GEOTRACES SCIENTIFIC STEERING COMMITTEE
ANNUAL REPORT TO SCOR 2016/2017

May 2017

ANNEX – NATIONAL REPORTS

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN AUSTRALIA

May 1st, 2016 to April 30th, 2017

New scientific results

The GEOTRACES Process Study 'K-Axis' ("Assessment of habitats, productivity and food webs on the Kerguelen Axis in the Indian Sector of the Southern Ocean") in 2016 examined the principal drivers of ecosystem structure and processes around the southern Kerguelen plateau and included a trace element biogeochemistry component. Depth-profiles of dissolved iron (<0.2 μm, dFe) to a depth of 2000 m were measured at 25 stations in the vicinity of Banzare Bank in the Indian sector of the Southern Ocean during austral summer 2016. Observed dFe concentrations in surface waters (≤100 m depth) ranged from below the detection limit (DL= 0.042 ± 0.027 nmol kg^{-1}) to 0.34 nmol kg^{-1}, with almost 50% of values below DL. Such low dFe values suggest drawdown of this essential micronutrient by phytoplankton over the summer. At depth (300-2000 m), the median dFe concentration was 0.28 nmol kg^{-1}, with maximum values near the coast (up to 1.27 nmol kg^{-1}). The cruise track crossed several fronts, enabling us to sample water masses reaching from south of the Southern Boundary (SB) to north of the south Antarctic Circumpolar Current front (sACCf). Observed dFe distributions and analysis of the physical oceanography in the region indicate a diverse mosaic of dFe supply mechanisms. We also note distinct contrasts between: (i) the 'southern' Banzare bank Fe supply, where waters South of the bank are mainly supplied from the Antarctic shelf and sea ice sources, while upwelling and divergence around the flanks and in the Princess Elizabeth Trough (PET) result in sustained phytoplankton blooms in the PET and around the flanks of Banzare bank, and (ii) the 'northern' Kerguelen Plateau where sediment and glaciers deliver Fe over the shallow and well-mixed plateau and horizontal transports deliver Fe downstream in the plume, resulting in a sustained phytoplankton bloom over the plateau compared to a "bloom and bust" in the plume.

New publications (published or in press)

- 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): 167-173.
- Boyd, P.W. and Bressac, M., 2016. Developing a test-bed for robust research governance of geoengineering: the contribution of ocean iron biogeochemistry. Philosophical Transactions of the Royal Society A, 374(2081), pp.20150299–22.
- Durand, A., Chase, Z., Townsend, A.T., Noble, T., Panietz, E. and Goemann, K. 2016. Improved methodology for the microwave digestion of carbonate-rich environmental samples. International Journal of Environmental Analytical Chemistry, pp.1–19.
- Hassler, C.S., van den Berg, C.M.G., and P.W. Boyd. 2017. Toward a Regional Classification to Provide a More Inclusive Examination of the Ocean Biogeochemistry of Iron-Binding Ligands, Front. Mar. Sci., 01, https://doi.org/10.3389/fmars.2017.00019
- Holmes, T.M., Chase, Z., van der Merwe, P., Townsend, A.T., Bowie, A.R. In Revision. The impact of hydrothermal vents on ocean iron concentrations and biogeochemistry: a review. Marine and Freshwater Research.

- Hutchins, D.A. and Boyd, P.W., 2016. Marine phytoplankton and the changing ocean iron cycle. Nature Climate Change, 6(12), pp.1072–1079.
- Heller, M.I., Wuttig, K. and Croot, P. L. 2016. Identifying the Sources and Sinks of CDOM/FDOM across the Mauritanian Shelf and Their Potential Role in the Decomposition of Superoxide (O_2^-). Front. Mar. Sci. 3:132. doi:10.3389/fmars.2016.00132
- Lannuzel, D., Chever, F., van der Merwe, P., Janssens, J., Roukaerts, A., Cavagna, A.J., Townsend, A.T., Bowie, A.R., and Meiners, K.M. 2016. Iron biogeochemistry in Antarctic pack ice during SIPEX2, Deep Sea Research II, 131 pp. 111-122.
- Lemaitre, N., Planquette, H., Dehairs, F., van der Merwe, P., Bowie, A.R., Trull, T.W. Laurenceau-Cornec, E.C., Davies, D., Bollinger, C., Le Goff, M., Grossteffan, E., and Planchon, F. 2016. Impact of the natural Fe fertilization on the magnitude, stoichiometry and efficiency of particulate biogenic silica, nitrogen and iron export fluxes", Deep Sea Research. Part 1, 117 pp. 1127.
- Ratnarajah, L. and Bowie, A.R., Nutrient cycling: are Antarctic krill a previously overlooked source in the marine iron cycle? 2016. Current Biology, 26 (19) pp. R884–R887.
- Ratnarajah, L., Nicol, S., Kawaguchi, S., Townsend, A.T., Lannuzel, D., Meiners, K.M. and Bowie, A.R. 2016. Understanding the variability in the iron concentration of Antarctic krill, Limnology and Oceanography, 61 (5) pp. 1651-1660.
- Samanta, M., Ellwood, M.J., Sinoir, M. and Hassler, C.S. In Press. Dissolved zinc isotope cycling in the Tasman Sea, SW Pacific Ocean. Marine Chemistry. http://doi.org/10.1016/j.marchem.2017.03.004
- Schallenberg, C., van Der Merwe, P., Chever, F., Cullen, J.T., Lannuzel, D., and Bowie, A.R. 2016. Dissolved iron and iron(II) distributions beneath the pack ice in the East Antarctic (120 °E) during the winter/spring transition, Deep Sea Research: Part II, 131 pp. 96–110.
- Scholz, F., Löscher, C. R., Fiskal, A., Sommer, S., Hensen, C., Lomnitz, U., Wuttig, K., Göttlicher, J., Kossel, E., Steininger, R., and Canfield, D. E. 2016. Nitrate-dependent iron oxidation limits iron transport in anoxic ocean regions. Earth and Planetary Science Letters 454: 272-281
- Sinoir, M., Ellwood, M.J., Butler, E.C.V., Bowie, A.R., Mongin, M., and Hassler, C.S. 2016. Zinc cycling in the Tasman Sea: Distribution, speciation and relation to phytoplankton community. Marine Chemistry 182, 25-37.
- Tagliabue, A., Bowie, B., Boyd, P., Buck, K., Johnson, K., and Saito, M. 2016. The integral role of iron in ocean biogeochemistry. Nature 543, 51–59, doi:10.1038/nature21058
- Velasquez, I.B., Ibisanmi, E., Maas, E.W., Boyd, P.W., Nodder, S. and Sander, S.G. 2016. Ferrioxamine Siderophores Detected amongst Iron Binding Ligands Produced during the Remineralization of Marine Particles, Front. Mar. Sci., 22 September 2016 | https://doi.org/10.3389/fmars.2016.00172
- Villa-Alfageme, M., Mas, J.L., Hurtado-Bermudez, S., and Masqué, P. 2016. Rapid determination of ^{210}Pb and ^{210}Po in water and application to marine samples, Talanta, Volume 160, Pages 28-35, https://doi.org/10.1016/j.talanta.2016.06.051.
- Winton, V.H.L., Edwards, R., Bowie, A.R. Keywood, M., Williams, A.G., Chambers, S.D., Selleck, P.W., Desservettaz, M., Mallet, M.D. and Paton Walsh, C. 2016. Dry season

aerosol iron solubility in tropical northern Australia. Atmospheric Chemistry and Physics, 16 (19) pp. 1282912848. ISSN 16807316 (2016)

Cruises

Voyages completed:

- *RV Akademik Tryoshnikov*: Leg 1, 20 December 2016 – 17 January 2017. Southern Ocean (GEOTRACES PI: Ellwood).
- *RV Aurora Australis* Voyage V1, December – January 2017, Antarctica, Mertz glacier region (GEOTRACES PIs: Lannuzel, Noble). Sea water and sea-ice samples were collected for micro-nutrient and Nd isotope measurements.
- *RV Investigator*, Jan – March 2017, Sabrina Seafloor Survey Antarctic margin (Totten glacier) (GEOTRACES PI: Noble). Sediment cores and large-volume seawater samples for Nd isotopic analysis were collected to investigate the interaction of the Totten Glacier with the Southern Ocean during the last deglaciation
- *RV Investigator* March 2017. Subantarctic Biogeochemistry of Carbon and Iron, Southern Ocean Time Series site (GEOTRACES PIs: Boyd, Ellwood, Bowie). Collected dissolved and particulate trace metal samples. First successful deployment of the RESPIRE particle interceptor trap, for coupled measurement of trace metal remineralization and respiration rates.

Voyages scheduled for the next 12 months:

- SR3-GEOTRACES repeat transect (GEOTRACES PI: Bowie) "Detecting Southern Ocean Change From Repeat Hydrography, Deep Argo And Trace Element Biogeochemistry" (Southern Ocean section from Tasmania to Antarctica) voyage in January/February 2018 (45 days). The SR3 section was previously occupied during IPY-GEOTRACES in 2008, and we have the opportunity to expand the GEOTRACES measurements and spatial resolution on the 2018 voyage. To be proposed as full GEOTRACES section
- SOTS time series (GEOTRACES PIs: Boyd, Ellwood, Bowie) "Subantarctic Biogeochemistry of Carbon and Iron, Southern Ocean Time Series site" (Subantarctic Southern Ocean south of Tasmania voyage in March 2018 (20 days)
- Two transit voyages around Australia under the project "Natural iron fertilisation of oceans around Australia: linking terrestrial dust and bushfires to marine Biogeochemistry" (PI Bowie) will provide GEOTRACES compliant aerosol data

New projects and/or funding

- ARC DP170102108 "Spinning the ferrous wheel: how is iron cycled in Southern Ocean waters?" Ellwood, Boyd, Armand, Wilhelm, Twining
- ARC LIEF funding, "A multi-institutional environmental radioactivity research centre" GEOTRACES CIs Masque, Boyd, Chase

Two shiptime awards for 2018-19 season:

- PIs Ellwood, Boyd, Chase, Abbott, Bowie. "Constraining external iron inputs and cycling in the southern extension of the East Australian Current", $2,185k in kind (23 days shiptime on *RV Investigator* in 2018-19)

- PIs Boyd, Ellwood, Bowie. "Surface and subsurface subantarctic Biogeochemistry of Carbon and Iron, Southern Ocean Time Series site", $1,520k (16 days shiptime on *RV Investigator* in 2018-19)

PhD theses

- Moneesha Samanta (submitted): Zinc isotopes as a tool to investigate zinc biogeochemical cycling in the SW Pacific Ocean, Australian National University
- Lavenia Ratnarajah, 2017. Effects of natural iron fertilisation by baleen whales and Antarctic krill on the Southern Ocean carbon cycle, University of Tasmania. Supervisors: Bowie, Lannuzel, Nicol, Meiners
- Axel Durand, 2017. Ocean Deoxygenation, a paleo-proxy perspective, University of Tasmania. Supervisors: Chase, Noble, Townsend, Bindoff
- Scott Meyerink (2016): Effects of Iron limitation on Silicon Metabolism and Silicon Isotopic Discrimination in Southern Ocean Diatoms, Australian National University

Meetings

Australian GEOTRACES scientists co-authored and presented results at the following meetings, including Goldschmidt 2016, AGU Fall Meeting 2016, SCAR 2016 and the Gordon Research Conference on Ocean Biogeochemistry 2016:

- Constable et al., 2016. Assessing Antarctic marine food webs on the Kerguelen Axis. SCAR Open Science Conference, Malaysia 2016.
- Noble et al., 2016. Testing the ice-ocean feedback mechanism: Reliable extraction of proxy data from surface sediments on the East Antarctic Margin. SCAR Open Science Conference, Malaysia 2016.
- Noble et al., 2016. Tracing Antarctic Bottom Water formation in the Adélie and George V Land: A proxy calibration study. International Conference on Paleoceanography, Utrecht. 2016
- Gonzalez et al., 2016. Fe and Cu organic ligands in natural incubation experiments. XVIII Seminario Ibérico de Química Marina. 20-22 July 2016. Universidad de Alicante. http://www.vsimposioccmar.com/seminario-iberico-de-quimica-marina
- Townsend et al., 2016. Novel resin extraction and preconcentration methods for the analysis of trace metals in open ocean seawater samples with sector field ICP-MS detection. RACI Australian Analytical and Environmental Conference, Adelaide July 2016
- Cabanes et al., 2016. Iron speciation and distribution of "usual suspects" binding ligands along the GEOTRACES (GP13) southwestern Pacific section. Gordon Research Conference on Ocean Biogeochemistry. June 12-17, The Chinese University of Hong Kong. https://www.grc.org/programs.aspx?id=17297
- Hassler et al., 2016. Linking nutrients to phytoplankton in the Pacific Ocean. Gordon Research Conference on Ocean Biogeochemistry. June 12-17, The Chinese University of Hong Kong. https://www.grc.org/programs.aspx?id=17297
- Bowie et al., 2016. The distribution of dissolved trace elements across a zonal section of the southwest Pacific Ocean. Goldschmidt 2016, Yokohama, Japan. 26 June - 1 July 2016.

- Ellwood et al., 2016. The Distribution of Dissolved Iron and Nutrients Across a South Pacific Zonal Section. Goldschmidt 2016, Yokohama, Japan. 26 June - 1 July 2016.
- Chase et al., 2016. Late summer distribution and stoichiometry of dissolved N, Si and P in the south central Kerguelen Plateau, Southern Ocean. AGU Fall Meeting, San Francisco, 12-16 December 2016. https://fallmeeting.agu.org/2016/
- Coffin et al., 2016. Volcanism, Iron, and Phytoplankton in the Heard and McDonald Islands Region, Southern Indian Ocean. AGU Fall Meeting, San Francisco, 12-16 December 2016.
- Watson et al., 2016. Submarine geology and geomorphology of active sub-Antarctic volcanoes: Heard and McDonald Islands. AGU Fall Meeting, San Francisco, 12-16 December 2016.
- Holmes et al., 2016. Iron speciation in proximity to an active volcanic hotspot, Kerguelen Plateau, Southern Ocean. AGU Fall Meeting, San Francisco, 12-16 December 2016.
- Spain et al., 2016. Heard Island and McDonald Islands acoustic plumes: split-beam echo sounder and deep tow camera observations of gas seeps on the Central Kerguelen Plateau. AGU Fall Meeting, San Francisco, 12-16 December 2016.
- Schofield et al., 2016. AIRBOX - a mobile air chemistry laboratory. Australian Meteorological and Oceanographic Society (AMOS) and Meteorological Society of New Zealand (MSNZ), in conjunction with the Australian/New Zealand Climate Forum (ANZCF) from Tuesday 7 to Friday 10 February 2017. Australian National University.

Outreach activities

- HEOBI voyage IN2016_v01 Subsea Volcanoes, Discovery Channel, V310305_SUBSEA_VOLCANOES_SA. Posted by: Shelley Ayres, date Posted: Jun 16, 2016 at 09:18. https://review.bellmedia.ca/view/1191292658
- ABC News article summarising the *RV Investigator* voyage to Antarctic waters (Sabrina Coast), and radio interview with Taryn Noble on the local ABC 06/03/17: http://www.abc.net.au/news/2017-03-06/antarctic-mission-hobart-tasmania-csiros-investigator-icebreaker/8328096

Other activities

- Philip Boyd was awarded the ASLO G. Evelyn Hutchinson Award for 2017 "*For his pioneering work on the complex interactions of biogeochemistry, climate change multiple drivers, and their impacts on ocean planktonic ecosystems*."

Submitted by Zanna Chase (Zanna.Chase@utas.edu.au).

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN BELGIUM

May 1st, 2016 to April 30th, 2017

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)

- Fonseca-Batista, D., Dehairs, F., Riou, V., Fripiat, F., Elskens, M., Deman, F., … Auel, H. (2017). Nitrogen fixation in the eastern Atlantic reaches similar levels in the Southern and Northern Hemisphere. Journal of Geophysical Research: Oceans, 122, 4618–4632. https://doi.org/10.1002/2016JC011775.
- Lemaitre N., H. Planquette, F. Planchon, F. Dehairs, P. van der Merwe, A. Bowie, T.W. Trull, C. Bollinger, M. Le Goff, E. Grossteffan, 2016. Impact of the natural Fe-fertilization on the magnitude, stoichiometry and efficiency of PN, BSi and PFe export fluxes, Deep-Sea Research, I, 117, 11-27.
- Charette M.A., P.J. Lam, M.C. Lohan, E.Y. Kwon, V. Hatje, C. Jeandel, A.M. Shiller, G.A. Cutter, A. Thomas, P.W. Boyd, W.B. Homoky, A. Milne, H. Thomas, P.S. Andersson, D. Porcelli, T. Tanaka, W. Geibert, F. Dehairs, J. Garcia Orellana, 2016. Coastal ocean and shelf-sea biogeochemical cycling of trace elements and isotopes: lessons learned from GEOTRACES 2, Proceedings of the Royal Society of Sciences, A, 374:20160076, http://dx.doi.org/10.1098/rsta.2016.0076.
- Roukaerts A., A.-J. Cavagna, F. Fripiat, D. Lannuzel, K. Meiners and F. Dehairs, 2016. Sea-ice algal primary production and nitrogen uptake rates off East Antarctica, Deep Sea Research II, 131, 140-149, http://dx.doi.org/10.1016/j.dsr2.2015.08.007.

New publications (submitted)

Fonseca-Batista D., Riou V., Michotey V., Fripiat F., Li X., Deman F., Guasco S., Brion N., Elskens M., Chou L., Dehairs F. Significant N_2 fixation in productive waters of the temperate Northeast Atlantic, in review for *Frontiers in Marine Sciences*

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.

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

- Lemaitre Nolwenn: Multi-proxy approach (^{234}Th, Ba_{xs}) of export and remineralization fluxes of carbon and biogenic elements associated with the oceanic biological pump, Joint PhD Université de Bretagne Occidentale, IUEM and Vrije Universiteit Brussel, 2017, 332 pp.
- Arnout Roukaerts: Primary production and nutrient cycling in Antarctic sea-ice and open waters. To be submitted summer 2017.
- Debany Fonseca Batista: Contribution of N2 fixation to primary and new production in the Atlantic Ocean. Finalized, spring 2017.
- 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. To be finalized in 2018.
- 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). Started in Dec 2016.
- Audrey Plante: Study of marine benthic hypoxia and its consequences on the exchange at the sediment-water interface and diagenesis.

Meetings

- Lemaitre N., H. Planquette, F. Dehairs, M. Leermakers, L. Monin, L. André and F. Planchon, 2016. Carbon export fluxes along the GEOVIDE transect in the North Atlantic (GEOTRACES GA01), Ocean Sciences 2016, New Orleans. Feb. 2016
- Dehairs F., N. Lemaitre, H. Planquette, L. Monin, L. André, S. Jacquet and F. Planchon, 2016. Mesopelagic carbon remineralization along the GEOVIDE transect in the North Atlantic (GEOTRACES GA01), Ocean Sciences 2016, New Orleans. Feb 2016
- Fonseca Batista D., F. Fripiat, F. Deman and F. Dehairs, 2016. Nitrate isotopic composition across a North-South transect in the Eastern Atlantic Ocean: Significance of nitrogen input through N2 fixation, Ocean Sciences 2016, New Orleans. Feb 2016

- Deman F., A. Roukaerts, B. Delille, F. Fripiat, D. Lannuzel, J.-L. Tison and F. Dehairs, 2016. A time-series study during spring transition in the fast ice at Davis Station, Antarctica: Preliminary results, CHINARE Meeting, Wuhan, China, Oct 2016.
- Fripiat F., M. Declercq, C. Sapart, F. Deman, D. Fonseca-Batista, C. Merten, A. Roukaerts, J.-L. Tison, M. Walter and F. Dehairs. Nitrogen cycle inferred from N and O isotopes in a changing Arctic Ocean, JESIUM, Ghent, Belgium, Sept 2016.
- Plante A., N. Roevros, A. Capet, M. Grégoire, N. Fagel and L. Chou (2017) Benthic hypoxia and early diagenesis in the Black Sea shelf sediments. Poster presentation, EGU, 23-28 April 2017, Vienna, Austria.
- Thomas H., F. Dehairs and J. Mol, 2017. Shelf Exchange Processes of CO2, Ra, and Ba in the Canadian Arctic Archipelago, Geophysical Research Abstracts, Vol. 19, EGU2017-5445, 2017. EGU General Assembly 2017.
- Deman F., D. Fonseca-Batista, F. Fripiat, E. Le Roy, D. Nuwam Thilakarathne, N. Lemaitre, A Roukaerts and F. Dehairs, 2017. N2-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 N2 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.

Submitted by Frank Dehairs (Vrije Universiteit Brussel) and Lei Chou (Université Libre de Bruxelles).

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN BRAZIL

May 1st, 2016 to April 30th, 2017

Activities

• Three activities related to GEOTRACES occurred during the Brazilian Conference on Oceanography (www.CBO2016.org), which was held in Salvador November 5-9, 2016. Those activities were:

1. The GEOTRACES session: 12 oral presentations and 3 posters;
2. II GEOTRACES BRAZIL meeting. This meeting followed the actions initiated in 2015 with the aim to bring Brazilian scientists together to plan activities and promote collaborations to increase participation in the scope of the GEOTRACES program;
3. Ocean Data View (ODV) hands-on workshop. This 8 hours workshop presented the basic ODV methods for the analysis of environmental data. The GEOTRACES Intermediate Data Product 2014 (IDP2014) and the Surface Ocean CO_2 Atlas (SOCAT) were used as examples.

