately 60 students from around the world, including the US, participated in the summer school.

US GEOTRACES also co-organized a second town hall during the 2018 Ocean Sciences meeting to assess community interest in developing an interdisciplinary study of the biogeochemistry of the Gulf of Mexico. Our partner in organizing the town hall was the Ocean Carbon and Biogeochemistry program. The town hall was led by Alan Shiller (University of Southern Mississippi, and US GEOTRACES SSC member) and by Heather Benway (Executive Director of the OCB Project Office). In addition to representation by these two US programs, Juan-Carlos Herguera of the Ensenada Center for Scientific Research and Higher Education presented on the large ongoing Mexican research initiative in the Gulf of Mexico. The town hall demonstrated widespread interest in developing a future program in the Gulf of Mexico that may be expanded to include the Caribbean Sea. Alan Shiller is leading the long-term planning that will be needed to implement a project in the Gulf of Mexico. The project will incorporate research on TEIs of interest to GEOTRACES, but will not focus exclusively on TEIs. The possibility of developing this initiative as a GEOTRACES process study is being discussed.

In an effort to help build GEOTRACES capacity in East Asia, Bob Anderson (director of the US GEOTRACES project office) participated in two meetings in the Republic of (South) Korea in late 2017. Anderson was invited to give a talk entitled “Indian Ocean GEOTRACES (Prospects for quantifying supply and removal of essential micronutrients in the Indian Ocean)” at the Korea Institute of Ocean Science and Technology International Seminar KIS 2017: New Observation and New Applications, 4-5 December 2017, Busan, Republic of Korea. While in Korea he also gave a keynote talk entitled “A GEOTRACES approach to identify sources of trace element nutrients in the Indian Ocean” at the workshop on strategic imperatives and implementation for Korea-US inDian Ocean Sciences (KUDOS) 2017, Seoul National University, 29 November – 1 December. Korea has recently acquired the NIOZ-TITAN clean sampling system for use aboard their new global class research vessel ISABU. Following a successful test of their system in the summer of 2017, Korean scientists are keen to begin developing an ambitious GEOTRACES program, with a focus on the Indian Ocean where they plan to use the ISABU over each of the next several years. During these meetings Anderson offered advice about the design and scientific goals of Korean GEOTRACES research.

Publications (GEOTRACES, GEOTRACES Compliant and GEOTRACES-related)

During the past year US GEOTRACES investigators published a total of 38 peer-reviewed journal articles, including papers published by lead authors in other nations for which U.S. GEOTRACES investigators serve as co-authors.

Special issue Marine Chemistry: The U.S.GEOTRACES Eastern Tropical Pacific Transect (**GP16**) – 19 Publications

- Black, E.E., Buesseler, K.O., Pike, S.M. and Lam, P.J. (2018) 234Th as a tracer of particulate export and remineralization in the southeastern tropical Pacific. Marine Chemistry 201, 35-50.
- Buck, K.N., Sedwick, P.N., Sohst, B. and Carlson, C.A. (2018) Organic complexation of iron in the eastern tropical South Pacific: Results from US GEOTRACES Eastern Pacific Zonal Transect (GEOTRACES cruise GP16). Marine Chemistry 201, 229-241.
- Cutter, G.A., Moffett, J.G., Nielsdóttir, M.C. and Sanial, V. (2018) Multiple oxidation state trace elements in suboxic waters off Peru: In situ redox processes and advective/diffusive horizontal transport. Marine Chemistry 201, 77-89.
- Hawco, N.J., Lam, P.J., Lee, J.-M., Ohnemus, D.C., Noble, A.E., Wyatt, N.J., Lohan, M.C. and Saito, M.A. (2018) Cobalt scavenging in the mesopelagic ocean and its influence on global mass balance: Synthesizing water column and sedimentary fluxes. Marine Chemistry 201, 151-166.
- Ho, P., Lee, J.-M., Heller, M.I., Lam, P.J. and Shiller, A.M. (2018) The distribution of dissolved and particulate Mo and V along the U.S. GEOTRACES East Pacific Zonal Transect (GP16): The roles of oxides and biogenic particles in their distributions in the oxygen deficient zone and the hydrothermal plume. Marine Chemistry 201, 242-255.
- Hoffman, C.L., Nicholas, S.L., Ohnemus, D.C., Fitzsimmons, J.N., Sherrell, R.M., German, C.R., Heller, M.I., Lee, J.-m., Lam, P.J. and Toner, B.M. (2018) Near-field iron and carbon chemistry of non-buoyant hydrothermal plume particles, Southern East Pacific Rise 15°S. Marine Chemistry 201, 183-197.
- Jenkins, W.J., Lott, D.E., German, C.R., Cahill, K.L., Goudreau, J. and Longworth, B. (2018) The deep distributions of helium isotopes, radiocarbon, and noble gases along the U.S. GEOTRACES East Pacific Zonal Transect (GP16). Marine Chemistry 201, 167-182.
- John, S.G., Helgoe, J. and Townsend, E. (2018a) Biogeochemical cycling of Zn and Cd and their stable isotopes in the Eastern Tropical South Pacific. Marine Chemistry 201, 256-262.
- John, S.G., Helgoe, J., Townsend, E., Weber, T., DeVries, T., Tagliabue, A., Moore, K., Lam, P., Marsay, C.M. and Till, C. (2018b) Biogeochemical cycling of Fe and Fe stable isotopes in the Eastern Tropical South Pacific. Marine Chemistry 201, 66-76.
- Kipp, L.E., Sanial, V., Henderson, P.B., van Beek, P., Reyss, J.-L., Hammond, D.E., Moore, W.S. and Charette, M.A. (2018) Radium isotopes as tracers of hydrothermal inputs and neutrally buoyant plume dynamics in the deep ocean. Marine Chemistry 201, 51-65.
- Lam, P.J., Lee, J.-M., Heller, M.I., Mehic, S., Xiang, Y. and Bates, N.R. (2018) Size-fractionated distributions of suspended particle concentration and major phase

composition from the U.S. GEOTRACES Eastern Pacific Zonal Transect (GP16). Marine Chemistry 201, 90-107.

- Lee, J.-M., Heller, M.I. and Lam, P.J. (2018) Size distribution of particulate trace elements in the U.S. GEOTRACES Eastern Pacific Zonal Transect (GP16). Marine Chemistry 201, 108-123.
- Marsay, C.M., Lam, P.J., Heller, M.I., Lee, J.-M. and John, S.G. (2018) Distribution and isotopic signature of ligand-leachable particulate iron along the GEOTRACES GP16 East Pacific Zonal Transect. Marine Chemistry 201, 198-211.
- Moffett, J.W. and German, C.R. (2018) The U.S.GEOTRACES Eastern Tropical Pacific Transect (GP16). Marine Chemistry 201, 1-5.
- Ohnemus, D.C., Lam, P.J. and Twining, B.S. (2018) Optical observation of particles and responses to particle composition in the GEOTRACES GP16 section. Marine Chemistry 201, 124-136.
- Pavia, F., Anderson, R.F., Vivancos, S., Fleisher, M., Lam, P., Lu, Y., Cheng, H., Zhang, P. and Lawrence Edwards, R. (2018) Intense hydrothermal scavenging of 230Th and 231Pa in the deep Southeast Pacific. Marine Chemistry 201, 212-228.
- Peters, B.D., Jenkins, W.J., Swift, J.H., German, C.R., Moffett, J.W., Cutter, G.A., Brzezinski, M.A. and Casciotti, K.L. (2018a) Water mass analysis of the 2013 US GEOTRACES eastern Pacific zonal transect (GP16). Marine Chemistry 201, 6-19.
- Peters, B.D., Lam, P.J. and Casciotti, K.L. (2018b) Nitrogen and oxygen isotope measurements of nitrate along the US GEOTRACES Eastern Pacific Zonal Transect (GP16) yield insights into nitrate supply, remineralization, and water mass transport. Marine Chemistry 201, 137-150.
- Sanial, V., Kipp, L.E., Henderson, P.B., van Beek, P., Reyss, J.L., Hammond, D.E., Hawco, N.J., Saito, M.A., Resing, J.A., Sedwick, P., Moore, W.S. and Charette, M.A. (2018) Radium-228 as a tracer of dissolved trace element inputs from the Peruvian continental margin. Marine Chemistry 201, 20-34.

Journal articles: (19 publications)

- Crusius, J., Schroth Andrew, W., Resing Joseph, A., Cullen, J. and Campbell Robert, W. (2017) Seasonal and spatial variabilities in northern Gulf of Alaska surface water iron concentrations driven by shelf sediment resuspension, glacial meltwater, a Yakutat eddy, and dust. Global Biogeochemical Cycles 31, 942-960.
- Gardner, W.D., Mishonov, A.V. and Richardson, M.J. (2018a) Decadal Comparisons of Particulate Matter in Repeat Transects in the Atlantic, Pacific, and Indian Ocean Basins. Geophysical Research Letters.
- Gardner, W.D., Richardson, M.J. and Mishonov, A.V. (2018b) Global assessment of benthic nepheloid layers and linkage with upper ocean dynamics. Earth and Planetary Science Letters 482, 126-134.
- Haley, B.A., Du, J., Abbott, A.N. and McManus, J. (2017) The impact of benthic processes on rare earth element and neodymium isotope distributions in the oceans. Frontiers in Marine Science 4, 426.