- We were successful to secure the participation of GEOTRACES investigators (Catherine Jeandel, Gideon Henderson, Peter Croot, Antonio Cobelo-Garcia and Felipe Niencheski) as invited speakers for the 46th World Chemistry Congress (IUPAC-2017) to be held in São Paulo, Brazil between July 9th to July 14th.
- The Scientific Committee on Oceanic Research (SCOR) awarded US$2500 towards sponsoring a three weeks visit by C. Jeandel to Salvador, Brazil in order to teach a course on marine geochemistry and the use of isotopic dilutions.
- V. Hatje is a Full Member of SCOR Working Group 145: Modelling Chemical Speciation in Seawater to Meet 21st Century Needs (MARCHEMSPEC).

Projects/grants

- A proposal to fund the Research and Development Network in Non-conventional Gas – GASBRAS, was approved by FINEP in January 2015. The proposal will cover the purchase of an ICP-MS ICAP RQ to be installed at the Federal University of Bahia.
- The renew proposals of the National Institute for Science and Technology in Tropical Environments/ INCT-Ambtropic and the Institute for the Science and Technology in Energy and Environment/ INCT- E&A were approved by CNPq. However, the payment of funds is delayed.
- Research in Brazil has taken a heavy toll from the economic crisis. The 2017 Federal Science budget decreased in 44%, being the lowest in the past 12 years. Many of the research grants awarded in 2016 have not yet been paid by CNPq and State funding agencies. The exchange programme to enable Brazilian students and scientists to visit leading institutions abroad, although resumed is investing a very small amount of resources.

Cruises

- One expedition was performed along the continental shelf of Bahia which included sample collection of surface and bottom waters to evaluate the impacts of anthropogenic and natural sources of REE and dissolved trace elements in coastal waters (CNPq 441829/2014-7).
- Four cruises, between 15N and 23S, will be carried out in partnership with the PIRATA-BR XVII on the new R/V Vital de Oliveira. We will share the hydrographic data with PIRATA scientists, and we will collect water samples at 12 full depth profiles (Fig.1). The ship still do not have trace metal sampling system, hence water samples will be collected only for the determination of REE and Ra isotopes (at least in one cruise). We are still evaluating the possibility to determine Nd isotopes.

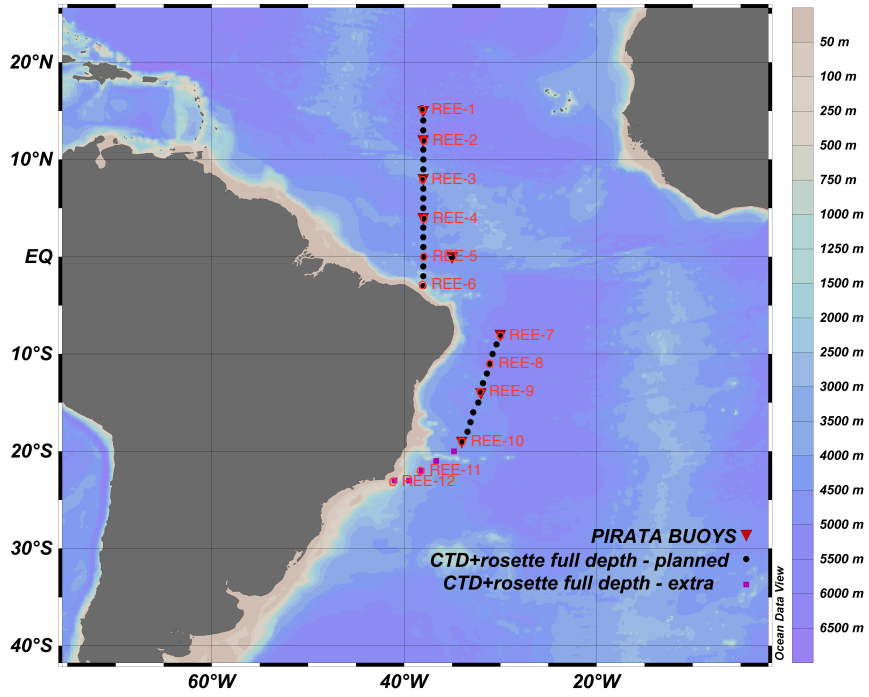

Figure 1. *Location of the 12 full depth profiles (REE1-12) that will be performed during the PIRATA-Br XVII where a single hydrograhic cast will sample seawater for selected hydrography stations parameters, REE, sulfluramid and perfluorooctanesulfonate (PFOS) dissolved oxygen.*

- Two expeditions were postponed due to lack of funding.

GEOTRACES-related articles

- Turner, D.; Achterberg, E. P.; Chen, C. A.; Clegg, S.; Hatje, V.; Maldonado, M.; Sander, S. G.; Berg, C. M. V. D.; Wells, M. Towards a quality-controlled and accessible Pitzer model for seawater and related systems. Frontiers in Marine Science, v. 3, p. 139, 2016.
- Charette, M.S.; Harette, M. A.; Lam, P. J.; Lohan, M. C.; Kwon, E. Y.; Hatje, V.; Jeandel, C.; Shiller, A. M.; Cutter, G. A.; Thomas, A.; Boyd, P.W.; Homoky, W. B.; Milne, A.; Thomas, H.; Andersson, P. S.; Porcelli, D.; Tanaka, T.; Geibert, W.; Dehairs, F.; Garcia-

Orellana, J. Coastal ocean and shelf-sea biogeochemical cycling of trace elements and isotopes: lessons learned from GEOTRACES. Philosophical Transactions of the Royal Society A- Mathematical Physical and Engineering Sciences, v. 374, 20160076, 2016.

Contributions to conferences

- GEOTRACES presentations and co-authorships by Brazilian Scientists at the following meetings: AGU Fall Meeting (San Francisco, USA, Dec 2016), CBO 2016 (Salvador, Brazil, Nov 2016).

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

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN CANADA

May 1, 2016 – April 30, 2017

Accomplishments

The Canadian GEOTRACES group had our first synthesis meeting coincident with the ArcticNet's 12th annual scientific meeting held in Winnipeg Manitoba Dec. 5-9th, 2016. The meeting was hosted by Dr. Feiyue Wang at the Centre for Earth and Ocean Science at the University of Manitoba and the Convention Centre Dec. 5-7th. The meeting provided the first opportunity for the group to bring together observations made on our Arctic research expedition completed on two legs aboard the Canadian Coast Guard Ship Amundsen in 2015. The first leg covered the Labrador Sea, Baffin Bay and Canadian Arctic Archipelago (July 10-August 10) and the second the Beaufort Sea (September 4-October 1st). Over the three days the project was able to hear updates from individual PI's and the highly qualified personnel, compare results and discuss plans for the future with respect to ongoing analysis and synthesis of project specific and core GEOTRACES parameters. To facilitate data synthesis activities we are using the UBC Workspace 2.0 cloud based file sharing service that provides secure data management capabilities. It is made available free of charge (50GB limit) to UBC faculty and collaborators. We are using this site as a working space and transitory data storage before submission to the international GEOTRACES Data Assembly Center. 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 project will have its next synthesis meeting in May 2017 at the Peter Wall Institute, University of British Columbia.

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

Susan Allen, Department of Earth, Ocean and Atmospheric Science, University of British Columbia

Summary

We have modelled four tracers in the Arctic Ocean using the ANHA Model from Paul Myers Group at University of Alberta. Barium concentration and del^{18}O illustrate the changes in freshwater circulation, showing strong influence of large scale atmospheric patterns. The model of ^{230}Th shows that observed changes in the Canadian Basin are a result of a switch in direction of the Atlantic layer circulation. We have also modelled ^{231}Pa and are in the process of modelling Manganese, Lead and Gallium. We are coordinating with observationalists: particularly with respect to ^{230}Th and Manganese and Gallium.

Conference Presentations

- Yu X, Allen S, Hu X, Myers P. (2015). Intermediate and deep water circulation changes in the Arctic.
- (2002-2013): Inferred from the distribution of 231Pa/230Th in the water column. Arcticnet Annual Science Meeting, Vancouver, Canada.

- Sha Y, Allen S, Hu X, Myers P. (2015). A simulation study of dissolved Barium and Oxygen isotope ratio in the Arctic. ArcticNet Annual Science Meeting, Vancouver, Canada.
- Yu X, Allen S, Hu X, Myers P. (2016). Intermediate and deep water circulation in the Arctic Ocean
- (2002-2013): Inferred from the distribution of 231Pa/230Th in the water column. Canadian Meteorological and Oceanographic Society Congress, Fredericton, Canada.
- Sha Y, Allen S, Hu X, Myers P. (2016). A simulation study of dissolved Barium and Oxygen isotope ratio in the Arctic. Canadian Meteorological and Oceanographic Society Congress, Fredericton, Canada.
- Grenier M., R. Francois, M. Rutgers van der Loeff, X. Yu, M. Soon, S. B. Moran, R. L. Edwards, Y. Lu, K. Lepore, X. Hu, P. Myers, and S. E. Allen. Arctic circulation changes in the Atlantic layer from dissolved 230Th profiles measured over the last 4 decades. Aquatic Sciences Meeting, Honolulu, (Hawaii, USA), February 2017.

Roberta Hamme, School of Earth and Ocean Sciences, University of Victoria

Conference Presentations

- Timmerman, A.H.V., Hamme, R.C., Miller, L.A., Francois, R., Soon, M., Giesbrecht, K.E., Varela D.E. (2017) Spatial variability of carbon export from sub-Arctic to the Arctic Ocean (Oral Presentation) ALSO (International), Honolulu, Hawaii.
- Timmerman, A.H.V., Hamme, R.C. (2016) Comparing primary production methods to better constrain historical, current and future rates. (Poster). OSM (International), New Orleans, Louisiana.

Outreach Activities

- Timmerman, A.H.V. (2016) Do the oceans matter to us? (Oral Presentation) Golden Rods and Reels, Victoria, BC.
- Timmerman, A.H.V. (2016) Do the oceans matter to us? (Oral Presentation) Lansdowne Middle School, Victoria, BC.
- Timmerman, A.H.V. (2017) Oceanographic research (Oral Presentation) University of Victoria undergraduate course, Victoria, BC.

Chris Holmden, University of Saskatchewan

Refereed Journal Publications

- Scheiderich, K., Amini M., Holmden, C., and Francois R. (2015) Global variability of chromium isotopes in seawater demonstrated by Pacific, Atlantic and Arctic Ocean samples. Earth Planet. Sci. Lett. 423, 87–97

Conference Presentations (invited)

- Holmden C., Scheiderich K., Amini M. and Francois, R. Cr isotope variability in the oceans: implications for the Cr isotope proxy. Invited talk: Goldschmidt Geochemistry Conference 2015, Prague, Czech Republic.
- Holmden C, Scheiderich K, Amini M & Francois R., Bacconais I. (2015) A Cr isotope proxy for ocean deoxygenation. Invited. AGU Fall Meeting, San Francisco, PP31F-02

Conference Presentations

- Baconnais I, Holmden C., and Francois R. Chromium isotope variability in modern ocean. Goldschmidt Abstracts, 2016, 137

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

Summary

We have analyzed several thousand bottle cast samples for a number of conservative and non-conservative tracers (e.g., S, T, $\delta^{18}O(H_2O)$, $\delta^{13}C(DIC)$, TA) and combined those with data (e.g., nitrate, SRP, O_2) 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). In addition, 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, in the Canada Basin, the ACD is being eroded from above by the increasing atmospheric pCO_2 and from below by intrusions of acidified North Atlantic Ocean waters (Luo et al., 2016).

Refereed Journal Publications

- 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.

Media Coverage and Outreach Activities

- **Public lecture:**
  Menace au large : L'acidification des océans
  https://coeurdessciences.uqam.ca/component/content/article/7-menu-horizontal/30-videos.html, Cœur des Sciences-UQAM, February 18, 2016

- **Media interviews:**
  Menace au large : L'acidification des océans, Canal Savoir, video interview with Sophie Malavoy, https://coeurdessciences.uqam.ca/component/content/article/7-menu-horizontal/30-videos.html, Cœur des Sciences-UQAM, February 18, 2016

  L'acidification des oceans, CKUT, interview with Julie Robert, February 18, 2016

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

Summary

Accomplishments to date include making improvements to our Arctic and Northern Hemisphere Atlantic (ANHA) configuration of NEMO. These include an improved river routing/freshwater discharge scheme, online passive tracers, Greenland melt inclusion, addition of a Lagrangian ice berg module, and coupling to the biogeochemical model BLING. The end result is model simulations, especially at 1/12 degree resolution, that compare very well with a broad suite of observational metrics through the Canadian Arctic and beyond. Research directions over the reminder of the project include further analysis of the model fields, focussing on transports and pathways through the CAA, as well as impact of Arctic freshwater on Baffin Bay and the sub-polar North Atlantic. We will also continue to provide model fields to all other groups who may wish to use them in their analysis of observational data.

Refereed Journal Publications

- Evolution of Baffin Bay water masses and transports in a sensitivity numerical experiment, including climate change conditions and Greenland runoff, N Grivault, X Hu and PG Myers, Atmosphere-Ocean, in press
- Water mass modification and mixing rates in a 1/12° simulation of the Canadian Arctic Archipelago KG Hughes, JM Klymak, X Hu, PG Myers, Journal of Geophysical Research: Oceans
- Potential positive feedback between Greenland Ice Sheet melt and Baffin Bay heat content on the west Greenland shelf, L Castro de la Guardia, X Hu, PG Myers, Geophysical Research Letters 42 (12), 4922-4930

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

Refereed Journal Publications

- 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 WG 139).

Conference Presentations

- Nixon, R.L., Ross, A.R.S. 2016. Evaluation of IMAC and Electrospray Ionization Mass Spectrometry for Recovery and Analysis of Copper-binding Ligands in Seawater. 18th Ocean Sciences Meeting, New Orleans LA, 21-26 February.

Summary

During 2016-17 we completed the development and evaluation of a novel method for recovering and analyzing organic ligands from seawater using immobilized metal-ion affinity chromatography (IMAC) and tandem mass spectrometry (MS/MS). The method was the subject of an oral presentation given by CCAR-funded graduate student Richard Nixon at the 2016 Ocean Sciences Meeting in New Orleans. A paper describing this work was also published as a Methods paper in a special issue of Frontiers Marine Biogeochemistry on Organic Ligands, sponsored by SCOR Working Group 139. The paper includes acknowledgement of the support provided by the Canadian Arctic GEOTRACES program.
IMAC extraction of samples collected during the 2015 Canadian Arctic GEOTRACES using the Trace Metal (TM) Rosette has also been carried out, providing new information about the relative abundance and UV absorption characteristics of copper-binding ligands collected at different locations and depths in the Canadian Arctic. Depth profiles for 6 stations from Leg 3b (CB-1, -2, -3, -4, CAA-8 and CAA-9) were presented at the December 2016 Project Meeting in Winnipeg, along with a brief summary of the published method. To our knowledge, these are the first depth profiles of copper ligands in Arctic waters.
These results will be presented in a talk at the 100th Canadian Chemical Conference and Exhibition in Toronto on May 29th, 2017 in a session organized by members of the Canadian Arctic GEOTRACES team.
During the final year of the project we plan to perform MS and MS/MS analysis on selected IMAC fractions in an effort to obtain molecular weight and structural information for the recovered ligands. These data will be compared with results obtained by other groups concerning primary productivity, trace element concentrations, and characterization of dissolved organic matter (e.g. thiols, humic substances, CDOM) to provide complementary information about the nature, abundance, and ecological role of organic ligands in the Arctic.

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

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.
- J. N. Smith, V. Rossi, K. O. Buesseler, J. Cullen, J. Cornett, R. Nelson, A. M. Macdonald, M. Robert and J. Kellogg, 2017. Time series transport of the Fukushima radioactivity plume through the northeast Pacific Ocean. Environmental Science and Technology, in review.

Conference Presentations (invited)

2016 Annual PICES Meeting, San Diego, CA, Nov 2-13, 2016
J.N. Smith, Transport of Fukushima radioactivity to North America, Nov. 3, 2016.
J.N. Smith and J. F. Mercier, Canadian response to the Fukushima accident. Nov 4, 2016.

Conference Presentations

Coordinated Research Proposal (CRP) Meeting, International Atomic Energy Agency, (IAEA) Monte Carlo, Monaco, April 26-30, 2016.
J.N. Smith, Radionuclide tracer measurements in Canada's three oceans. April 27, 2016

2017 Ocean Sciences Meeting, Honolulu, Hawaii, February 28, 2017
J.N. Smith, J. Cornett, T. Guilderson and T. Kenna, Tracer ^{129}I Measurements on US and Canadian 2015 Arctic Ocean Geotraces missions

Media Coverage and Outreach Activities

Training Course on Marine Radioactivity June 8-10, 2016, Xiamen University, Xiamen, ChinaJ.N. Smith, Applications of artificial radionuclides as Fukushima tracers of marine processes, June 10, 2016

Media interviews on Fukushima issues with *Associated Press*, *Voice of America*, *Japan Times*.

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

Refereed Journal Publications

- Schuback N., Hoppe C., Maldonado M. and P. Tortell. Primary productivity and the coupling of photosynthetic electron transport and carbon fixation in the Arctic Ocean. Limnology and Oceanography, doi: 10.1002/lno.10475
- Fenwick, L. Zimmerman, S., Williams, B., Vagle, S., Capelle D.W., and P.D. Tortell. Methane and nitrous oxide distributionsacross the North American Arctic Ocean during summer, 2015. Journal of Geophysical Research-Oceans, Oct. 2016. doi: 10.1002/2016JC012493
- Jarnikova T., Dacey J., Lizotte M., Levasseur, M. and P. Tortell. The distribution of methylated sulfur compounds, DMS and DMSP, in Canadian Subarctic and Arctic waters during summer, 2015. Submitted to Journal of Geophysical Research-Oceans. Oct. 2016, ms ID 2016JC012442
- Hoppe, C, Schuback, N, Seminuik D., Giesbrecht K., Mol J., Thomas H., Maldonado M., Rost B., Tortell P. Resistance of Arctic phytoplankton to ocean acidification and high irradiance. Submitted to Polar Biology, March 10, 2017.

Conference Presentations (invited)

- 2017, Canadian Chemistry Conference (Toronto), Tortell PD, Fenwick L, Capelle DW, Damm E, Zimmermann S, Williams WJ, Vagle S. Factors Influencing the Distribution of Climate-active Trace Gases in the Canadian Arctic Ocean

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, submitted to Polar Biology (Mar 9, 2017), POBI-D-17-00051.
- 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.*, 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.C., 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.

Stephanie Waterman, University of British Columbia

Activity Summary

Relevant research group activities focus on observational and realistic modelling studies of **turbulent mixing rates and mechanisms in the Canadian Arctic Ocean.** We are engaged in 3 specific projects:

1. analysis of the hydrographic and pioneering turbulence measurements collected from an autonomous robotic ocean glider in the Amundsen Gulf in association with the Arctic GEOTRACES field campaign. These measurements represent the densest turbulence sampling scheme in the western Arctic Ocean to date, and the first study to statistically demonstrate the natural variability of turbulence in this region. They are being used to quantify turbulent mixing rates and upward heat fluxes from subsurface warm Atlantic-sourced water. (= PhD thesis of Benjamin Scheifele)
2. a characterization of the spatial and temporal variability of internal waves and their effect on mixing in the Canadian Arctic Ocean based on an analysis of the historical ArcticNet (and its predecessors) data record between 1997 and 2016. The large scope of the analysis promises a more complete quantification of internal wave field energetics and mixing patterns that exist in the Canadian Arctic Ocean than has been available previously. (= MSc thesis of Melanie Chanona and in collaboration with ArcticNet Investigator Yves Gratton);
3. a study of the impact of enhanced mixing in the Arctic region via experiments with the realistic numerical model of the Arctic Ocean developed by the Myers UofA group. Specifically, we are quantifying the impact of including an additional parameterization of mixing due to the breaking of internal tides by examining the resultant changes to dense water formation, shelf--basin exchange, and the larger Arctic circulation in the model solution. (=MSc thesis of Jacquie-Lee Thibault).

Refereed Journal Publications

(3 currently in preparation)

Conference Presentations

(Apr 1 2016 - Mar 31 2017)
(KEY: presenting author in *italics*; HQP author in **bold**)

- 2016 ArcticNet Annual Scientific Meeting, Dec 2016, Winnipeg Canada Turbulent dissipation rates, mixing and heat fluxes in the Canadian Arctic from glider-based microstructure measurements. B. Scheifele, S. Waterman and J. Capenter.
- Forum for Arctic Modeling & Observational Synthesis, Nov 2016, Woods Hole USA Spatial and temporal variability of internal waves and their effect on mixing in the Canadian Arctic. M. Chanona, S. Waterman and Y. Gratton.
- Forum for Arctic Modeling & Observational Synthesis, Nov 2016, Woods Hole USA Quantifying the impact of internal tide mixing on shelf-basin exchange in a numerical model of the Arctic Ocean. J.-L. Thibault, S. Waterman and P. Myers.
- VIIIth International Symposium on Stratified Flows, Sep 2016, San Diego USA Estimating mixing rates and turbulence from glider-based microstructure measurements in the Beaufort Sea. B. Scheifele, S. Waterman and J. Capenter.
- 50th Canadian Meteorological & Oceanographic Society (CMOS) Congress, Jun 2016, Fredericton Canada Estimating mixing rates and turbulence from glider-based microstructure measurements in the Beaufort Sea. B. Scheifele, S. Waterman, J. Capenter and L. Merckelbach.

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

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN CHINA-BEIJING

May 1st, 2016 to April 30th, 2017

New scientific results

- Cu speciation in southern Yellow Sea are greatly influenced by in situ primary production; while in Bohai Sea, the complexing ligands are mainly coming from fluvial discharge.
- Southern Yellow Sea is a complex and dynamic coastal area, and the spatial distribution of dissolved trace metals is influenced by fluvial discharge, as well as various physical and biological processes.
- The average dissolved trace metal concentrations of southern Yellow Sea are comparable to pristine coastal seawaters of the US and Europe.
- Identification of large benthic flux of dissolved iron from coastal sediments using the 224Ra/228Th disequilibrium method.
- Toxic Metal pollution in the Yellow Sea and Bohai Sea, China: distribution, controlling factors and potential risk.

New publications (published or in press)

- Li, L., Wang, X.J., Liu, J.H. and Shi, X.F. (2017) Dissolved trace metal (Cu, Cd, Co, Ni, Ag) distribution and Cu speciation in the Southern Yellow Sea and Bohai Sea, China. Journal of Geophysical Research Oceans. doi: 10.1002/2016JC012500
- Grasse P., M. Brzezinski, D. Cardinal, G. F. de Souza, P. Andersson, I. Closset, Z. Cao, M. Dai, C. Ehlert, N. Estrade, R. Francois, M. Frank, G. Jiang, J. L. Jones, E. Kooijman, Q. Liu, D. Lu, K. Pahnke, E. Ponzevera, M. Schmitt, X. Sun, J. N. Sutton, F. Thil, D. Weis, F. Wetzel, A. Zhang, J. Zhang and Z. Zhang (2017) GEOTRACES inter-calibration of the stable silicon isotope composition of dissolved silicic acid in seawater, Journal of Analytical Atomic Spectrometry, 32, 562-578.
- Hong Q.Q., P.H. Cai, X.M. Shi, L. Qing, G.Z. Wang (2017) Solute transport into the Jiulong River estuary via pore water exchange and submarine groundwater discharge: New insights from 224Ra:228Th disequilibrium. Geochimica et Cosmochimica Acta 198, 338-359.
- Xiao, C.L., H.M. Jian, L.F. Chen, C. Liu, H.Y. Gao, C.S. Zhang, S.K. Liang, Y.B. Li (in press) Toxic metal pollution in the Yellow Sea and Bohai Sea, China: distribution, controlling factors and potential risk. Marine Pollution Bulletin.
- Song, B.B., H.J. He, L.F. Chen, S.F. Yang, Y.G. Yin, Y.B. Li (in press) Speciation of Mercury in Microalgae by Isotope Dilution – Inductively Coupled Plasma – Mass Spectrometry, Analytical Letters.
- Xu, B.C., D.S. YANG, W.C. Burnett, X.B. Ran, Z.G. YU, M.S. Gao, S.B. Diao, X.Y. Jiang (2016) Artificial water sediment regulation scheme influences morphology, hydrodynamics and nutrient behavior in the Yellow River estuary, Journal of Hydrology, 539: 102-112.

Cruises

- July 2016, a cruise to the Bohai Sea and Yellow Sea in China. 40 stations were visited and both surface and bottom water were collected. Dissolved trace metals (Cu, Pb, Zn, Co, Ni, Cd, etc.) will be analyzed. Cu, Pb, Zn and Cd speciation will also be analyzed in bottom waters.

New projects and/or funding

- On the barium isotopic compositions, fractionation and its potential as a proxy for paleoproductivity in the ocean, Youth Foundation supported by National Natural Science Foundation of China (PI: Zhimian Cao), 2017.01-2019.12.
- Distributions and influencing factors of dissolved Al in northern South China Sea and its application in tracing terrestrial material transport, NSFC (2017.1-2020.12).

PhD theses

- Wang Z.W. (supervised by S.M. Liu and J. L. Ren of OUC) 2017. Biogeochemical cycle of dissolved manganese and its impact factors in the marginal seas of China. Ocean University of China.

Meetings

- Special session - Biogeochemical Cycling of Trace Elements in the Ocean: GEOTRACES and Beyond. The 3rd Xiamen Symposium on Marine Environmental Sciences (XMAS-III), Jan 9th - 11th, 2017, Xiamen, China. Conveners: Martin Frank, Jing Zhang, Zhimian Cao.
- East Asia GEOTRACES Workshop: Trace Element and Isotope (TEI) study in the Northwestern Pacific and its marginal seas. The Institute of Low Temperature Science (ILTS), Hokkaido University, Sapporo, Hokkaido, Japan, Jan 16-18, 2017.
- 1st Planning Meeting for the 2019 GEOTRACES-China Cruise, 6th Jan, 2017, Xiamen, China. Participants: Jing Zhang, Minhan Dai, Meixun Zhao, Liping Zhou, Jingling Ren, Fei Chai, George T.F. Wong, Zhimian Cao.
- Symposium of preliminary results for GEOTRACES GP06-CN cruise. Ocean University of China, Qingdao, China, Apr 21, 2017. Attendees come from Ocean University of China, Xiamen University, Kyushu University, Shanghai Jaio Tong University, Tongji University, East Normal University, Dalian Maritime University, the First Institute of Oceanography (SOA) etc. There are 14 talks, including three invited talks.

Outreach activities

- Open Day of the new *R/V Tan Kah Kee* of Xiamen University equipped with a clean sampling system for GEOTRACES-type study, Apr 15th - 16th, 2017, Xiamen, China.

Other activities

- Xiamen University's new vessel *R/V Tan Kah Kee* was launched in May 2016.

- The State Key Laboratory of marine environmental science (MEL) of Xiamen University is building the first Trace Elements and Isotopes Sampling System in China. The system consists of a winch unit with an 8000 meter Vectran conducting cable, a commercial available CTD unit designed for TEIs sampling with twenty-four 12 liters Niskin-X or OTE C-Free bottles mounted on an epoxy-coasted aluminum carousel, a 20' subsampling clean van, and a 20' analytical clean van for a microwave-assisted digestion instrument and a Fe(II)Lume FIA analyzer. The sampling system will be tested during the sea trial cruise of *R/V Tan Kah Kee* in July, 2017 and is expected to be launched in 2018. With the sampling system ready, scientists in China will start to contribute to the international GEOTRACES program.

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

New scientific results

We analyzed trace metal concentrations and their solubility of the size-fractionated aerosols collected daily for a whole year in Dongsha atoll, which is located in the Norther South China Sea (SCS), to investigate the impact of anthropogenic aerosols on trace metal cycling in the SCS and the Northwestern Pacific Ocean. Figure 2 exhibits the Fe concentrations and solubility in the aerosols. We have also measured elemental composition in the sinking particles collected in 2015 and 2016 at 2000 and 3500 m of Taiwan time series station (SEATS) in the SCS to study elemental fluxes in the ocean. Collaborating with Kyoto University, we have measured the isotopic composition of Cd, Zn, Ni, Cu, and Fe in the aerosol and sinking particle samples to identify their sources and investigate their fractionation mechanism.

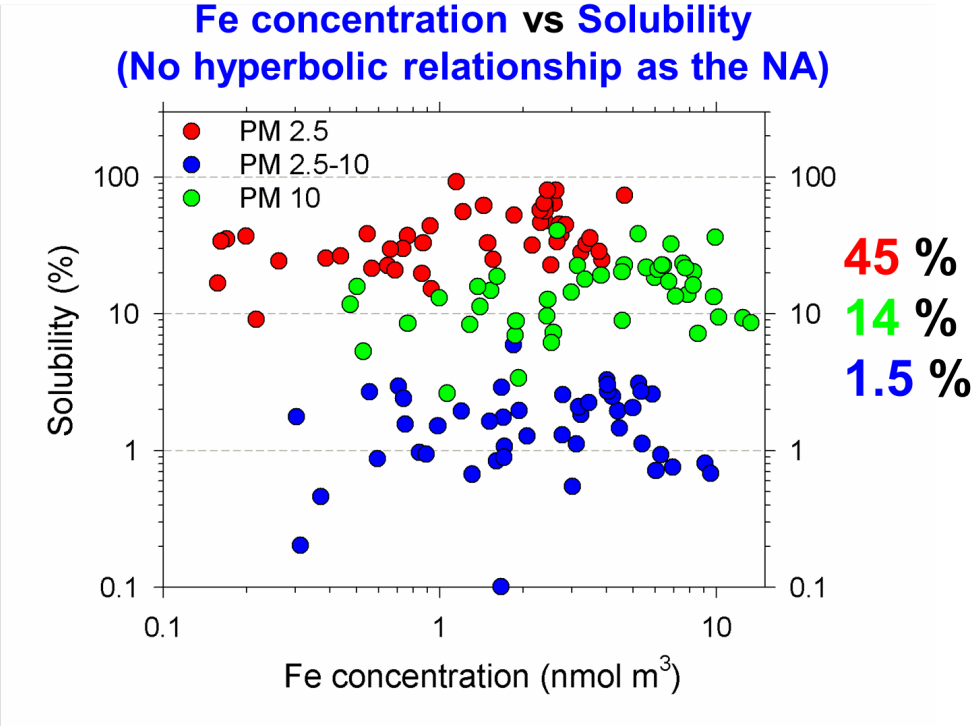

Figure 2. *Comparison of Fe concentration and solubility in size-fractionated aerosols collected in the South China Sea (Ho et al. in prep). The averaged solubility of PM 2.5 and PM 2.5-10 are 45 and 1.5%, respectively, resulting in the total averaged Fe solubility to be 14%. The result indicates that anthropogenic aerosols are the major soluble Fe sources in the surface water of the oceanic region.*

New Publications (2016/5-2017/4)

- Liao, W.-H., S.-C. Yang, and T.-Y. Ho (2017) Trace metal composition of size-fractionated plankton in the Western Philippine Sea: the impact of anthropogenic aerosol deposition. Limnology and Oceanography doi: 10.1002/lno.10564.
- Chien, C.-T., T.-Y. Ho, M. E. Sanborn, Q.-Z. Yin, and A. Paytan (2017) Lead concentrations and isotopic compositions in the Western Philippine Sea. Marine Chemistry 189: 10-16.
- Lee, C.-P., Cheng, C.-Y., and L.-S. Wen (2017) Vertical distributions and diurnal variations of high-molecular-weight dissolved arsenic in the oligotrophic ocean Limnology and Oceanography doi: 10.1002/lno.10560.

New projects

- A three year GEOTRACES project proposed by Tung-Yuan Ho to Taiwan Ministry of Science and Technology (MOST) has been funded. The title of the project is: *Taiwan GEOTRACES II: Biogeochemical cycling and seasonal transformation of aerosol trace metals in the Western Philippine Sea.* The GEOTRACES scientific cruises are most likely to be carried out in 2018 and 2019.

Other activities

- Five Taiwanese researchers, including four junior scientists, were invited by Prof. Hajime Obata to attend the East Asia GEOTRACES workshop held on 16-18 January 2017 in Sapporo, Japan to discuss the current status of trace elements and their isotopes (TEI) studies in the Northwestern Pacific Ocean and its marginal seas.
- The second new R/V, 3900 ton and 85×16 m long and wide, of Taiwan Ocean Research Institute (TORI) has been designed and the RV will be mainly used for open ocean research, including GEOTRACES study.

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

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN CROATIA

May 1, 2016 – April 30, 2017

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 elemental sulphur species, including nanoparticles, in natural waters, 5) characterization of marine aerosols (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 organic persistence in marine sediments; 9) study of stability of silver nanoparticles in seawater.

Meetings

Active participation in the COST Actions ES1205, ES1302, TD1407 and TD1105.

- Organization of WG1 and WG4 meeting group within COST ES1302 (WG 1 - trace metals chemical speciation and bioavailability http://anaerobicmetals.eu/working-group-1-chemical-speciation-and-bioavailability/, WG4 -Fate of trace metals in environment), Zagreb, June 2016.
- Atmospheric Deposition of Trace Elements on Carbonate Material of Historic Buildings in Two Urban Sites, K. Vidović, P. Orlović-Leko, I. Ciglenečki, D. Nekić, COST Action TD1105 - Sixth Scientific Meeting EuNetAir, Academy of Sciences, Prague, Czech Republic, October 2016. www.ama-science.org/proceedings, DOI 10.5162/6EuNetAir2016/19
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Current Projects

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)

- 2016-2018: Monitoring program of coastal Adriatic Sea (Croatian side) (trace metals, organic matter)

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

New scientific results

1- Global seawater εNd database was updated and combined with other tracers as hydrography parameters (temperature, salinity, nutrients, oxygen) and dissolved carbon-14 (^{14}C) and $\delta^{13}C$ (Tachikawa et al., 2017, Fig. 3).

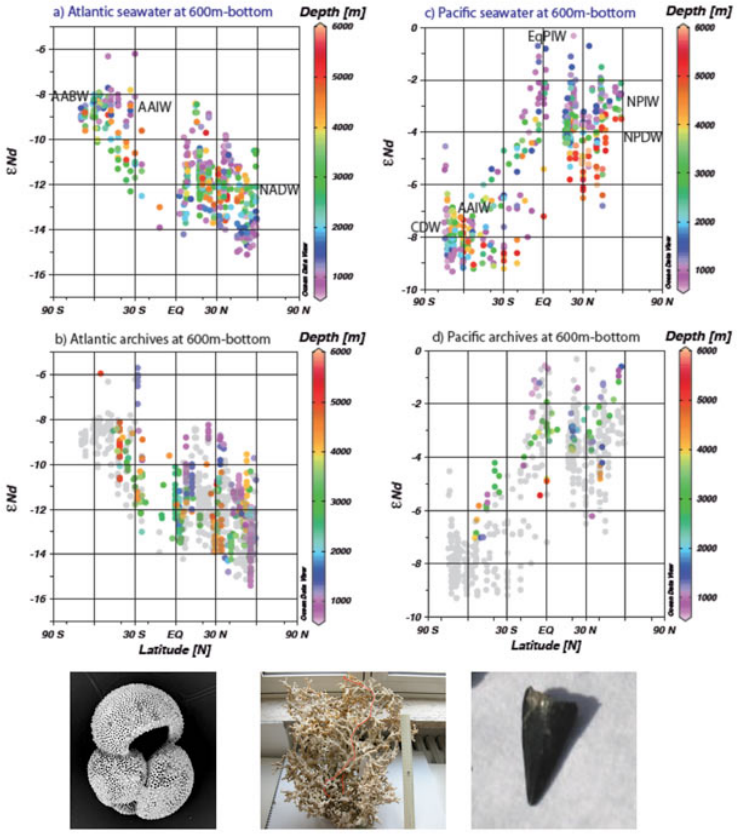

Figure 3. *Tachikawa et al. (2017). Major latitudinal trends of seawater (a and c) and archive (b and d, and pictures blow) εNd values in the Atlantic and Atlantic sector of the Southern Ocean (a and b) and Pacific and Pacific sector of the Southern Ocean (c and d) at ≥ 600 m. Major water masses are indicated. The grey dots on archive figures show seawater values. All the figures were created using Ocean Data View (ODV, Schlitzer, 2017).*

The database contains also sedimentary authigenic and biogenic carbonate εNd values from the Holocene. It allows drawing the following general schemes:
- At water depths ≥1500 m, large-scale water mass mixing is a primary control of deep water εNd distribution.
- At ≥200 m, basin-scale seawater temperature-salinity-εNd diagrams demonstrate the isotopic evolution of different water masses.

- At 600–1500 m water depths, the relationships are weaker. Basin-scale seawater vertical εNd profiles demonstrate larger variability.
- At surface and subsurface depths, suggesting local/regional detrital influence at shallower water depths.
- Empirical equations were established to predict the main, largescale, deepwater εNd trends from hydrography parameters revealing that continental influence on seawater and archive εNd is observed mainly within 1000 km from the continents.
- Seawater and archive εNd values present clear latitudinal trends in the Atlantic and Pacific Oceans at water depths ≥600 m: this reinforces the potentiality of Nd isotopes to distinguish between northern/southern sourced water contributions at intermediate and deep water depths in the present and past ocean.

2- Dulaquais et al. (2017) proposed the first comprehensive study of cobalt behaviour in the Mediterranean Sea. This work was conducted in the framework of MedBlack GEOTRACES cruise (GA04N).

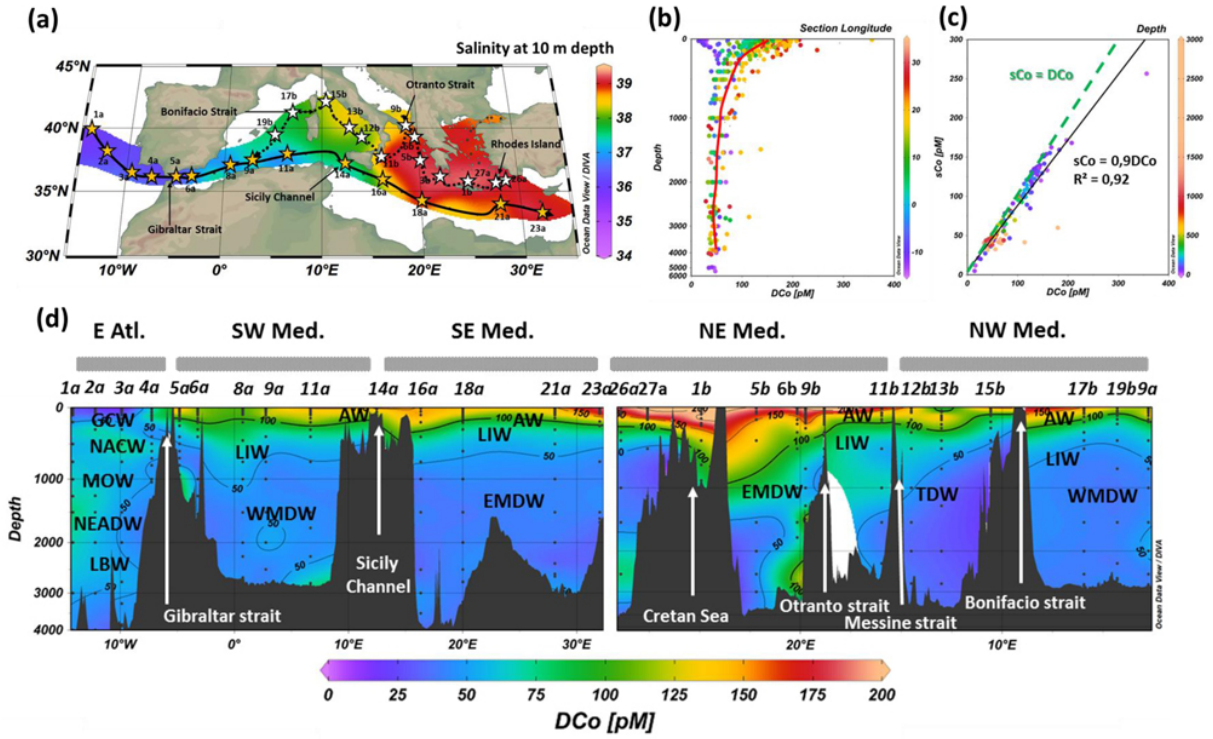

Figure 4. *Distribution and partitioning of dissolved cobalt (DCo) in the (Dulaquais et al., 2017). DCo concentrations along the GA04N section (a) and a scavenged like profile in all the different sub-basins of the Mediterranean Sea (b). In the Mediterranean Sea, DCo was almost entirely composed of soluble cobalt (sCo), the colloids representing only 10% of the DCo pool (c). Resulting from high recycling rate and its stabilization under a soluble form, surface DCo concentrations increased eastward with ageing of surface waters (d). Differently accumulation of DCo by remineralization in the intermediate water was not discernable (d) and surprisingly the zonal distribution of DCo in the deep sea showed homogenous concentrations (d). These features were related to scavenging rates depth dependents and of different magnitude in the two Mediterranean basins as well as to the fast Mediterranean circulation that homogenize concentrations in the deep sea. Figures were made using ODV (Schlitzer, 2017).*

Dulaquais et al. (2017) measured the following cobalt (Co) fractions: soluble (sCo<0.02 μm), dissolved (DCo<0.2 μm), colloidal (cCo, as DCo minus sCo), and particulate (pCo>0.2 μm) (Fig. 2). While soluble Co is the predominant form (90%) of the dissolved Co in the Mediterranean Sea, colloidal Co and particulate Co show a close distribution, yielding the authors to suspect a biogeochemical link between these two fractions. More striking is the scavenged-like profile observed everywhere, with up to 350 nM dissolved Co concentrations in the surface waters dropping to 45 nM at depth. Such behaviour results from several mechanisms. High-surface Co inputs at Gibraltar Strait are horizontally transported by the Mediterranean circulation, surface dissolved Co is stabilized in a soluble form and biogenic particulate Co is very rapidly regenerated: all these processes concur to the accumulation of dissolved Co in the surface layers. Conversely, low particulate Co export, low remineralization of biogenic particulate Co at depth, and removal of dissolved Co by scavenging prevented its accumulation in the intermediate and deep sea.

3- Trace element concentrations were determined in dry (aerosols) and wet (precipitation) deposition samples from the North Atlantic, north of 40°N, during the GEOVIDE cruise (GEOTRACES cruise GA01) in May/June 2014 (Shelley et al., 2017). Atmospheric aerosol loading in the study region was low (~ 2–500 ng m-3) throughout the cruise, as inferred from the very low aerosol Ti concentrations determined (0.0084–1.9 ng m-3). Wet deposition appeared to be of roughly equal or greater importance than dry deposition to the total depositional flux of TEs, which is consistent with other regions of the Atlantic Ocean outside of the influence of the Saharan plume.