- Hein, J.R., Konstantinova, N., Mikesell, M., Mizell, K., Fitzsimmons, J.N., Lam, P.J., Jensen, L.T., Xiang, Y., Gartman, A., Cherkashov, G., Hutchinson, D.R. and Till, C.P. (2017) Arctic Deep Water Ferromanganese-Oxide Deposits Reflect the Unique Characteristics of the Arctic Ocean. Geochemistry, Geophysics, Geosystems 18, 3771-3800.
- Heller, M.I., Lam, P.J., Moffett, J.W., Till, C.P., Lee, J.-M., Toner, B.M. and Marcus, M.A. (2017) Accumulation of Fe oxyhydroxides in the Peruvian oxygen deficient zone implies non-oxygen dependent Fe oxidation. Geochimica et Cosmochimica Acta 211, 174-193.
- Kipp, L.E., Charette, M.A., Moore, W.S., Henderson, P.B. and Rigor, I.G. (2018) Increased fluxes of shelf-derived materials to the central Arctic Ocean. Science Advances 4, 10.1126/sciadv.aao1302.
- Lerner, P., Marchal, O., Lam, P.J., Buesseler, K. and Charette, M. (2017) Kinetics of thorium and particle cycling along the U.S. GEOTRACES North Atlantic Transect. Deep Sea Research Part I: Oceanographic Research Papers 125, 106-128.
- Lupton, J.E. and Jenkins, W.J. (2017) Evolution of the south Pacific helium plume over the past three decades. Geochemistry, Geophysics, Geosystems 18, 1810-1823.
- Marconi, D., Sigman Daniel, M., Casciotti Karen, L., Campbell Ethan, C., Alexandra Weigand, M., Fawcett Sarah, E., Knapp Angela, N., Rafter Patrick, A., Ward Bess, B. and Haug Gerald, H. (2017) Tropical dominance of N2 fixation in the North Atlantic Ocean. Global Biogeochemical Cycles 31, 1608-1623.
- Mukherjee, P., Glamoclija, M. and Gao, Y. (2018) Insignificant impact of freezing and compaction on iron solubility in natural snow. Journal of Atmospheric Chemistry, 10.1007/s10874-10018-19375-10872.
- Noble, A.E., Ohnemus, D.C., Hawco, N.J., Lam, P.J. and Saito, M.A. (2017) Coastal sources, sinks and strong organic complexation of dissolved cobalt within the US North Atlantic GEOTRACES transect GA03. Biogeosciences 14, 2715-2739.
- Saito, M.A., Noble, A.E., Hawco, N., Twining, B.S., Ohnemus, D.C., John, S.G., Lam, P., Conway, T.M., Johnson, R., Moran, D. and McIlvin, M. (2017) The acceleration of dissolved cobalt's ecological stoichiometry due to biological uptake, remineralization, and scavenging in the Atlantic Ocean. Biogeosciences 14, 4637-4662.
- Schroth, A.W., Crusius, J., Gassó, S., Moy, C.M., Buck, N.J., Resing, J.A. and Campbell, R.W. (2017) Atmospheric deposition of glacial iron in the Gulf of Alaska impacted by the position of the Aleutian Low. Geophysical Research Letters 44, 5053-5061.
- Shelley, R.U., Roca-Martí, M., Castrillejo, M., Masqué, P., Landing, W.M., Planquette, H. and Sarthou, G. (2017) Quantification of trace element atmospheric deposition fluxes to the Atlantic Ocean (>40°N; GEOVIDE, GEOTRACES GA01) during spring 2014. Deep Sea Research Part I: Oceanographic Research Papers 119, 34-49.
- Shiller, A.M., Chan, E.W., Joung, D.J., Redmond, M.C. and Kessler, J.D. (2017) Light rare earth element depletion during Deepwater Horizon blowout methanotrophy. Sci Rep 7, 10389.
- Tang, Y., Stewart, G., Lam, P.J., Rigaud, S. and Church, T. (2017) The influence of particle concentration and composition on the fractionation of 210Po and 210Pb along the North Atlantic GEOTRACES transect GA03. Deep Sea Research Part I: Oceanographic Research Papers 128, 42-54.

- Till, C.P., Shelley, R.U., Landing, W.M. and Bruland, K.W. (2017) Dissolved scandium, yttrium, and lanthanum in the surface waters of the North Atlantic: Potential use as an indicator of scavenging intensity. Journal of Geophysical Research: Oceans 122, 6684-6697.
- Woosley, R.J., Millero, F.J. and Takahashi, T. (2017) Internal consistency of the inorganic carbon system in the Arctic Ocean. Limnology and Oceanography: Methods 15, 887-896.

Although not yet officially published, we draw attention to the following paper online that will be of interest to GEOTRACES investigators working in the North Atlantic Ocean.

Holzer, M., Smethie, W. M., & Ting, Y.-H. (2018). Ventilation of the subtropical North Atlantic: Locations and times of last ventilation estimated using tracer constraints from GEOTRACES section GA03. Journal of Geophysical Research: Oceans, 123. https://doi.org/10.1002/ 2017JC013698

Dissertations

- Black, E.E.. 2018. PhD. An investigation of basin-scale controls on upper ocean export and remineralization, MIT-WHOI Joint Program, Woods Hole, MA.
- Wambaugh, Z. 2017. M.S. in Ocean and Earth Sciences. Thesis Title: Selenium distribution and cycling in the eastern equatorial Pacific Ocean. Old Dominion University.
- McQuiggan, K. A. 2018. M.S. in Ocean and Earth Sciences. Thesis Title: Biogeochemical cycling of selenium in the western Arctic Ocean. Old Dominion University.
- Mukherjee, P. 2018. P.D. Thesis title: Investigation of chemical and physical processes on Arctic aerosols through a combined approach of field and laboratory studies. Rutgers University.

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