During this study, TE flux estimates were derived from two different techniques: (1) the traditional approach of summed wet and dry deposition TE fluxes, using concentration data, precipitation rates, and dry deposition velocities and, (2) using the inventory of the cosmogenic radioisotope beryllium-7 (^{7}Be) in the upper ocean as a proxy for atmospheric deposition. The use of the low-background gamma spectrometers at the LAFARA underground laboratory allowed us to quantify ^{7}Be activities as deep as 150 m depth (Fig. 3).
These two approaches yielded TE flux estimates that were in excellent agreement (within one standard deviation) for about half of the TEs under investigation. However, for the remaining TEs, differences between the flux estimates ranged from two to forty times, with the traditional approach generally being the higher of the two estimates. Therefore, factors that may contribute to this variation, such as differences in the timescale of integration and selection of representative deposition velocities and precipitation rates, are discussed. Our results suggest that the ^{7}Be approach continues to show promise in this application, particularly in regions where precipitation samples cannot be routinely collected.

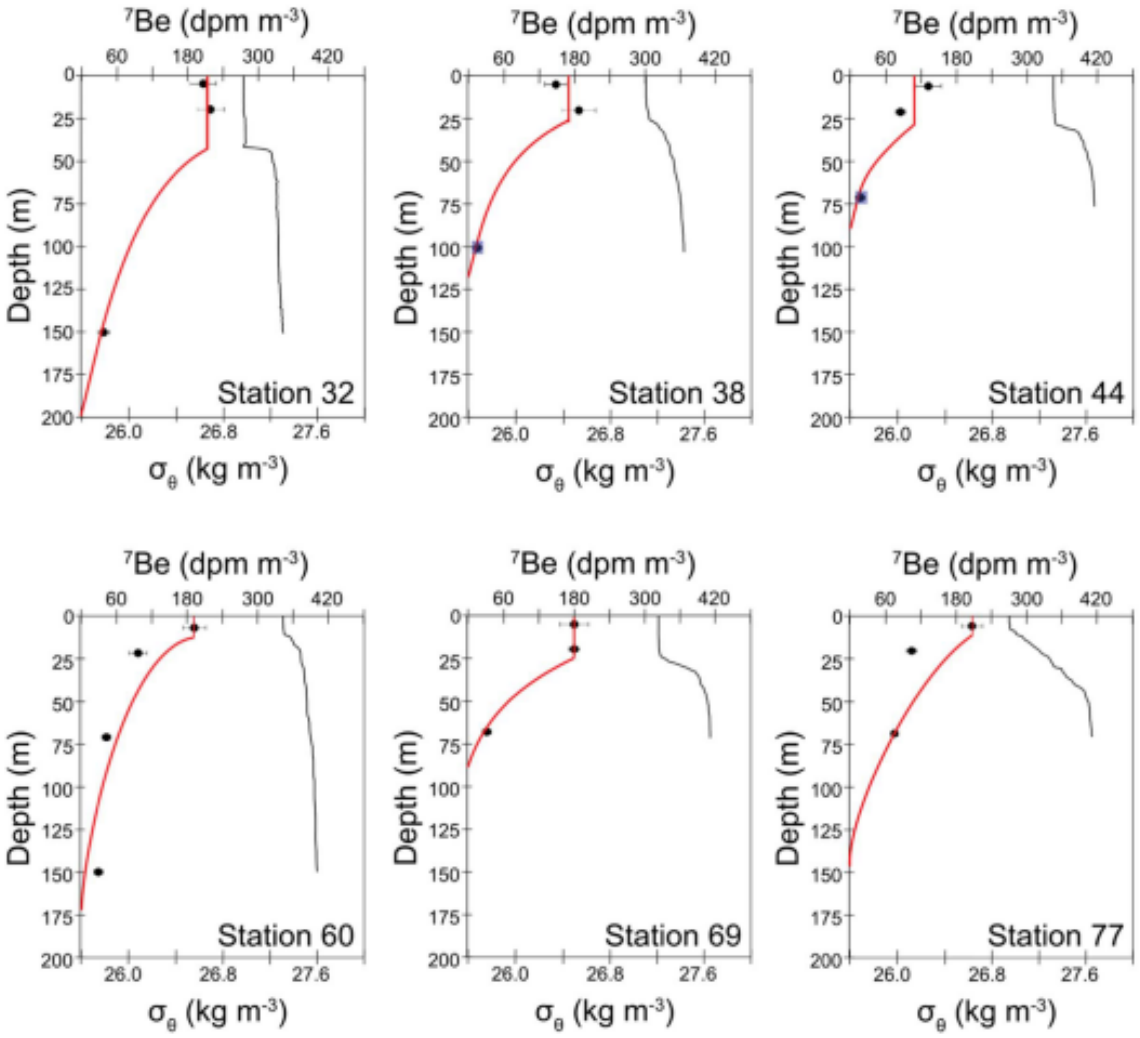

Figure 5. *Concentration profiles (black dots), integrated inventory of ^{7}Be (red continuous line) in the water column and potential density anomaly (σθ, black continuous line) for all stations sampled during the GEOVIDE cruise (Shelley et al., 2017).*

4- The first inter-calibration study of the stable silicon isotope composition of dissolved silicic acid in seawater, $d^{30}Si(OH)_4$, is presented as a contribution to the international GEOTRACES program (Grasse et al., 2017, Fig. 6). Eleven laboratories from seven countries (including two French labs) analyzed two seawater samples from the North Pacific subtropical gyre (Station ALOHA) collected at 300 m and at 1000 m water depth. Sampling depths were chosen to obtain samples with a relatively low (9 µM, 300 m) and a relatively high (113 µM, 1000 m) silicic acid concentration as sample preparation differs for low- and high concentration samples. Data for the 1000 m water sample were not normally distributed so the median was used to represent the central tendency for the two samples. Median $d^{30}Si(OH)_4$ values of +1.66‰ for the low-concentration sample and +1.25‰ for the high-concentration sample were obtained. Agreement among laboratories was overall considered very good; however, small but statistically significant differences among the mean isotope values obtained by different laboratories were detected, likely reflecting inter-laboratory differences in chemical preparation including preconcentration and purification methods together with different volumes of seawater analyzed, and the use of different mass spectrometers including the Neptune MC-ICP-MS (Thermo Fisher™, Germany), the Nu

Plasma MC-ICP-MS (Nu Instruments™, Wrexham, UK), and the Finnigan™ (now Thermo Fisher™, Germany) MAT 252 IRMS. Future studies analyzing $d^{30}Si(OH)_4$ in seawater should also analyze and report values for these same two reference waters in order to facilitate comparison of data generated among and within laboratories over time.

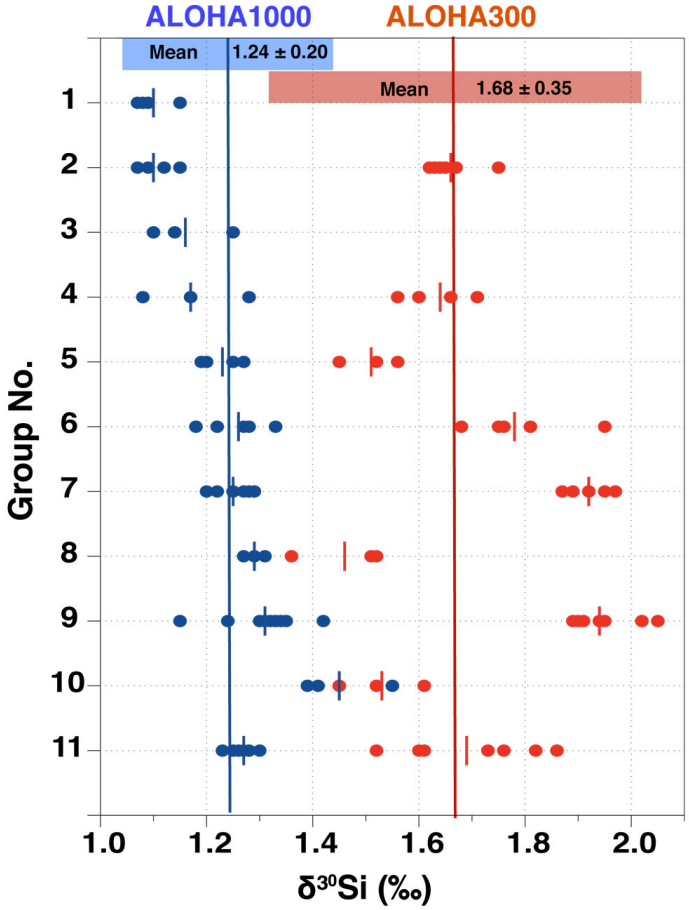

Figure 6. *$\delta^{30}Si(OH)_4$ results from all groups for ALOHA300 (red circles) and ALOHA1000 (blue circles). The vertical lines indicates the mean value of all measurements for ALOHA1000 (blue) and for ALOHA300 (red). The data points represent the individual $\delta^{30}Si(OH)_4$ values for Si isotopes measurements. Short vertical solid lines are the means obtained by individual laboratories for the two samples. Uncertainty in the mean for all measurements (2 s.d.) is indicated by the horizontal bars at the top of the figure (modified from Grasse et al. 2017).*

5- A massive diatom-bloom is observed annually in the surface waters of the naturally Fe-fertilized Kerguelen Plateau (Southern Ocean). In the Closset et al. (2016) study, silicon isotopic signatures ($\delta^{30}Si$) of silicic acid (DSi) and suspended biogenic silica (BSi) were investigated in the whole water column with an unprecedented spatial resolution in this region, during the KEOPS-2 experiment (spring 2011). We used $\delta^{30}Si$ measurements to track the silicon sources that fuel the bloom, and investigated the seasonal evolution of Si biogeochemical cycle in the iron fertilized area. We compared the results from a HNLC reference station with stations characterized by different degrees of iron enrichment and bloom conditions. Dissolved and particulate $\delta^{30}Si$ signatures were generally highly variable in the upper 500 m, reflecting the effect of the intense silicon utilization in spring, while they were quite homogeneous in deeper waters. The Si-isotopic and mass balance identified a unique Winter Water (WW) Si-source for the iron-fertilized area originating from the southeastern Kerguelen Plateau and spreading northward. However, when reaching a

retroflection of the Polar Front (PF), the $\delta^{30}Si$ composition of WW silicic acid pool was getting progressively heavier. This would result from sequential diapycnal and isopycnal mixings between these initial WW and mixed layer (ML) water masses, highlighting the strong circulation of surface waters that defined this zone. When comparing the results from the two KEOPS expeditions, the relationship between DSi depletion, BSi production and their isotopic composition appears decoupled in the iron fertilized area. This seasonal decoupling could help to explain the low apparent fractionation factor observed here in the ML at the end of summer. Taking into account these considerations, we refined the seasonal net BSi production in ML of the iron-fertilized area to 3.0 ± 0.3 mol Si $m^{-2}y^{-1}$, which was exclusively sustained by surface water phytoplankton populations. These insights confirm that the isotopic composition of dissolved and particulate silicon is a promising tool to improve our understanding on the Si-biogeochemical cycle since the isotopic and mass balance allows resolving the processes involved i.e. uptake, dissolution, mixing.

6- Dissolved/particle interaction with lithogenic particles dominates the release of dissolved Fe in the deep water masses of the Atlantic sector of the Southern Ocean (Bonus/Goodhope cruise, Abadie et al. 2017, Fig. 7)

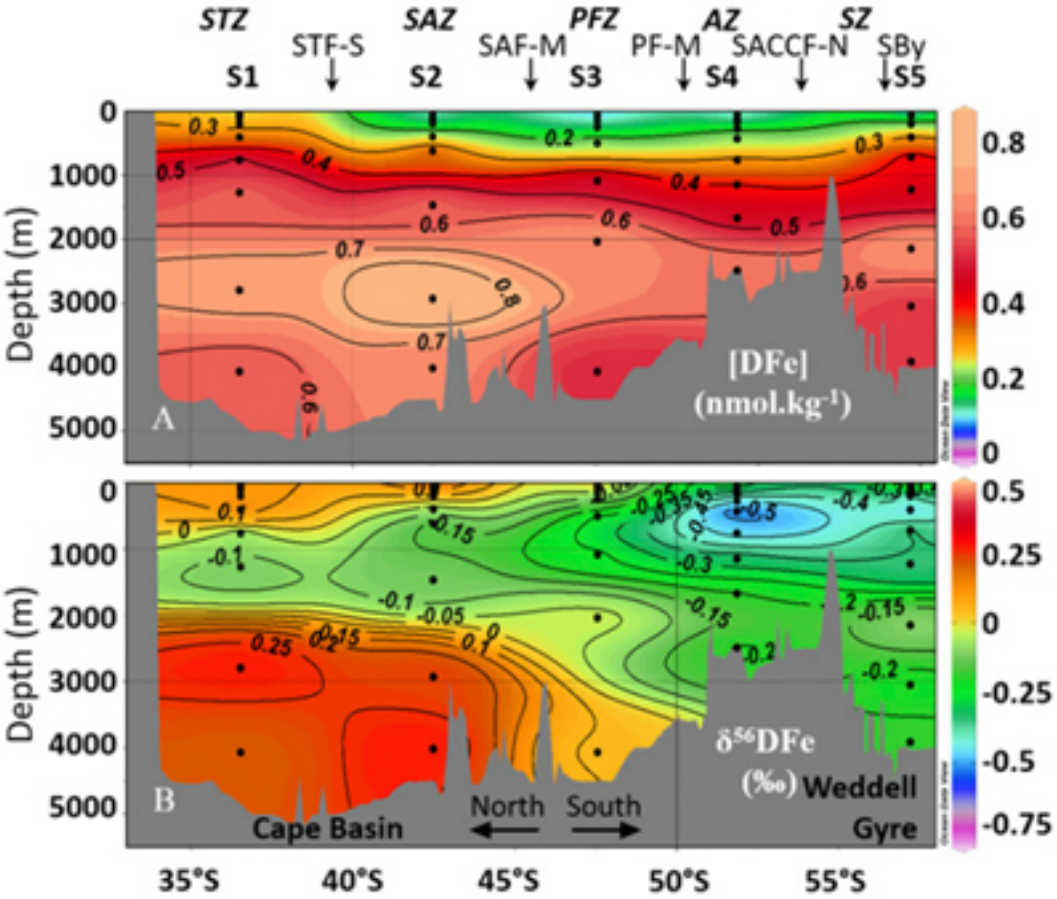

***Figure** 7. Abadie et al. (2017). Section of (A) dissolved Fe (DFe, in nmol kg^{-1}) and (B) DFe isotopic composition ($d^{56}Fe$ relative to IRMM-14 in per mil) of seawater samples taken during the Bonus-GoodHope cruise (Feb.-March 2008). Figure was made using ODV (Schlitzer, 2017).*

7- Dissolved neodymium (Nd) isotopic composition (expressed as εNd) has been analyzed for 82 seawater samples collected from 13 stations stretching from the Alboran Sea to the Iceland Basin (Dubois-Dauphin et al., in press). The distribution of the εNd values of water

masses was thus investigated for the first time along the western European margin in order to explore whether the water masses flowing in the eastern subpolar and subtropical Atlantic reveal distinct isotopic patterns. In the northeast Atlantic, the North Atlantic Current surface water located in the inter-gyre region (north of 46°N) displays εNd values of between -14.0±0.3 and -15.1±0.3, reflecting the subpolar gyre signature. Along the western European margin, εNd values of surface water decrease toward the north (from -10.4±1.6 to -13.7±1.0) in agreement with the gradual mixing between subtropical and subpolar water. At intermediate depth, εNd values decrease from -9.9±0.4 within the Gulf of Cádiz to -12.1±0.3 within the Porcupine Seabight, indicating a strong dilution of the MSW with subpolar water. Within the Rockall Trough and the Iceland Basin, the more negative εNd values at mid-depth (< -13.5±0.3) indicate that the MSW has no influence, even during periods of low NAO index.

8- Dissolved REEs and Y concentrations of six seawater stations (MONOPOL Cruise) located along the 89°E meridian (from 17°N to 8°N) in the Bay of Bengal have been investigated in order to estimate the relative importance of dissolved and lithogenic particles from the Ganges-Brahmapoutra river inputs, and bottom sediment releases, on the dissolved REE concentration distributions, and the residence time of dissolved REEs in the Bay of Bengal (Yu et al., 2017).

9- In the Mediterranean Sea, generally low ^{231}Pa concentrations were found due to the short water residence time (Fig. 8). The impact of deep water formation was highlighted by low concentrations of ^{231}Pa concentrations particularly in the eastern basin.

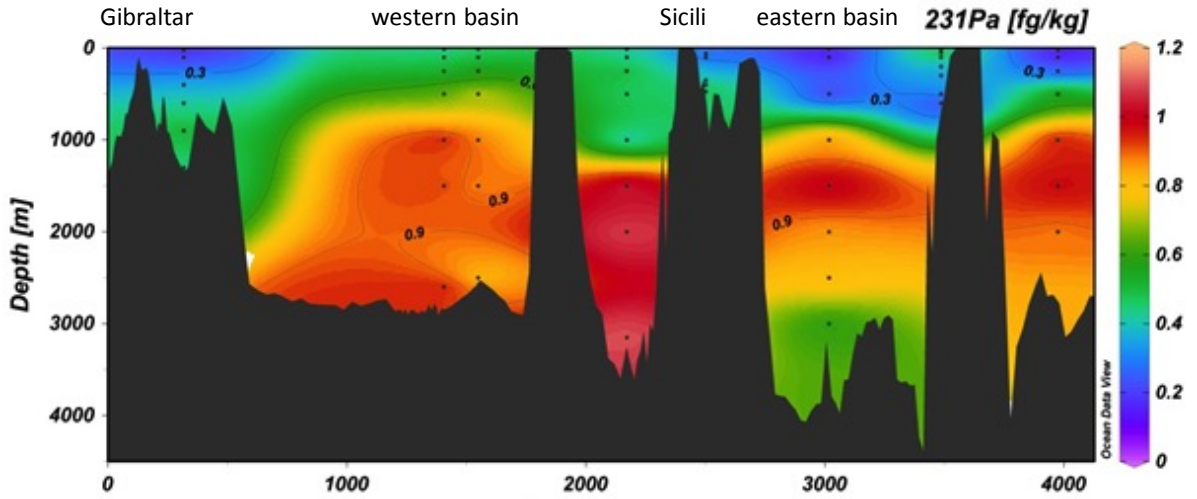

***Figure 8**. Distribution of ^{231}Pa along the MedSeA GA04S section (Gdaniec et al., unpublished). Figure was made using ODV (Schlitzer, 2017).*

10- The abundance and composition of particulate organic carbon (POC) is critical for the removal of numerous trace elements by scavenging (Aumont et al., 2017, Fig. 9). Observations and laboratory experiments have shown that POC is composed of numerous organic compounds with very different reactivities. Yet, this variable reactivity of POC has never been extensively considered in modeling studies. Here, we introduced in the global ocean biogeochemical model NEMO-PISCES a description of the variable composition of POC based on the theoretical Reactivity Continuum Model proposed by Boudreau and

Ruddick (1991). We show that accounting for a variable lability of POC increases POC concentrations in the ocean's interior by one to two orders of magnitude due to a better preservation of small slowly sinking particles. Furthermore, the carbon flux that reaches the sediments is increased by more than a factor of two, which is in better agreement with global estimates of the sediment oxygen demand. The impact on the major macro-nutrients (nitrate and phosphate) remains modest. However, iron (Fe) distribution is strongly altered, especially in the upper mesopelagic zone as a result of more intense scavenging: Vertical gradients of Fe are milder in the upper ocean which appears to be closer to observations.

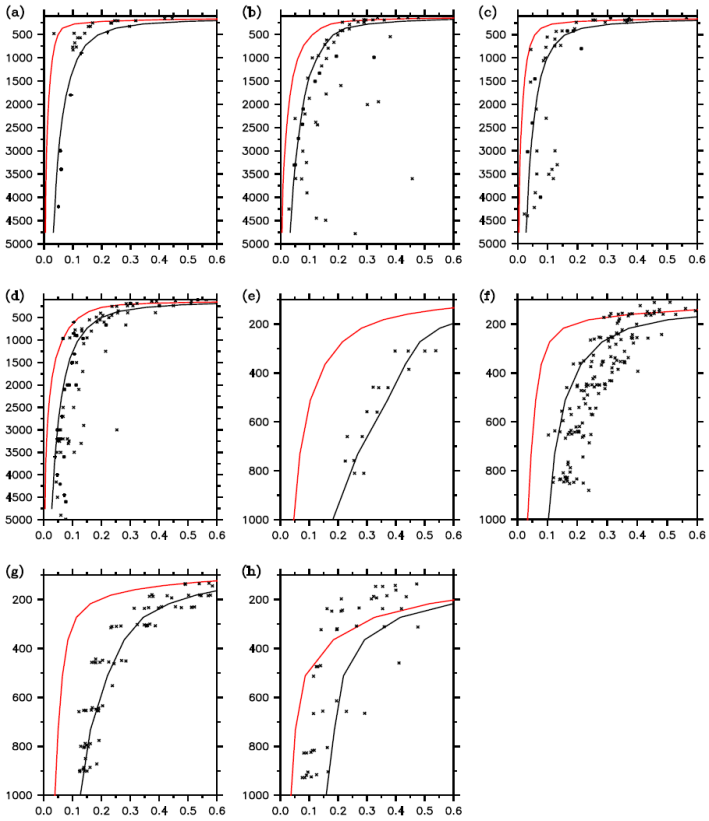

***Figure 9**. From Aumont et al. (2017). Modelled and observed total POC concentrations (µM) in different regions of the ocean: (a) western, (b) oligotrophic and (c) eastern North Atlantic Ocean, (d) Hawaii region, (e) northwest, (f) northeast, (g) central and (h) southern Pacific Ocean. The continuous lines are concentrations averaged over the region: without (in red) and with the reactive continuum parameterization (in black). The black speckles are observations in the respective regions from Druffel et al. (1992); Lam et al. (2011, 2015b).*

11- An extensive compilation of published neodymium (Nd) concentrations and isotopic compositions (Nd IC) has been realized in order to establish a new high resolution database of the distribution of these parameters for all the Mediterranean margins (Ayache et al., 2016, Fig. 10). Data were extracted from different kinds of samples: river solid discharge deposited on the shelf, sedimentary material collected on the margin or geological material outcropping above or close to a margin. Additional analyses of surface sediments were done, in order to improve this dataset in key areas (e.g Sicilian strait). This new geological map has been used to perform a high resolution regional oceanic simulation (NEMO-MED12 1/12° of horizontal resolution) of Nd IC in the Mediterranean Sea (Fig. 11).

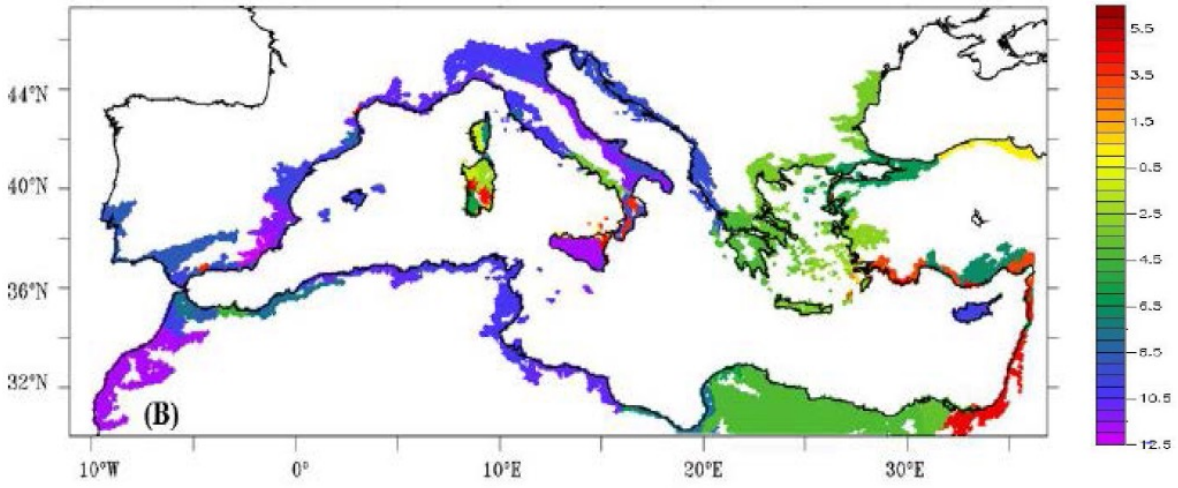

Figure 10. *High resolution map of the Nd isotopic signature of all the margins surrounding the Mediterranean Sea Ayache et al., 2016).*

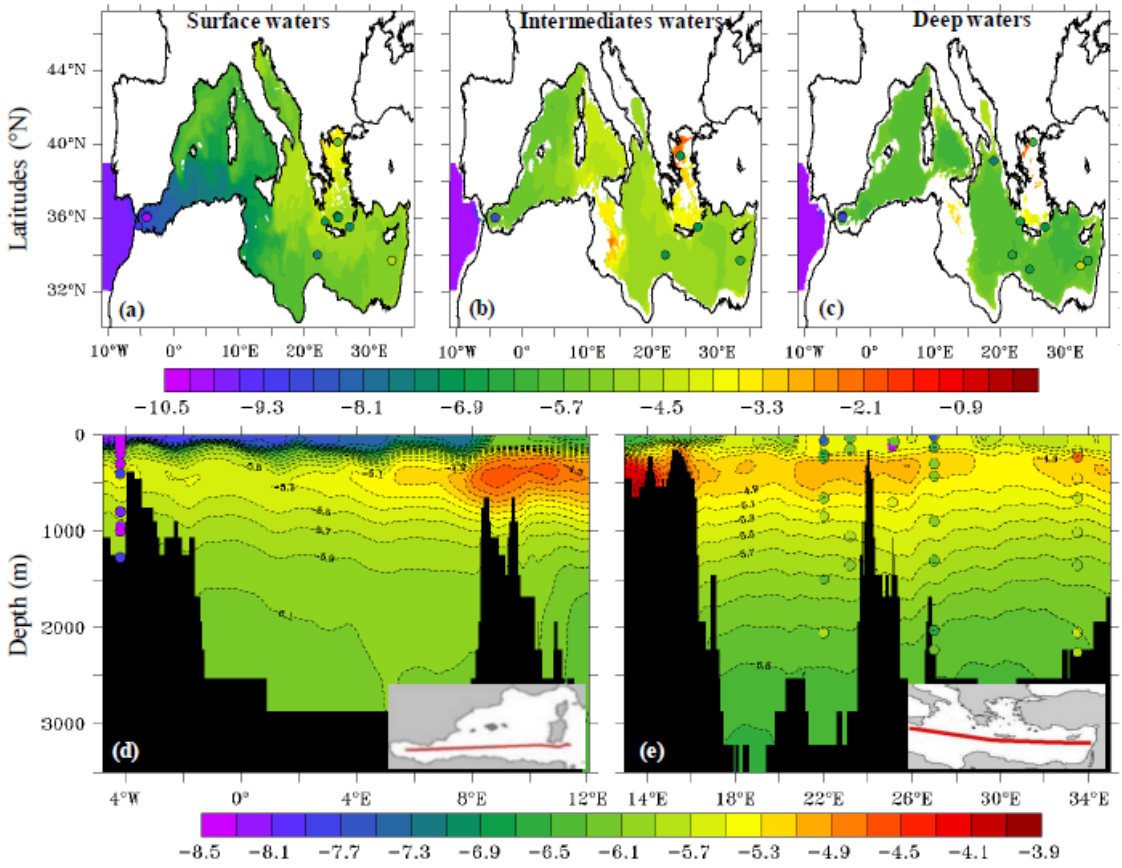

Figure 11. *Ayache et al. (2016). Simulated Nd isotopic composition. Upper panel: horizontal maps for surface waters (a), intermediate waters (b), and deep waters (c). Lower panel E-W section in WMed (d), and EMed (e), whereas color-filled dots represent in situ observations (Tachikawa et al., 2004).*

The Boundary Exchange (BE) parameterization was performed via a relaxing term toward the isotopic composition of the margin and was the only source considered in this study. The model correctly simulates the main features of the Nd distribution with a well identified

signature of the main Mediterranean water masses, and a realistic East-West gradient in the surface waters. This reinforces the preceding conclusions on BE as an important process in the Nd oceanic cycle. Nevertheless the comparison with the available data the Med Sea reveals that this approach simulates too radiogenic values in the surface and intermediate waters (especially in the EMed). This bias could reflect that dust and river inputs are not simulated so far, although they could be important sources of Nd in the Mediterranean Sea and can have locally a significant impact on εNd distribution.

12- We combined new GEOTRACES observations (GA02) and global modelling to give a first assessment of the main sources and redistribution of Mn throughout the ocean (van Hulten et al., 2017). We simulated the distribution of dissolved Mn using the global-scale circulation model (NEMO-PISCES, Fig. 12). The simulation includes simple parameterisations to account for the sources, processes and sinks of Mn in the ocean. Oxidation and (photo)reduction, aggregation and settling, as well as biological uptake and remineralisation by plankton are included in the model. Our model provides, together with the observations, the following insights: The most important sources for the upper ocean are sediments, dust, and, more locally, rivers, whereas hydrothermal vents are the most important in the deep ocean. The observed sharp hydrothermal signals are produced by assuming both a strong source and a strong removal of Mn near hydrothermal vents. The high surface concentrations of manganese are caused by the combination of photoreduction and sources contributing to the upper ocean.

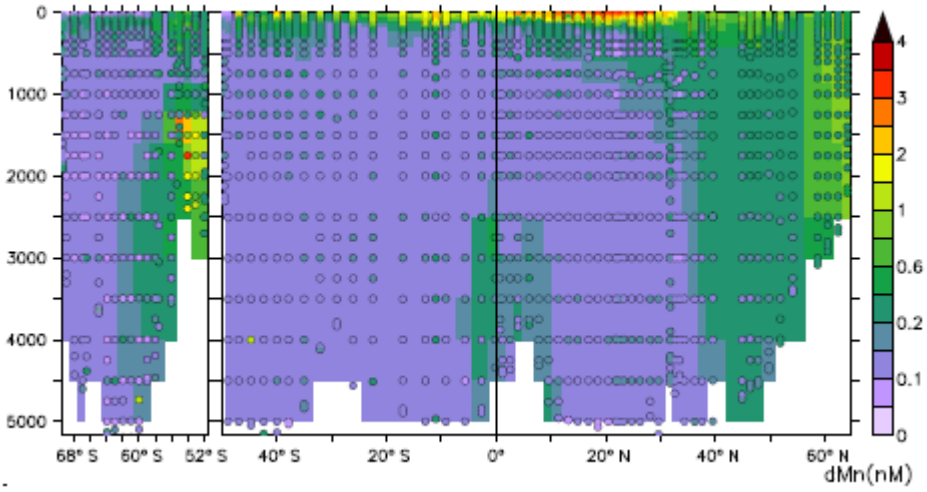

***Figure 12**. van Hulten et al. (2017). Simulated Dissolved Mn (nM) at the Zero-Meridian section component of the GIPY5 dataset, and the west Atlantic GA02 GEOTRACES transects Observations are presented as colored dots.*

New publications (published or in press)

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- Conway T., John S. G., Lacan F. 2016. Intercomparison of dissolved iron isotope profiles from reoccupation of three GEOTRACES stations in the Atlantic Ocean. Marine Chemistry doi:10.1016/j.marchem.2016.04.007.
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- Grasse P., M. A. Brzezinski, D. Cardinal, G. F. de Souza (main authors) et al., 2017. GEOTRACES Intercalibration of the Stable Silicon Isotope Composition of Dissolved Silicic Acid in Seawater. J. Anal. At. Spectrom, 32, 562-578.
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- Shelley R. U., Roca-Martí M., Castrillejo M., Sanial V., Masqué P., Landing W. M., van Beek P., Planquette H., 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 119, 34-49
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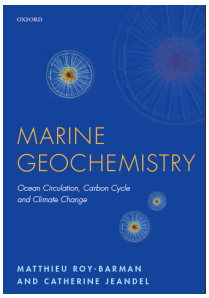
Other publications



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Cruises

- Several short cruises conducted in the coastal seas along the French Mediterranean coastline (MED-SGD project, ANR-15-CE01-0004; PI: P. van Beek)
- HERMINE (N/O Pourquoi Pas? 12/03/2017-29/04/2017). One scientist from LEMAR (Hannah Whitby), one from the University of Liverpool (Arthur Gourain), and one for the University of Tasmania (Thomas Holmes) were on board.
- MINGULAY-ROCKALL: 80 seawater samples (10 l) have been collected in June 2016 in the Rokall Trough and on the Celtic margin.

New projects and/or funding

- KINETICS (LEFE/ECCO, INSU/CNRS funding). This project aims at establishing the kinetics of the release of chemical species from the sediments, with a focus on Si and Ni isotopes.
- SWINGS: South West Indian GEOTRACES Section. Letter of Intent submitted April 3rd, the main project is currently under writing.
- MED-SGD (ANR-15-CE01-0004) is funded between 2016 and 2019. The aim of the MED-SGD project is to study the fluxes of chemical species associated with SGD, Submarine Groundwater Discharge, and released into the coastal seas (Western Mediterranean Sea)
- SINDIA: Silicon Cycle along the land to ocean continuum in India (INSU, EC2CO-LEFE)

PhD theses

- Since the 9 of March 2017, we are welcoming Viet Pham who will do his PhD thesis on the REE and Nd isotopes collected as part of PANDORA (GP12). He will be in LEGOS until March 2020.
- Lise Artigue started a PhD in October 2016, on Fe isotopes in the KEOPS and PANDORA cruises, under the supervision of F. Lacan
- Emilie Le Roy is currently a phD student at LEGOS under the supervision of F. Lacan and P. van Beek (2016-2018). She studies the distribution of natural radionuclides along the GA01-GEOTRACES section in the N-Atantic.

- Simon Bejannin is currently a phD student at LEGOS under the supervision of P. van Beek (2016-2018). He studies the fluxes of chemical elements associated with SGD, Submarine Groundwater Discharge and transferred to the coastal seas.
- Mangalaa K.R., 2016. Silicon biogeochemical cycle along the land to ocean continuum: Focus on Indian monsoonal estuaries. Université Pierre et Marie Curie Paris VI, 2016. English. 237pp.
- Houda Beghoura, PhD, Modelling the role of sedimentary particulate Fe (2016-2019), supervised by Thomas Gorgues (LOPS) and Hélène Planquette (LEMAR)
- Quentin Dubois-Dauphin – Restitution de l'hydrologie de l'Atlantique Nord-Est et de la Méditerranée occidentale depuis la dernière période glaciaire à partir de la composition isotopique du néodyme mesurée dans l'eau de mer et les coraux d'eau froide. Thèse de l'Université de Paris-Sacaly. Supervision: C. Colin (100 %). Allocataire MEN. Defended the 3rd of June 2016, mention très honorable.

Presentations in international conferences

- Ayache, M., Dutay JC, Arsouze T., Revillon S. and Jeandel C. High resolution neodymium characterization along the Mediterranean Sea margins: implications for εNd modeling. EGU, Vienna, 2016
- 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. April 2017.
- Benetti, M. G. Reverdin, N.P. Holliday, J. Olafsson, P. Lherminier, G. Sarthou, Laura de Steur, A. E. Sveinbjörnsdóttir, S. Torres-Valdes, E. Tynan, I. Yashayaev., Freshwater exports from Arctic to the Labrador and Greenland shelf and slope, 2017, EGU Meeting, European Geosciences Union, Vienna (Austria), 23-28 April.
- 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. April 2017.
- Le Roy E., Sanial V., Charette M., Henderson P., Souhaut M., Lacan F., van Beek P. Radium isotopes (226Ra & 228Ra) along the GEOVIDE transect in the North Atlantic (GEOTRACES GA01). Radium and Radon as environmental tracers,VI international Ra-Rn meeting, Girona (Spain), July 2016. Poster.
- Lemaitre, F. Planchon, H. Planquette , F. Dehairs , L. Monin , L. André , M. Leermarkers, D. Fonseca-Batista , A. Roukaerts , C. Mourgues , D. Verstraeten, M. Castrillejo, Y. Tang, C. Jeandel , V. Sanial , R. Sauzède , L. Foliot Carbon export fluxes along the GEOVIDE transect in the North Atlantic (GEOTRACES – GA01) EGU, Vienna, Austria. April 2016.
- Michael S.M, Joseph A Resing, Catherine Jeandel and Francois Lacan, Aluminum and Manganese Distributions in the Solomon Sea: Results from the 2012 PANDORA Cruise AGU San Francisco, 2016, POSTER
- Shelley R., Sarthou G., Tymen G., Losno R., Tito de Morais L., Benhra A., and Zohra Bouthir F., 2016, A case study of aerosol trace element deposition to Moroccan coastal waters, European Aerosol Conferences, Tours, 4-9 September

- 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. April 2017.
- Yu, Z., Colin, C., Douville, Duchamp-Alphonse, S., Sepulcre, S., Bassinot, F., Seasonal distribution of dissolved neodymium concentrations and εNd in the Bay of Bengal. ICP12 Utrecht, 29 August -2 Sept 2016.

Presentations in national conferences

- Dubois-Dauphin Q., Montagna P., Siani G., Douville E., Wienberg C., Hebbeln D., Liu Z., Kallel N., Dapoigny A., Revel M., Pons-Branchu E., Colin C. (2016) Hydrological variations of the intermediate water masses of the western Mediterranean Sea during the past 20 ka inferred from neodymium isotopic composition in foraminifera and cold-water corals. Journées scientifiques Climat et Impacts 15 et 16 Novembre 2016 Université Paris-Sud, Orsay, Poster.
- Planquette, H. et al., LEFE-CYBER: 16-17 June 2016, EPOC, Bordeaux. Exploring the role of particles in trace element cycling in the central Arctic Ocean (TRANSARC II cruise).
- Yu Z. Colin C., Douville E., Meynadier L., Duchamp-Alphonse S., Sépulcre S., Wan S., Song L., Wu Q., Xu Z., Bassinot F. (2016) Yttrium and rare earth element partioning in seawaters from the Bay of Bengal : new insights into the influence of river inputs. Journées scientifiques Climat et Impacts 15 et 16 Novembre 2016 Université Paris-Sud, Orsay, Oral.

Outreach activities

- Oral presentation about trace elements and isotopes and the ocean and visit of the LEGOS clean lab for high school teachers. May 2016, Toulouse.
- Communications about the Abadie et al. PNAS 2017 paper on Toulouse University, CNRS, Observatoire Midi Pyrenees website and LEGOS websites.

Other activities

- In the context of the LMI ICEMASA, LEMAR hosted a post-graduate student from South Africa, Natasha van Horsten (CSIR, Cape Town and Stellenbosch University, Stellenbosch, supervision: Dr T. Mtshali, Dr P. Monteiro, Dr A. Roychoudhury). During her 3 month stay (Sept.-Nov 2016), she was trained on the FIA for Fe(III) measurements in seawater, and analysed samples from South African cruises in the Atlantic sector of the Southern Ocean (winter and summer cruises). These results will help to better understand the seasonal variability of the Fe reservoirs in this HLNC area. Natasha van Horsten will start a PhD (2017-2020), co-supervised by T. Mtshali/A. Roychoudhury (CSIR/Univ Stellenbush, South Africa) - E. Bucciarelli/G. Sarthou/H. Planquette (LEMAR, Univ. Brest, France).
- Organization of the first GEOTRACES Summer School. We received more than 110 applications and selected 60 participants (https://geotracesschool.sciencesconf.org/).

- The special issue related to the GEOVIDE project is now open in Biogeosciences. Around 20 articles are planned to be submitted. Guest editors are: Gideon Henderson, Maeve Lohan, Laurent Bopp, Catherine Jeandel, and Gilles Reverdin.

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

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN GERMANY

May 1st, 2016 to April 30th, 2017

New scientific results

Two international intercalibration studies (co-) led by German scientists were successfully completed:

- Dissolved Si isotope intercalibration on seawater from ALOHA, led by P. Grasse (Geomar, Germany) and M. Brzezinski (USA): Grasse *et al.* (2016) (see below)
- Dissolved rare earth element intercalibration on seawater from SAFe, North Pacific, led by M. Behrens and K. Pahnke (ICBM, Germany): Behrens *et al.* (2016) (see below)

New publications (published or in press)

- Behrens, M. K., 2017. Controls on rare earth element and neodymium isotope distributions in the West Pacific: local imprint vs. lateral transport, PhD thesis, University of Oldenburg, pp. 143.
- Behrens, M.K., Muratli, J., Pradoux, C., Wu, Y., Böning, P., Brumsack, H.-J., Goldstein, S.L., Haley, B., Jeandel, C., Paffrath, R., Pena, L.D., Schnetger, B., Pahnke, K., 2016. Rapid and precise analysis of rare earth elements in small volumes of seawater - Method and intercomparison. Marine Chemistry 186, 110-120. doi: doi:10.1016/j.marchem.2016.08.006.
- Bridgestock, L., van de Flierdt, T., Rehkämper, M., Paul, M., Middag, R., Milne, A., Lohan, M.C., Baker, A.R., Chance, R., Khondoker, R., Strekopytov, S., Humphreys-Williams, E., Achterberg, E.P., Rijkenberg, M.J.A., Gerringa, L.J.A., de Baar, H.J.W., 2016. Return of naturally sourced Pb to Atlantic surface waters. Nature Communications 7, 12921.
- Bridgestock, L., Rehkämper, M., van de Flierdt, T., Murphy, K., Khondoker, R., Baker, A.R., Chance, R., Strekopytov, S., Humphreys-Williams, E., Achterberg, E.P., 2017. The Cd isotope composition of atmospheric aerosols from the Tropical Atlantic Ocean. Geophysical Research Letters 44, 2932-2940. doi: 10.1002/2017GL072748.
- Casacuberta, N., Masqué, P., Henderson, G., Rutgers van-der-Loeff, M., Bauch, D., Vockenhuber, C., Daraoui, A., Walther, C., Synal, H.A., Christl, M., 2016. First 236U data from the Arctic Ocean and use of 236U/238U and 129I/236U as a new dual tracer. Earth and Planetary Science Letters 440, 127-134.
- Charette, M.A., Lam, P.J., Lohan, M.C., Kwon, E.Y., Hatje, V., Jeandel, C., Shiller, A.M., Cutter, G.A., Thomas, A., Boyd, P.W., Homoky, W.B., Milne, A., Thomas, H., Andersson, P.S., Porcelli, D., Tanaka, T., Geibert, W., Dehairs, F., Garcia-Orellana, J., 2016. Coastal ocean and shelf-sea biogeochemical cycling of trace elements and isotopes: lessons learned from GEOTRACES. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences 374.
- Ehlert, C., Reckhardt, A., Greskowiak, J., Liguori, B.T.P., Böning, P., Paffrath, R., Brumsack, H.-J., Pahnke, K., 2016. Transformation of silicon in a sandy beach ecosystem: Insights from stable silicon isotopes from fresh and saline groundwaters. Chemical Geology 440, 207-218.

- Filippova, A., Frank, M., Kienast, M., Rickli, J., Hathorne, E.C., Yashayaev, I., Böning, P., Pahnke, K., 2017. Water mass circulation and weathering inputs in the Labrador Sea based on coupled Hf-Nd isotope composition and rare earth element distribution. Geochimica et Cosmochimica Acta 199, 164-184.
- Fröllje, H., Pahnke, K., Schnetger, B., Brumsack, H.-J., Dulai, H., Fitzsimmons, J.N., 2016. Hawaiian imprint on dissolved Nd and Ra isotopes and rare earth elements in the central North Pacific: local survey and seasonal variability. Geochimica et Cosmochimica Acta 189, 110-131. doi: 10.1016/j.gca.2016.06.001.
- Fröllje, H., 2016. Rare Earth Element and Neodymium Isotope Tracing of Element Input and Past Ocean Circulation: Study From North and South Pacific Seawater and Sediments. PhD thesis, University of Oldenburg, pp. 168.
- German, C.R., Casciotti, K.A., Dutay, J.C., Heimbürger, L.E., Jenkins, W.J., Measures, C.I., Mills, R.A., Obata, H., Schlitzer, R., Tagliabue, A., Turner, D.R., Whitby, H., 2016. Hydrothermal impacts on trace element and isotope ocean biogeochemistry. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences 374.
- Grasse, P., Brzezinski, M., Cardinal, D., de Souza, G.F., Andersson, P., Closset, I., Cao, Z., Dai, M., Ehlert, C., Estrade, N., Francois, R., Frank, M., Jiang, G., Jones, J.L., Kooijman, E., Liu, Q., Lu, D., Pahnke, K., Ponzevera, E., Schmitt, M., Sun, X., Sutton, J., Thil, F., Weis, D., Wetzel, F., Zhang, A., Zhang, J., Zhang, Z., 2016. GEOTRACES Intercalibration of the Stable Silicon Isotope Composition of Dissolved Silicic Acid in Seawater. Journal of Analytical Atomic Spectrometry, 32(3), 562–578. http://doi.org/10.1039/C6JA00302H.
- Laukert, G., 2017. Ocean circulation and shelf processes in the Arctic Mediterranean traced by radiogenic neodymium isotopes, rare earth elements and stable oxygen isotope, PhD thesis, University of Kiel, pp. 172.
- Laukert, G., Frank, M., Bauch, D., Hathorne, E.C., Rabe, B., von Appen, W.-J., Wegner, C., Zieringer, M., Kassens, H., 2017. Ocean circulation and freshwater pathways in the Arctic Mediterranean based on a combined Nd isotope, REE and oxygen isotope section across Fram Strait. Geochimica et Cosmochimica Acta 202, 285-309.
- Milne, A., Schlosser, C., Wake, B.D., 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, 2377-2387. doi: 10.1002/2016GL072314.
- Poehle, S., Koschinsky, A., 2017. Depth distribution of Zr and Nb in seawater: The potential role of colloids or organic complexation to explain non-scavenging-type behavior. Marine Chemistry 188, 18-32.
- Rutgers van der Loeff, M., Venchiarutti, C., Stimac, I., van Ooijen, J., Huhn, O., Rohardt, G., Strass, V., 2016. Meridional circulation across the Antarctic Circumpolar Current serves as a double 231Pa and 230Th trap. Earth and Planetary Science Letters 455, 73-84.
- Schlitzer, R., 2016. Quantifying He fluxes from the mantle using multi-tracer data assimilation. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences 374.

- Xie, R., Galer, S.G., Abouchami, W., Rijkenberg, M., de Baar, H., De Jong, J., Andreae, M.O., in press. Non-Rayleigh control of upper-ocean Cd isotope fractionation in the western South Atlantic. Earth and Planetary Science Letters.

Cruises

- **GEOTRACES Process Study GPpr09**, R/V Sonne cruise SO245 to the oligotrophic South Pacific gyre (Antofagasta, Chile-Wellington, New Zealand, Dec. 17, 2015 – Jan. 28, 2016). Chief-Scientist: Tim Ferdelman, MPI Bremen, GEOTRACES PIs: Katharina Pahnke (ICBM, Oldenburg), Peter Croot (Galway), Bob Anderson (LDEO).
- **GEOTRACES Section GN05**, R/V Polarstern cruise PS100 to the Fram Strait (Tromsø-Tromsø, Norway, July 18-Sept. 6, 2016). Chief-Scientist: Torsten Kanzow, AWI. GEOTRACES PIs: Michiel Rutgers van der Loeff, Walter Geibert (AWI), Martin Frank (Geomar), Micha Rijkenberg (NIOZ).

New projects and/or funding

- The cruise proposal for a detailed study on trace metals and dissolved organic matter in the Amazon estuary and in the associated plume of the freshwater discharge into the Atlantic Ocean (*RV Meteor*) has been approved (PIs: Andrea Koschinsky (main PI), Thorsten Dittmar, Martin Frank). Once the cruise is included in the cruise schedule of *RV Meteor*, the cruise will be proposed to GEOTRACES as a process study.

PhD theses

- Henning Fröllje (summa cum laude), 2016, Rare Earth Element and Neodymium Isotope Tracing of Element Input and Past Ocean Circulation: Study From North and South Pacific Seawater and Sediments. ICBM University of Oldenburg (Supervisor: K. Pahnke)
- Melanie Behrens, 2017, Controls on rare earth element and neodymium isotope distributions in the West Pacific: local imprint vs. lateral transport. ICBM University of Oldenburg (Supervisor: K. Pahnke)
- Georgi Laukert (summa cum laude), 2017, Ocean circulation and shelf processes in the Arctic Mediterranean traced by radiogenic neodymium isotopes, rare earth elements and stable oxygen isotopes. University of Kiel (Supervisor: M. Frank)
- Sandra Pöhle, 2017 (submitted), Input and Particle Reactivity of Tranition Metals from subgroups IV, V and VI in the water column of the Atlantic Ocean. Jacobs University Bremen (Supervisor: A. Koschinsky)

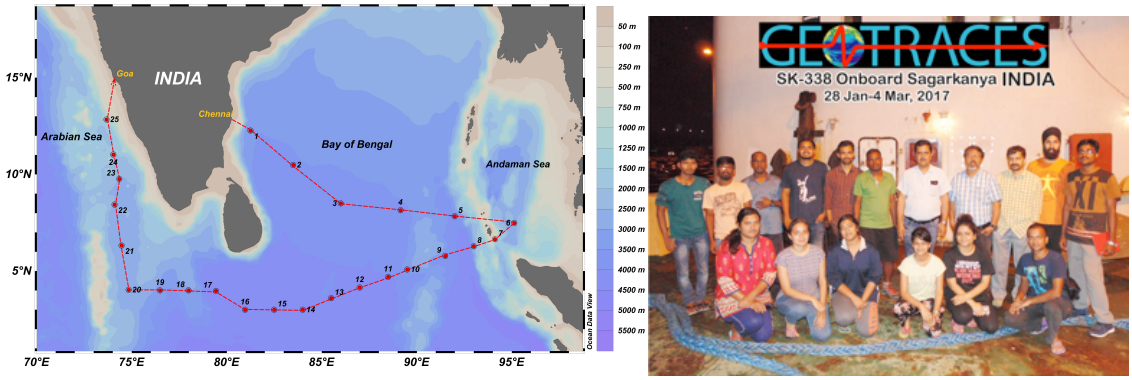
Other activities

The seaFAST system of Jacobs University, Bremen (A. Koschinsky), is currently being installed in the clean lab of the Alfred Wegener Institute in Bremerhaven for the preparation and analysis of contamination-prone elements in seawater such as Ti. Samples from GEOTRACES cruise M121 (GA08, Nov.-Dec. 2015) in the SE Atlantic will be analyzed for dissolved Ti, Zr, Nb, V, Mo, and W.

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

The GEOTRACES-India cruise in the Indian Ocean

The GEOTRACES-India cruise onboard Sagar Kanya (SK 338, GI10; Fig. 13) was started on January 28, 2017 from Chennai and ended on March 3, at Goa with about 20 participants (Fig. 14). During 35 days of cruise time samples for trace elements and isotopes in seawater, sediments and aerosol have been collected in the Bay of Bengal, the Andaman Ocean, the Indian Ocean and the Arabian Sea in 25 sampling stations. The cruise was successful and most of the objectives of the cruise were met. For the first time, McLANE pumps were operated successfully to collect the particulate matter.



Figures 13 and 14. *Cruise track for SK 338 and the participants.*

Dissolved Zinc (DZn) distributions from the Northeastern and Indian Oceans

Total dissolved Zinc (DZn) were analyzed in 12 full vertical profiles to understand their distributions in the northeastern Indian Ocean including Andaman Sea and Indian Ocean. DZn was measured using flow injection system by fluorometric detection. Overall, the DZn concentrations range from 0.24 nM to 11.53 nM with surface low and increased with depth, indicating a typical nutrient type distribution. Relatively high surface (≤ 25m) concentrations was observed in the northern stations closer to the river prone Ganga-Brahmaputra, Irrawady and Salween rivers compared to the southern stations. A strong Zn-Si relationship was observed in all stations sampled in the northeastern Indian Ocean with a slope consistent to a global average value. Decoupling of Zn and Si in some of the stations where dissolved oxygen is less than 50 µM has been observed in the transect.

Dissolved eHf in the Indian Ocean

As a part of GEOTRACES-India programme, Hf isotopic compositions were measured, for the first time, in the Arabian Sea and North-East (N-E) Indian Ocean water columns. Surface waters in the northen AS are unradiogenic in ε_{Hf} compared to southern AS, indicating the continental input from the Himalaya and aeloian inputs. ε_{Hf} varies within a narrow range of -2.16 to 2.14 in the intermediate to bottom waters of the Arabian Sea. In the N-E Indian Ocean waters, ε_{Hf} varies from -10.35 to +7 .78.Surface waters of the Indian Ocean are quite less radiogenic Hf, which is possibly resulting from the dissolution of unradiogenic Hf from the sediments delivered from the G-B system in the north and dust deposition from Australian deserts in the southern Indian Ocean. Deep and bottom waters of Andaman Sea having high

radiogenic ε_{Hf}, which could be due to local input from volcanics. Deep and bottom waters in the BoB also moderately less radiogenic, could be due to leaching of sediment discharged from the G-B system. The intermediate waters of the BoB are radiogenic in Hf, similar to those of the Andaman Sea which indicates the supply of the intermediate water from the Andaman to the Eastern BoB. However, the deep and bottom waters from the Indian Ocean display a ranges of 0.32 to 4.96 and -0.56 to +3.95respectively.

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

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN IRELAND

May 1st, 2016 to April 30th, 2017

National and international service

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

New Results

- Radium Quartet in the North East Atlantic: Measurements of the Radium quartet were undertaken during CE16008 & CE16009 along the western Irish continental shelf and the North East Atlantic. Samples for 223Ra, 224Ra and 226Ra were measured using a RADDEC and 228Ra is being assessed by 224Ra in-growth over time. Preliminary data for 223Ra and 224Ra have indicated new potential ground water sources along the Irish coast.
- Titanium in the South Pacific: Data collected from a transect across the South Pacific during Sonne expedition SO245 is currently being finalized for publication. This data is being assessed in terms of the water mass contributions for Ti in South Pacific water masses and the role of scavenging in this low dust supply region.
- Dr Sarah Nicholas (NUI Galway) was a co-author on a Nature Geosciences paper on iron cycling in the water column supplied by hydrothermal vents resulting from GEOTRACES GP16 (Fitzsimmons et al., 2017).
- New work was published on the role of reactive oxygen species on metal and CDOM/FDOM cycling along the Mauritanian coast (Heller et al., 2016). This work suggests that some FDOM originally classified as terrestrial may be produced in situ in marine environments.

Cruises

- Biogeochemical (Radium isotopes, Nutrients) and optical measurements (CDOM/FDOM) during Western European Shelf Pelagic Acoustic Survey (WESPAS). Expedition on the Celtic Explorer (16 June - 30 July, 2016, CE16008 & CE16009, Galway to Cork & Cork to Falmouth). (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 10-17, CV16035, Galway to Galway). (iCRAG project)
- NUI Galway is collaborating with IFREMER during the HERMINE hydrothermal vent expedition (March 2016) and will analyse samples collected during that expedition for Ti.
- 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) are carrying out a resurvey of the A02 line for GO-Ship using the Irish vessel *RV Celtic Explorer* (April – May 2017). This is the first time that an Irish research vessel has been 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 participated as an at sea POGO lecturer on the recent North South Atlantic (NoSoAT) training school onboard the *RV Polarstern* from Bremerhaven to Cape Town during Oct/Nov 2016. During this training school Prof Croot ran the physical oceanography program and also introduced the students to the work of GEOTRACES.

Other activities

- COST Action TD1407: Network on technology-critical elements (NOTICE), Prof Peter Croot is a co-chair of WG1 which is involved in intercalibration efforts for TCEs (e.g. REE, Pt group etc).
- Synchrotron work on marine aerosols and particles at ALS in Berkeley, USA and ESRF in Grenoble, France. Collaboration with LEMAR and IFREMER in France. Aerosol collection at Mace Head (in collaboration with Sarah Nicholas & Darius Ceburnis).
- NUI Galway hosted a joint SMART/POGO Atlantic Ocean Climate School in Galway in Sept 2016. This summer school was attended by 30 international students from all around the world.

Projects

- Determination of the Radium quartet along the western Irish shelf (iCRAG project)
- Spatially-resolved speciation of Fe aerosols entering the waters of the Irish Shelf. Analysis of aerosols collected at Mace Head using μXRF and μXANES at beamline 10.3.2 at the Advanced Light Source – Lawrence Berkeley National Laboratory (USA).

New publications (involving GEOTRACES researchers in Ireland):

- Fitzsimmons, J.N., John, S.G., Marsay, C.M., Hoffman, C.L., Nicholas, S.L., Toner, B.M., German, C.R., Sherrell, R.M., 2017. Iron persistence in a distal hydrothermal plume supported by dissolved-particulate exchange. Nature Geosci advance online publication.
- Heller, M.I., Wuttig, K., Croot, P.L., 2016. Identifying the Sources and Sinks of CDOM/FDOM across the Mauritanian Shelf and Their Potential Role in the Decomposition of Superoxide (O2-). Frontiers in Marine Science 3 (132).

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

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN ISRAEL

May 1st, 2016 to April 30th, 2017

This report summarizes activities between June 2016 and April 2017 by scientists in Israel that are related to the GEOTRACES objectives. 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.

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

Research & funding

- ***Sediment traps***: My group operates a sediment trap mooring that has been deployed continuously in the center of the north Gulf of Aqaba/Eilat since January 2014. This mooring combines two types of traps and time resolutions:
  - KC-Denmark cylinder trap stations deployed at five depth points (water depth is 600 meters) that are sampled at a monthly resolution
  - McLane PARFLUX-II time series trap that collects the sinking particulates at a depth of 400 meters (water depth is 600 meters) on a ~daily resolution (between 24-48 hours) across the year
  - The mooring also hosts continuously a S4 current meter (InterOcean Systems, Inc.) that records current direction and velocity at a 10 minute resolution
  - The collected samples are weighted, analyzed for their organic C and N content, $d^{13}C$ and $d^{15}N$ of the organic fraction, major and trace element concentrations of the bulk fraction, ^{230}Th, ^{232}Th, ^{234}U, ^{238}U. Planktonic assemblages are picked from different grain size fractions of the trap material
- ***Dust***: Two dust samplers are deployed continuously at the IUI.
- ***Seawater***: seawater profiles are sampled regularly and analyzed for trace element concentrations. The Pb isotopic composition of seawater is also measured on most of these samples. Seawater profiles have been sampled systematically for 234Th.
- **Funding**: Funding is provided by the Israel Science Foundation as well as collaborative work funded by the Schulich Science Foundation.

Personnel

- During the reporting period, the HUJI/IUI research group includes: two postdocs (Alison Hartman (now at USGS Missouri), Daniel Palchan), a PhD student (Natalie Tchernichovsky), 3 MSc students (Tal Ben-Altabet, Ortal Sava, Merav Gilboa), an undergraduate research assistant (Ohad Steinberg), and a lab technician (Barak Yarden).
- Israeli and international collaborators include: Dr. Ahuva Almogi-Labin (Geological Survey of Israel), Dr. Stephanie Kienast (Dalhousie University), Dr. Adina Paytan (UCSC), Prof. Jerry McManus (LDEO), Dr. Claudia Benitez-Nelson (U South Carolina)

Related publications

- Torfstein A., Teutsch N., Tirosh O., Shaked Y., Rivlin T., Zipori A., Stein M., Lazar B. and Erel Y. (submitted after revision) Chemical characterization of atmospheric dust from a weekly time series in the north Red Sea between 2006-2010. Geochimica et Cosmochimica Acta.
- Torfstein A. and Kienast S.S (in review) No correlation between atmospheric dust and surface ocean chlorophyll-a in the oligotrophic Gulf of Aqaba, northern Red Sea.

Other sampling equipment and facilities at IUI

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

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

Workshops and meetings

- Yeala Shaked presented and participated in the GEOTRACES synthesis workshop: Biogeochemical cycling of trace elements within the ocean, that took place between 1-4 August 2016 in Lamont-Doherty Earth Observatory, Palisades, NY, USA. She has taken the lead on a synthesis paper on availability of iron to phytoplankton in the ocean using GEOTRACES data.
- Yeala Shaked presented in ASLO in Honolulu research on dust as a source of iron to Trichodesmium and had numerous discussions related to the GEOTRACERS synthesis paper

Research & funding

- The research involves 2 PIs (Shaked, Nir Keren), 2 PhD students (Nivi Kessler, Chana Kranzler), a post-doc (Sunbhajit Basu), two research technicians (Murielle Dray, Rachel-Armoza-Zvoluni). 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).
- We combine laboratory studies of cultured cyanobacteria and field studies with natural phytoplankton from Eilat. Emphasis is placed on mechanistic understanding of bio-mediated transformations and uptake of both dissolved and particulate Fe
- The PhD of Chana Kranzeler (HUJI) was approved: “Iron acquisition mechanisms in a unicellular, planktonic cyanobacterium”

- Funding is provided by the Israeli Science Foundation for the study of "Bioavailability of particulate Fe to planktonic cyanobacteria"

Related publications in 2016-2017

- Kranzler, C., Kessler, N., Keren, N. and Y. Shaked. 2016. Enhanced ferrihydrite dissolution by a unicellular, planktonic cyanobacterium: insights into the bioavailability of particulate iron. Environmental Microbiology and Environmental Microbiology Reports. doi:10.1111/1462-2920.13496
- Schoffman H, Lis H, Shaked Y and N. Keren .2016. Iron–Nutrient Interactions within Phytoplankton. Frontiers in Plant Sciences. 7(1223). doi: 10.3389/fpls.2016.01223

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 Fe zonal section across the North Pacific (~47°N) at GP02. Our data revealed important external Fe sources at mid-depth from the Sea of Okhotsk and the continental margin, followed by long-range transport in the formation of Fe-rich intermediate water. We explained the differences in surface macronutrient consumption between the western and eastern gyre as well as the formation of the high nutrient and low chlorophyll region in the whole subarctic Pacific (Nishioka and Obata, in press).

New publications

Twelve papers have been published as shown below

- Eigl, R., P. Steier, S. Winkler, K. Sakata and A. Sakaguchi (2016): First study on 236U in the Northeast Pacific Ocean using a new target preparation procedure for AMS measurements. Journal of Environmental Radioactivity, 162-163, 244-250.
- Ge, T. T., X. C. Wang, J. Zhang, C. L. Luo and Y. J. Xue (2016): Dissolved inorganic radiocarbon in the Northwest Pacific continental margin. Radiocarbon, 58, 517-529.
- Hain, K., T. Faestermann, L. Fimiani, L. Golser, J. Gómez-Guzmán, G. Korschinek, F. Kortmann, C. L. von Gostomski, P. Ludwig, P. Steier, H. Tazoe and M. Yamada (2017): Plutonium isotopes (239–241Pu) dissolved in Pacific Ocean waters detected by accelerator mass spectrometry: No effects of the Fukushima Accident observed. Environmental Science and Technology, 51, 2031-2037.
- Inoue, M., Y. Shirotani, S. Nagao, H. Kofuji, Y. N. Volkov and J. Nishioka (2016): Migration of the FDNPP-derived 134Cs and 137Cs along with 226Ra and 228Ra concentrations across the northwestern North Pacific Ocean. Journal of Environmental Radioactivity, 162, 33-38.
- Ito, M., K. I. Ohshima, Y. Fukamachi, G. Mizuta, Y. Kusumoto and J. Nishioka (2017): Observations of frazil ice formation and upward sediment transport in the Sea of Okhotsk: A possible mechanism of iron supply to sea ice. Journal of Geophysical Research-Ocean, 122, 788-802.
- Kanna N. and J. Nishioka (2016): Bio-availability of iron derived from subarctic first-year sea ice. Marine Chemistry, 186, 189-197.
- Kondo, Y., H. Obata, N. Hioki, A. Ooki, S. Nishino, T. Kikuchi and K. Kuma (2016): Transport of trace metals (Mn, Fe, Ni, Zn and Cd) in the western Arctic Ocean (Chukchi Sea and Canada Basin) in late summer 2012. Deep-Sea Research-I, 116, 236-252.
- Kurisu, M., K. Sakata, C. Miyamoto, Y. Takaku, T. Iizuka and Y. Takahashi (2016): Variation of iron isotope ratios in anthropogenic materials emitted through combustion processes. Chemistry Letters, 45, 970-972.
- Kurisu, M., Y. Takahashi, T. Iizuka and M. Uematsu (2016): Very low isotope ratio of iron in fine aerosols related to its contribution to surface ocean. Journal of Geophysical Research-Atmospheres, 121, 11119-11136.

- Mashio, A. S., H. Obata, H. Tazoe, M. Tsutsumi, A. Ferrer i Santos and T. Gamo (2016): Dissolved platinum in river water and seawater around Tokyo Bay and Otsuchi Bay in Japan. Estuarine, Coastal and Shelf Science, 180, 160-167.
- Nomura, T, A. Sakaguchi, P. Steier, R. Eigl, A. Yamakawa, T. Watanabe, K. Sasaki, T. Watanabe, R. Golser, Y. Takahashi and H. Yamano (2017): Reconstruction of the temporal distribution of U-236/U-238 in the Northwest Pacific Ocean using a coral core sample from the Kuroshio Current area. Marine Chemistry, 190, 28-34.
- Tazoe, H. H. Obata, M. Tomita, S. Namura, J. Nishioka, T. Yamagata, Z. Krube and M. Yamada (2017): Novel method for low level Sr-90 activity detection in seawater by combining oxalate precipitation and chelating resin extraction. Geochemical Journal, 51, 193-197.

Meetings

- We had a national GEOTRACES session during annual meeting of Geochemical Society of Japan 2016 in September 14-16, 2016, for pursuing scientific discussion on recent Japanese GEOTRACES studies (23 papers were presented). This annual meeting was held at Osaka City University, Osaka.
- We had the Goldschmidt Conference 2016 on June 26 - July 1, at Pacifico Yokohama in Kanagawa. During the GS2016, several GEOTRACES-related sessions were held. More than 13 papers were presented by Japanese scientists. We also had 1-day Workshop, " Exploring GEOTRACES data with Ocean Data View" (Organizers: R. Schlitzer, J. Zhang and E. Masferrer) on June 26, 2016.
- We had an international workshop, "East Asia GEOTRACES Workshop: Trace Element and Isotope (TEI) study in the Northwestern Pacific and its marginal seas" on January 16-18, 2017 at Hokkaido University, Hokkaido, to evaluate the current status of trace elements and their isotopes (TEI) studies in the Northwestern Pacific Ocean and its marginal seas, and to identify important scientific questions and directions for future regional collaborative studies. Total of 56 registered scientists from China, Germany, Korea, Russia, Taiwan, United States and Japan, took part in the workshop. The workshop consisted of 5 plenary talks, 17 keynote talks and 25 short topics talks related to GEOTRACES & Bio-GEOTRACES.

Presentations in international meetings

13 papers were presented during the Goldschmidt Conference 2016 as listed below. There were more presentations in the Oceanographic Society of Japan, Japan Geoscience Union etc.

- Amakawa, H., T.-L. Yu and C.-C. Shen. Nd concentration and isotopic composition in the south Indian Ocean and Indian sector of the Southern Ocean. Goldschmidt Conference, Yokohama (JP), June 26 - July 1, 2016.
- Isshiki, K. Distribution of total dissolved chromium in Pacific and Indian Oceans. Goldschmidt Conference, Yokohama (JP), June 26 - July 1, 2016.
- Kondo, Y., H. Obata, N. Hioki, A. Ooki, S. Nishino, T. Kikuchi and K. Kuma. Transport of trace metals (Mn, Fe, Ni, Zn and Cd) in the western Arctic Ocean in late summer 2012. Goldschmidt Conference, Yokohama (JP), June 26 - July 1, 2016.

- Mashio, A., H. Obata, H. Fukuda and H. Ogawa. Distributions and geochemical cycles of platinum in Otsuchi Bay, Japan after the tsunami in 2011. Goldschmidt Conference, Yokohama (JP), June 26 - July 1, 2016.
- Nakayama, N., T. Gamo and H. Obata. Nanometer size fractionation of sulfides over the hydrothermal area in Okinawa Trough. Goldschmidt Conference, Yokohama (JP), June 26 - July 1, 2016.
- Norisuye, K., K. Takahashi, S. Hasegawa, S. Takano, W. Konagaya, Y. Sohrin, H. Obata and T. Gamo. Dissolved bismuth in the subarctic North Pacific. Goldschmidt Conference, Yokohama (JP), June 26 - July 1, 2016.
- Obata, H., T. Kim, T. Gamo and J. Nishioka. Distributions of dissolved zinc in the western and central North Pacific. Goldschmidt Conference, Yokohama (JP), June 26 - July 1, 2016.
- Oka, A. and H. Obata. A modeling study on global distribution of rare earth elements in the ocean. Goldschmidt Conference, Yokohama (JP), June 26 - July 1, 2016.
- Sakaguchi, A., T. Nomura, P. Steier, T. Watanabe, T. Nakakuki, K. Sasaki, Y. Takahashi, A. Yamakawa and H. Yamano. Spatial and temporal distribution of 236U in the northwest Pacific Ocean. Goldschmidt Conference, Yokohama (JP), June 26 - July 1, 2016.
- Takano, S., W. Uehara, K.-C. Shin, T. Hirata, M. Tanimizu and Y. Sohrin. Distributions of Nickel, Copper and Zinc Isotopes in the North Pacific Ocean. Goldschmidt Conference, Yokohama (JP), June 26 - July 1, 2016.
- Wong, K. H., T. Kim, H. Obata and T. Gamo. Distribution and speciation of copper in seawater of East China Sea and its surrounding areas. Goldschmidt Conference, Yokohama (JP), June 26 - July 1, 2016.
- Zhang, J., Q. Liu and Z.-H. Zhao. Water mass analysis and fraction estimates using rare earth elements. Goldschmidt Conference, Yokohama (JP), June 26 - July 1, 2016.
- Zheng, L, T. Minami, S. Takano and Y. Sohrin. Distributions of dissolved trace metals (Al, Mn, Fe, Co, Ni, Cu, Zn, Cd, and Pb) along 160°W in the Pacific Ocean. Goldschmidt Conference, Yokohama (JP), June 26 - July 1, 2016.

Cruise

- One GEOTRACES-related cruise in subtropical northwestern Pacific was conducted to take clean seawater samples for trace element analyses. KH-16-7 cruise by R/V Hakuho-Maru (Dec. 6 – 26, 2016; PI: Ichiro Yasuda).

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

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN THE NETHERLANDS

May 1st, 2016 to April 30th, 2017

New scientific results

Progress is being made with the interpretation and publication of results from cruises GA02 and GA04N. The data from GA04N has been submitted for consideration to Standards and Intercalibration committee for inclusion into the IDP. No cruises have been done in the past year, but we are optimistic about the outcome of pending funding applications. A Neptune multicollector ICP-MS has been installed at NIOZ and we are starting to set-up the required methods for stable isotope measurements in sea water samples.

Water column samples were collected at 18 stations on a GEOTRACES cruise (process study) with *RV Pelagia* from 28th May to 15th June 2016 in the Baltic Sea. Benthic flux measurements with landers and porewater sampling were carried out a selection of stations. Analyses of Fe and other elements are in progress (flow injection for Fe, SEAFAST-ICP-MS analyses).

New publications (published or in press)

- Bridgestock, L., van de Flierdt, T., Rehkämper, M., Paul, M., Middag, R., Milne, A., Lohan, M.C., Baker, A.R., Chance, R., Khondoker, R., Strekopytov, S., Humphreys-Williams, E., Achterberg, E.P., Rijkenberg, M.J.A., Gerringa, L.J.A. and de Baar, H.J.W., 2016. Return of naturally sourced Pb to Atlantic surface waters. Nature Communications, 7: 12921.
- Buck K.N., Gerringa L.J.A., Rijkenberg M.J.A., 2016. An Intercomparison of Dissolved Iron Speciation at the Bermuda Atlantic Time-series Study (BATS) Site: Results from GEOTRACES Crossover Station A. Front. Mar. Sci. 3:262. doi: 10.3389/fmars.2016.00262
- Caprara, S, Buck, K.N., Gerringa, L.J.A., Rijkenberg, M.J.A., Monticelli, D., 2016. A compilation of iron speciation data for open oceanic waters, a Data report. Front. Mar. Sci. 3:221. doi: 10.3389/fmars.2016.00221
- Dulaquais, G.,H. Planquette, S.L 'Helguen, M. J. A. Rijkenberg, and M. Boye (2017), The biogeochemistry of cobalt in the Mediterranean Sea, Global Biogeochem. Cycles, 31, 377–399, doi:10.1002/ 2016GB005478.
- Gerringa, L.J.A., Rijkenberg, M.J.A., Bown, J., Margolin, A.R., Laan, P., de Baar, H.J.W., 2016. Fe-binding dissolved organic ligands in the oxic and suboxic waters of the Black Sea. Front. Mar. Sci. 3:84. doi: 10.3389/fmars.2016.00084
- Lambelet, M., van de Flierdt, T., Crocket, K., Rehkämper, M., Kreissig, K., Coles, B., Rijkenberg, M.J.A., Gerringa, L.J.A., de Baar, H.J.W., Steinfeldt, R., 2016. Neodymium isotopic composition and concentration in the western North Atlantic Ocean: Results from the GEOTRACES GA02 section. Geochim. Cosmochim. Acta, 177: 1–29.
- Margolin, A.R., Gerringa, L.J.A., Hansell, D.A., Rijkenberg, M.J.A., 2016. Net removal of dissolved organic carbon in the anoxic waters of the Black Sea. Mar. Chem. 183, 13-24. doi:10.1016/j.marchem.2016.05.003

- Rolison, J.M., Stirling, C.H., Middag, R., Rijkenberg, M.J.A., 2017. Uranium stable isotope fractionation in the Black Sea: Modern calibration of the 238U/235U paleo-redox proxy. Geochimica et Cosmochimica Acta 203: 69-88.
- van Hulten, M., Middag, R., Dutay, J.C., de Baar, H., Roy-Barman, M., Gehlen, M., Tagliabue, A. and Sterl, A., 2017. Manganese in the west Atlantic Ocean in the context of the first global ocean circulation model of manganese. Biogeosciences, 14(5): 1123-1152
- Vance, D., Little, S.H., Archer, C., Cameron, V., Andersen, M., Rijkenberg, M.J.A., Lyons, T.W., 2016. The oceanic budgets of nickel and zinc isotopes: the importance of sulphidic environments as illustrated by the Black Sea. Philosophical Transactions of the Royal Society A. issue 2081, article ID 20150284
- Vance, D., Little, S.H., de Souza, G.F., Khatiwala, S., Lohan, M.C., Middag., R., 2017 Silicon and zinc biogeochemical cycles coupled through the Southern Ocean. Nature Geoscience, DOI: 10.1038/NGEO2890
- Xie, R.C., Galer, S.J.G., Abouchamie, W., Rijkenberg, M.J.A., de Baar, H.J.W., de Jong, J., Andreae, M.O., submitted. Non-Rayleigh control of upper ocean Cd isotope fractionation in the western South Atlantic. (submitted)
- Dijkstra, N., Kraal, P, Seguret, M.J.M., Gonzalez, S., Rijkenberg, M.J.A., Slomp, C.P. submitted. Phosphorus dynamics in and below the redoxcline in the Black Sea and implications for phosphorus burial. (submitted)

Cruises

- Baltic Sea cruise, *RV Pelagia*, 28th May to 15th June 2016: Nynashamn (Sweden) - Texel (Netherlands).

New projects and/or funding

- 'Iron limitation and viral lysis, phytoplankton caught between a rock and a hard place'. Project funded in the Netherlands polar Programme. PI's Rob Middag and Corina Brussaard.

PhD theses

- Dijkstra, N. 2017. Phosphorus dynamics in the Black Sea and Baltic Sea. Utrecht Studies in Earth Sciences 126. 197p.

Meetings

- Prof. de Baar attended the 2016 GEOTRACES Steering Committee Meeting on behalf of the Dutch GEOTRACES programme.
- Dr. Middag attended the GESAMP workshop 'Changing Atmospheric Acidity and the Oceanic Solubility of Nutrients', held at the University of East Anglia, Norwich, United Kingdom from February 27 through March 2, 2017.

Conference attendance

- Middag, R., van Heuven, S., de Baar, H.J.W., Bruland, K.W.. The Relationships of Dissolved Cadmium with Major Nutrient Phosphate along the Ocean Conveyor of the West Atlantic Ocean. Invited oral presentation at the 2016 Goldschmidt meeting – Yokohama, 29-06-2016, Japan.
- Slagter, H.A., Gerringa, L.J.A., de Baar, H.J.W, Rijkenberg, M.J.A.. Iron in the Arctic Ocean: influence of increasing input of yellow substance. Oral presentation at the Netherlands Polar Programme symposium, The Hague, 03-11-2016, Netherlands
- González, A.G., Slagter, H.A.. Long-term observation program via multi-interdisciplinary oceanographic cruises. Poster presentation at the Netherlands Polar Programme symposium, The Hague, 03-11-2016, Netherlands
- Séguret, M.J.M., Dijkstra, N., Anderson, A., Severmann, S., Rijkenberg, M., Laan, P., Slomp, C.P. (2016). Water column iron dynamics along a shelf-to-basin transect in the Black Sea. Nederlands Aardwetenschappelijk Congres, Veldhoven, The Netherlands.

Outreach activities

- Lecture L.J.A. Gerringa at Nassau scholengemeenschap Breda: 4-2-2016. “Bipolair” zee onderzoek.

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

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN NEW ZEALAND

May 1st, 2016 to April 30th, 2017

New scientific results

- **GEOTRACES GA04N Black Sea and Mediterranean Sea Expedition.** The unique oceanographic properties of the Black Sea and Mediterranean Sea were exploited to better understand how specific processes influence the distributions of trace metals and their isotopes. 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. The Black Sea is the world's largest anoxic marine basin and is an ideal natural laboratory for investigating the behavior of trace metals and their isotopes under variable redox 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 results form the basis of the PhD research programmes of recently completed graduate students John Rolison and Ejin George. We have also measured the Fe and Cd isotopic compositions of surface waters collected from the Mediterranean Sea. This will be followed by Zn isotope analysis of surface waters, and a combined Cd, Zn and Fe isotope investigation of water samples collected from depth profiles in the Mediterranean Sea.

- **GEOTRACES GP13 South Pacific Ocean Expedition**. Using techniques in double spiking and MC-ICPMS, we have obtained measurements of Cd isotopic composition and Cd concentration for water column samples collected from a suite of 8 depth profiles and an additional 15 surface locations along the GEOTRACES GP13 zonal section. This cruise transect extends for 5,500 km from offshore Australia to the remote interior of the subtropical Pacific Ocean, an understudied region of the world's oceans, where Cd concentrations in the upper water column are at ultra-trace levels, and some of the lowest detected globally. These results form the basis of the PhD research of graduate student Ejin George, who submitted his thesis and passed his oral exam in March 2017. These results were presented at the 2016 Goldschmidt Conference in Japan. The Cd isotope and Cd concentration datasets for the GP13 expedition were submitted to the 2017 International Data Product.

New publications (published or in press)

- 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

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

- Ejin George – University of Otago (supervisors: Claudine Stirling, Rob Middag, Sylvia Sander). Title: ''The biogeochemical cycling of cadmium in the southwest Pacific Ocean and Black Sea'. PhD exam passed: April 2017.

Meetings

- C.H. Stirling, E. George, M. Gault-Ringold. Biogeochemical cycling of ultra-trace levels of cadmium in the Southwest Pacific Ocean. *International Goldschmidt Conference*, Yokohama, Japan, June–July 2016.

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

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN NORWAY

May 1st, 2016 to April 30th, 2017

New projects and/or funding

- Dr. Murat Ardelan at the Department of Chemistry at the Norwegian University of Science and Technology (NTNU) is participating in the Nansen LEGACY (http://site.uit.no/nansenlegacy/) a multidisciplinary initiative (project budget ca. 800 million NOK.) to understand and predict the natural and human influences on the Barents Sea ecosystem beyond the present ice edge. Dr. Ardelan will study the trace metal & DOM interactions in the Barents sea.
- A new collaborative PhD. Study on the uptake of Fe by cyanobacteria between the Departments of Chemistry (Dr. Murat Ardelan) and biotechnology at the Norwegian University of Science and Technology (NTNU) has been initiated.

PhD theses

- Nicolas Sanchez will defend his PhD on *Biogeochemistry of Iron in the Patagonia Fjords and Waters around Antarctic Peninsula* in July 2017 at the Department of Chemistry at the Norwegian University of Science and Technology (NTNU), mentored by Dr. Murat Ardelan.

Other activities

- Dr. Phillip Wallhead and collagues at the Biogeochemistry group at The Norwegian Institute for Water Research (NIVA) are developing a ROMS-FABM-ERSEM (Regional Ocean Modeling System- Framework for Aquatic Biogeochemical Model European Regional Seas Ecosystem Model) for the pan-Arctic domain at 20 km resolution. A model hindcast for 1980-2014 is due to be delivered at the end of May 2017 (for the EU H2020 TAPAS project). Although they will not model dissolved Fe in this particular run, ERSEM has flexible elemental stoichiometry and can be used to to model dissolved Fe.
- Wallhead et al. have also previously used SINMOD biogeochemical model to investigate climate change and acidification of the sea floor in the Arctic Ocean and Nordic Seas. They have submitted a publication to JGR Oceans with title: *Bottom water acidification and warming on the Eurasian Arctic Shelves: Dynamical downscaling projections.*

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

New scientific results

• For the first time the trace element (Al, Fe, Mn, Cd, Cr, Co, Cu, Mo, Ni, Pb) speciation in sinking particles in the White Sea was examined using a modified method of selective chemical leaching [Tessier et al., 1979]. Sinking particles were collected by use of 18 sediment traps deployed at different layers of the water column (deployment period varied from 1 month to 1 year). Based on contribution of the lithogenic fraction, the three groups of trace metals were distinguished: 1) Al and Cr as a typical lithogenic elements (till 90% of total content); 2) Fe, Mo, Ni, Co and Cd – with the intermediate contribution of lithogenic fraction (from 50 to 75% of total content); 3) Mn, Cu and Pb as the least lithogenic elements and in the same time the most geochemically labile elements. For each of them a contribution of adsorbed, organic and associated with amorphous hydroxides fractions in sum exceeds 50% (of total content), for Mn this value is the maximal one (to 90%). In direction to the sea bottom the Mn content in the form of hydroxides as well as in the adsorbed ones distinctly increased. Partitioning of the Mn occurrence forms in the sinking particles in the near-bottom layers is close to that in the uppermost (0–2 cm) sediment layer [**Demina et al., 2017**].

• A measurement procedure for determining of Ru, Pd, Ir, Pt and Au mass fractions in ferromanganese deposits by inductively coupled plasma-mass spectrometry after acid digestion and anion exchange pre concentration is presented. To eliminate incomplete recovery after sorption pre concentration of the platinum-group elements (PGE) and Au, a standard addition method was used. Detection limits ranged from 0.02 ng (Pd, Ir) to 0.19 ng (Ru). The measurement results for ferromanganese nodule reference material NOD-A-1 and NOD-P-1 agree with earlier reported values. Intermediate precision of PGE concentration data for nodule reference materials in this work was 5–24% (1s) and could reflect sample heterogeneity [**Berezhnaya, Dubinin, 2017**].

• The age of the pelagic sediments from Brazil Basin was determined using strontium isotope stratigraphy data for biogenic apatite. For layer 0–5 cm the age of sediments was 24.1±0.2 million years, and for layer 86–90 cm it was 24.8±0.2 million years. The average sedimentation rate in the Late Oligocene was close to 13 mm per 1000 years. The chemical composition of ferromanganese micronodules, nodules, and films on weathered volcanic rocks was investigated in these sediments to study minor and major element behavior during the ore-forming process and diagenesis. Hydrogenous Fe-Mn nodule found on the surface of the sediment with Mn/Fe value 1.05–1.95 in its composition was formed at a growth rate of 1.2–2.4 mm per million years, which is 1000 times lower than the growth rate of the buried nodules (Mn/Fe = 0.4) on the horizon 83 cm. During diagenesis, the buried nodule changed the mineral composition (asbolane-buserite partially substituted by goethite), and part of elements (Mn, Ni, Li, Tl) were lost by a nodule, but it kept the elements associated with iron oxyhydroxide (Ce, Th, Be, As, V). The composition of manganese micronodules from two studied layers was determined by two steps of mineralization during oxic and suboxic diagenesis. The Sr isotope composition of manganese micronodules from both layers is the same as for Sr in contemporary ocean water. The $^{143}Nd/^{144}Nd$ value in manganese micronodules differs between sediment layers, reflecting the isotopic composition of Nd in paleoocean at the time of micronodule formation, and did not differ between the size fractions [**Dubinin et al., 2017**].

• The chemical composition of zooplankton of the Kara Sea proper and two bays of Novaya Zemlya Archipelago was determined. The results revealed similar distribution of major, trace and rare-earth elements in zooplankton from the aquatic environments that were studied. The C_{org} comprised 49.5±4.8% of the dry zooplankton weight, while the summed content of other major elements (Na, P, S, K, Mg, Ca) made up to 4.82%. The elements studied were arranged into three groups by the content level: K, S, P, Al, Ti, Sc, Cd, Se, Cs, Rb and Corg corresponded to the average chemical composition of ocean zooplankton, while the contents of Na, Ca, Mg, Fe, Mn, Zn, Sr, Ba, B, Cu, Pb, Cr, Ni, V, Co, Sb, Mo, Ag, Be, Ga and Hg were lower, and Li, As, and U significantly exceeded the respective reference values [**Lobus, 2016**].

• For the dominant species of mesozooplankton (*Senecella siberica*, *Limnocalanus macrurus*, *Calanus* spp.) content of C_{org}, lipids, and also major (Na, Mg, P, S, K and Ca), trace (Li, Be, B, Al, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, As, Se, Rb, Sr, Y, Mo, Ag, Cd, Sb, Cs, Ba, Hg, Tl, Pb, Bi, Th and U) and rare-earth (La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb and Lu) elements has been determined in the Ob River-estuarine system and the adjacent shelf of the Kara Sea. We have revealed high accumulation of Li in *Calanus* spp., which concentration is approximately 350 times more than ones in *S. siberica* and *L. macrurus*. Total accumulation of chemical elements per unit of volume (1 m^3) is higher in *L. macrurus* than in *S. siberica* and *Calanus* spp., 6.63, 0.69, 0.41 mg, respectively. Intensity of biological accumulation of elements and location of the maximum accumulation of elements by zooplankton community depend on the hydrophysical mode in the Ob River estuary. Postmortem change of chemical composition in dead *L. macrurus* has multidirectional character. The revealed distinctions of the chemical composition in alive and dead zooplankton reflect depots of elements in an organism and peculiarities of lifetime accumulation and postmortem transformation of substances [**Lobus et al., *in press***].

• Continuous sampling of aerosols is carried out on the NW coast of the Kandalaksha Bay of the White Sea. Aerosol matter (PM2.5) from 30 filters collected in summer and autumn, 2013, and spring, 2014, was studied by scanning electron microscopy. The elemental composition of aerosol matter was determined by the inductively-coupled plasma mass-spectrometry (ICP-MS) with Agilent 7500. The major portion of aerosol particles collected in summer is of biogenic origin. Heavy metal concentrations in aerosols are at the Arctic background level. The distribution of trace element concentrations is characterized by simultaneous peaks of different elements. The backward trajectory analysis shows an increase in Ni and Cu concentrations corresponding to the arrival of air masses from the western part of the Kola Peninsula where metallurgical industry occurs. That suggests the influence of smelters [**Starodymova et al., 2016**].

• The data on the distribution of atmospheric black carbon (BC) in the marine boundary layer of the North Atlantic and Baltic, North, Norwegian, Barents and White Seas from the 67th research cruises of the RV "*Akademik Mstislav Keldysh*" since August 25 to October 10, 2016 are processed and interpreted. During some parts of the cruise, 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 and regions with gas flaring 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., 2016**].

• Authigenic minerals were studied in Holocene shelf sediments of the Laptev Sea (cold methane seep site, water depth 71 m). The study presents the first finds of large hard carbonate concretions with Mg-calcite cement in recent sediments of the Arctic shelf seas.

These concretions differ from previously reported glendonites and concretions from bottom sediments of the White Sea, Kara Sea, Sea of Okhotsk, etc. A study of the morphology, microstructure, and composition of these newly reported concretions revealed the multistage formation of carbonates (structural varieties of Mg-calcite and aragonite). It was shown that organic matter played an important role in the formation of authigenic carbonates, i.e., in the formation of sedimentary–diagenetic Mg-calcite. The role of methane as a possible source for authigenic carbonate formation was estimated. It was found that methane-derived Mg-calcite accounts for 17–35% of concretion materials. Mg-calcite had $\delta^{13}C\text{-}C_{carb}$ values between –24 and –23‰ and $\delta^{13}C\text{-}C_{org}$ values between –44.5 and –88.5‰. Authigenic carbonate formation in the Arctic shelf seas can act as a biogeochemical filter mechanism limiting methane emissions from bottom sediments to the water column and atmosphere [**Kravchishina et al., 2017**].

• The vertical distribution of chlorophyll *a*, particulate organic carbon and its isotopic composition, total suspended particulate matter, and the structure of the phytoplankton community were studied in the Middle and South Caspian Sea in May–June 2012. The vertical distribution of the values of the organic carbon isotopic composition was primarily controlled by the vertical structure of phytoplankton and chlorophyll *a* in the water column up to ~500 m and by biogeochemical processes at the redox barrier (~600 m layer). A significant amount of weakly transformed chlorophyll *a* was found close the sea bottom. The high level of the Caspian Sea and processes related to this phenomenon in the water column (formation of stable stratification, development of hypoxia and anoxia, availability of free hydrogen sulfide and methane in depressions, etc.) contribute to slowing the complete transformation of OM in sedimentation, removing incompletely decomposed organic substances from the carbon cycle [**Kravchishina et al., 2016**].

New publications (published or in press) GEOTRACES Compliant and GEOTRACES-related

- Alekseychik P., Lappalainen H.K., Petäjä T., Zaitseva N., Heimann M., Laurila T., Lihavainen H., Asmi E., Arshinov M., Shevchenko V., Makshtas A., Dubtsov S., Mikhailov E., Lapshina E., Kirpotin S., Kurbatova Y., Ding A., Guo H., Park S., Lavric J.V., Reum F., Panov A., Prokushkin A., Kulmala M. (2016) Ground-based Station Network in Arctic and Subarctic Eurasia: an Overview. Geography, Environment, Sustainability. V. 09. No 02. P. 75–88.
- Berezhnaya E.D., Dubinin A.V. (2017) Determination of Platinum Group Elements and Gold in Ferromanganese Nodule Reference Samples. Geostandards and Geoanalytical Research. V. 41. No 1. P. 137–145. DOI: 10.1111/ggr.12130
- Berezhnaya E.D., Dubinin A.V. (2017) Determination of the Platinum-Group Elements and Gold in Ferromanganese Nodule Reference Material NOD-A-1. Geochemistry International. V. 55. No. 2. P. 218–224. DOI: 10.1134/S0016702917010037
- Budko D.F., Demina L.L., Lisitsin A.P., Kravchishina M.D., Politova N.V. (2017) The Heavy Metal Occurrence Forms in the Modern Bottom Sediments of the White and Barents Seas. Doklady Earth Sciences. V. 474. No 1. P. 93–98.
- Demina L.L., Bud'ko D.F., Alekseeva T.N., Filippov A.S., Novigatsky A.N., Kochenkova A.I. (2017). The Distribution of Geochemically Different Fractions of the Group of Heavy Metals (Mn, Fe, Cd, Co, Cr, Cu, Mo, Ni, Pb) in the Processes of Early Diagenesis of Bottom Sediments of the White Sea. Geochemistry International. No 1. P. 107–112.

- Dubinin A.V., Uspenskaya T.Yu., Rimskaya-Korsakova M.N., Demidova T.P. (2017) Rare Elements and Nd and Sr Isotopic Composition in Micronodules from the Brazil Basin, Atlantic Ocean. Lithology and Mineral Resources. V. 52. No. 2. P. 81–101. DOI: 10.1134/S0024490217020043
- Kravchishina M.D., Lein A.Yu., Savvichev A.S., Reykhard L.E., Dara O.M., Flint M.V. (2017) Authigenic Mg-Calcite at a Cold Methane Seep Site in the Laptev Sea. Oceanology. V. 57. No. 1. P. 174–191. DOI: 10.1134/S0001437017010064
- Kravchishina M.D., Lein A.Yu., Pautova L.F., Klyuvitkin A.A., Politova N.V., Novigatsky A.N., Silkin V.A. (2016) Vertical Distribution of Suspended Particulate Matter in the Caspian Sea in Early Summer. Oceanology. V. 56. No. 6. P. 819–836. DOI: 10.1134/S0001437016050064
- Lobus N.V. (2016) Elemental Composition of Zooplankton in the Kara Seaand the Bays on the Eastern Side of Novaya Zemlya. Oceanology. V. 56. No 6. P. 809–818. DOI: 10.1134/S0001437016050088
- Lobus N.V., Drits A.V., Flint M.V. (In press) Accumulation of Chemical Elements in the Dominant Species of Copepods in the Ob Estuary and the Adjacent Kara Sea Shelf. Oceanology.
- Makarov V.I., Popova S.A., Shevchenko V.P. (2016) Long-term Trends in Black (Elemental) Carbon Concentrations in the Ambient Air of West Siberia and the White Sea Region. Chemistry for Sustainable Development. V. 24. No. 4. P. 459–465.
- Shevchenko V.P., Kopeikin V.M., Evangeliou N., Lisitzin A.P., Novigatsky A.N., Pankratova N.V., Starodymova D.P., Stohl A., Tompson R. (2016) Atmospheric Black Carbon Over the North Atlantic and the Russian Arctic Seas in Summer–Autumn Time. Chemistry for Sustainable Development. V. 24. No. 4. P. 441–446.
- Shevchenko V.P., Vinogradova A.A., Lisitzin A.P., Novigatsky A.N., Panchenko M.V., Pol'kin V.V. (2016) Aeolian and Ice Transport of Matter (Including Pollutants) in the Arctic. In: Implications and Consequences of Anthropogenic Pollution in Polar Environments. From Pole to Pole (Ed. R. Kallenborn). Springer. P. 59–73.
- Starodymova D.P., Shevchenko V.P., Sivonen V.P., Sivonen V.V. (2016) Material and Elemental Composition of Surface Aerosols on the North-Western Coast of the Kandalaksha Bay of the White Sea. Atmospheric and Oceanic Optics. V. 29. No 6. P. 507–511. DOI**:** 10.1134/S1024856016060154

New projects and/or funding

- Russian Science Foundation (RSF) project No. 14-27-00114-P "Sediment-biogeochemical studies of seas of the European part of Russia (dispersed sedimentary matter, bottom sediments, diagenesis). Interaction of geospheres, particle and energy fluxes", 2017–2018, under the direction of Academician A.P. Lisitzin.
- Programme of Presidium of Russian Academy of Sciences, project No. 0149-2015-0056 "Biogeochemistry of heavy metals and natural processes of biosorption purification of seas and oceans" under the direction of Dr L.L. Demina.
- Russian Foundation of Basic Research (RFBR) grant No. 16-05-00037 "Pelagic "biofilter" at the river-sea boundary: patterns of functioning in the large Arctic rivers estuaries" under the direction of Ph.D. A.V. Drits.

Meetings

- EGU General Assembly, Vienna, 23–28 April 2017. Poster presentation: Evangeliou N., Shevchenko V.P., Yttri K.E., Echhardt S., Sollum E., Pokrovsky O.S., Kobelev V.O., Korobov V.B., Lobanov A.A., Starodymova D.P., Vorobyev S.N., Thompson R., Stohl R. Elemental carbon in snow from Western Siberia and Northwestern European Russia during spring 2014, 2015 and 2016.
- XXIII Workshop "Siberian Aerosols" in Tomsk, Russia, November 29 – December 02, 2016. Oral presentation by Starodymova D.P., Vinogradova A.A., Zaharova E.V., Shevchenko V.P., Sivonen V.P., Sivonen V.V. Trace-elemental composition of near-the-ground aerosols on NW Kandalaksha Bay coast of the White Sea (in Russian).

Cruises GEOTRACES-related

- Shirshov Institute of Oceanology of Russian Academy of Sciences (IO RAS) cruise to the North Atlantic along 60°N: the 51th cruise of *RV Academik Ioffe*, June 3 – July 13, 2016, cruise leader is Dr Sergey Gladyshev. Our objectives for the expedition include 1) studying of the Deep Winter Convection – Labrador Sea water formation in the Irminger Sea; 2) Western Boundary Current System formation – role of the cascading from the shelf; 3) studying of lateral and vertical fluxes of suspended particulate matter – concentration, quantity, chemical composition (macro- and microelements including metals); 4) paleoclimatic reconstructions (sediment corer sampling) with which her research interests are well aligned (Fig. 14).

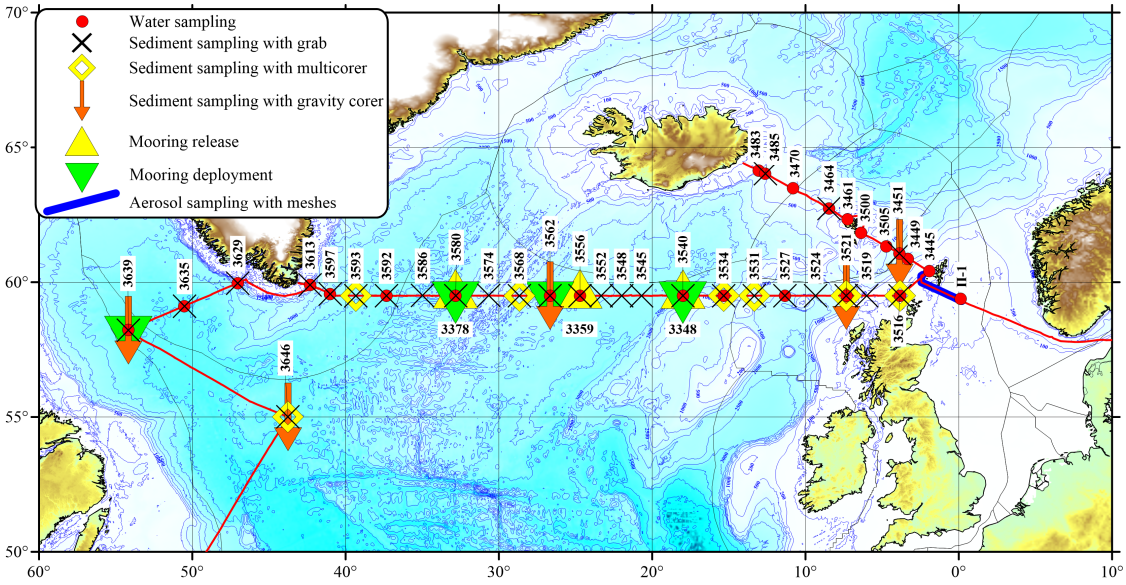


Figure 14. *The map of sampling sites in 51th cruise of RV Akademik Ioffe, June–July 2016.*

- IO RAS cruise to the Kara Sea. The 66th cruise of RV *Academik Mstislav Keldysh*, from July 16 to August 16 2016, cruise leader is Prof. Mikhail Flint. Multidisciplinary researches of the Kara Sea ecosystem (**Fig. 15**). One of the main object was to evaluate the specificity of the physical, hydrochemical, biological and geochemical processes of the ecosystems of the Kara Sea in the areas of large-scale impact desalinating runoff of the Ob and Yenisei rivers.

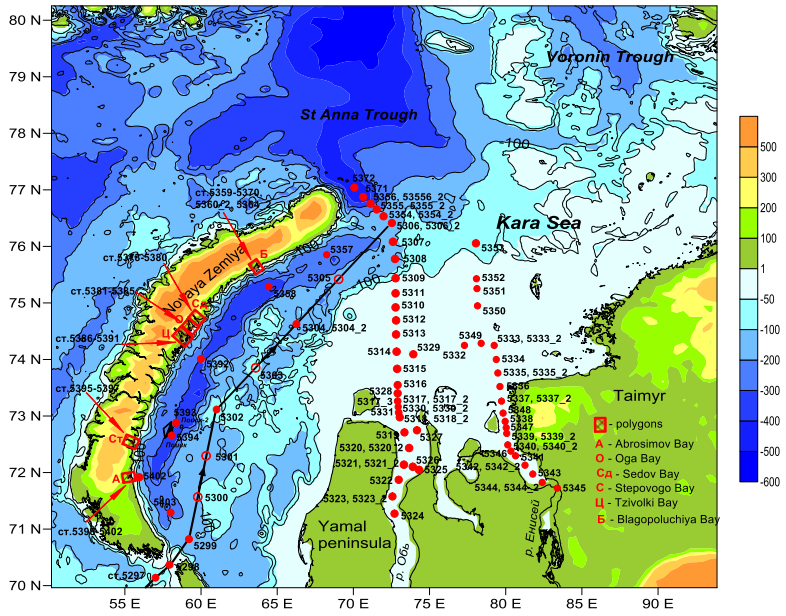


***Figure 15**. The map of sampling sites during 66th cruise of RV Academik Mstislav Keldysh, July–August 2016.*

- IO RAS cruise to the Barents Sea: the 67th cruise RV *Academik Mstislav Keldysh* from August 25 to October 10, 2016. The main objectives were modern sedimentation processes researches including biogeochemical studies of suspended particulate matter and bottom sediments [**Fig. 16**].

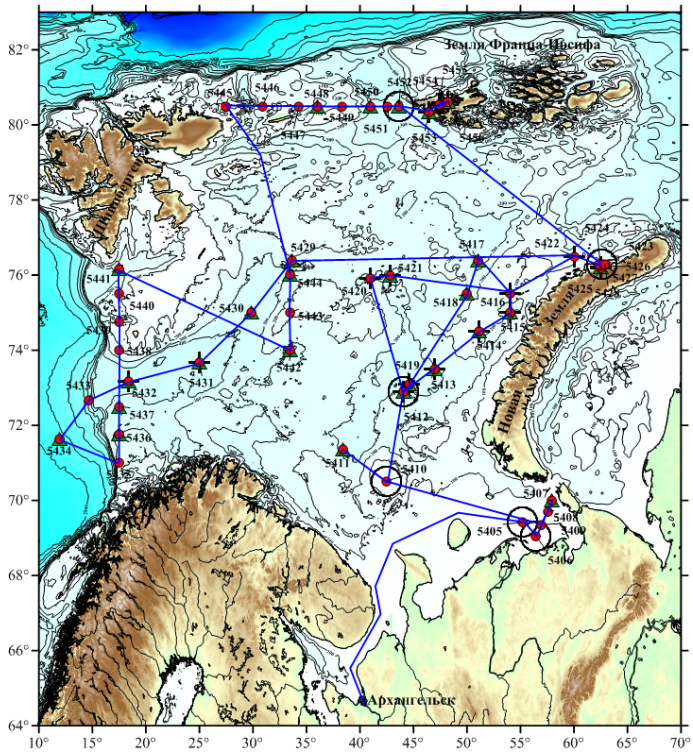


***Figure 16**. The map of sampling sites during 67th cruise of RV Academik Mstislav Keldysh, August–October 2016. Circle – water samples collecting; triangle – multicorer samples; cross – geological gravity corer; big circle – mooring deployment.*

- Marine Hydrophysical Institute of RAS and IO RAS cruise to the Black Sea: the 91th cruise of RV *Professor Vodyanitsky*, November 16 – December 5, 2016. The related studies of the system – particulate matter of the water column (suspended particulate matter, trapped matter) and the upper sediment layer makes it possible to reveal most fully the processes of sedimentogenesis and early diagenesis.

Outreach activities

- We announced the opportunities for cooperation in trace element research with Russia: http://www.geotraces.org/news-50/news/116-news/1215-opportunities-for-cooperation-in-trace-element-research-with-russia
  We noted a great interest to our expedition in 2017. We've received some proposals from Europe, United States of America and Australia. The expedition was planned by IO RAS (http://ocean.ru/) on board *RV Akademik Mstislav Keldysh*. The main purpose of the complex researches is studying of the Arctic Seas' ecosystems, including the climate change, continental discharge and biological productivity, particulate and dissolved matter pathways.
  We are planning to collect samples for joint trace element researches with our colleagues from University of Southern Mississippi (USA) and Macquarie University (Australia).

Other activities

- New sediment traps and other necessary equipment for moorings deployment in the Barents Sea and the North Atlantic.

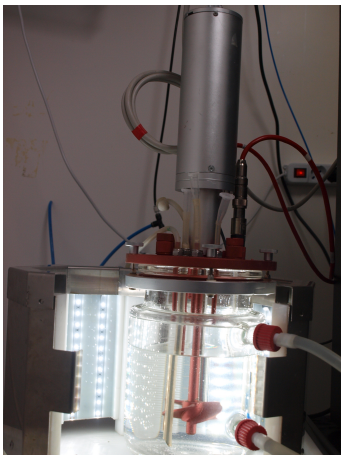
Submitted by Marina Kravchishina (kravchishina@ocean.ru)

New scientific results

- The research performed on mercury cycling in the marine ecosystems was related to the optimization of the method for direct determination of MeHg in seawater with the detection limit in the range of 3.94–15.9 fM. The hydride generation volatilization coupled with cryogenic trapping, separation by gas chromatography and detection by cold vapor atomic fluorescence spectrometer after pyrolysis was used. Method performance was compared with the reference ethylation method and results from a previous study. Sample repeatability represents the biggest single contribution to the expanded standard uncertainty in hydride generation, together with recovery in ethylation method.
- Further dissolved gaseous mercury (DGM) was studied in surface and deep waters of the Mediterranean Sea over the last 15 years during several oceanographic cruises on board the Italian research vessels Urania and Minerva Uno, covering the Western and Eastern Mediterranean Basins as well as Adriatic Sea as its northernmost part. DGM represents a considerable portion of THg (on average 20%) in Mediterranean waters. DGM was the highest in the northern Adriatic, the most polluted part of the Mediterranean Sea as a consequence of Hg mining in Idrija and heavy industry in northern Italy, and near the Gulf of Lion. Generally, average DGM concentration was higher in the West and East Mediterranean Deep Waters (WMDW and EMDW) and Levantine Intermediate Water (LIW) than in overlaying Modified Atlantic Water (MAW); however, it was the highest in N Adriatic Surface waters (NAdSW) and consequently in outflowing Adriatic Deep Waters (AdDW). In deep water profiles the portion of DGM typically increased at depths with oxygen minimum and then towards the bottom, especially in areas with strong tectonic activity (Alboran Sea, Strait of Sicily, Tyrrhenian Sea), indicating its bacterial and/or geotectonic origin.
- Despite the distance from large anthropogenic emission sources, toxic mercury is transported via the atmosphere and oceans to the Southern Ocean. Seawater samples were collected at selected stations and were analysed for total mercury (HgT) (8 stations), dissolved gaseous mercury (DGM) (62 stations) and methylmercury (12 stations) during winter (Weddell Sea), spring (Weddell Sea) and summer (Amundsen and Ross Seas) in the Southern Ocean. The HgT distribution in water columns was found to not vary significantly with depth. In the Weddell Sea the average column concentration was higher in spring (2.6 ± 1.3 pM, 2 stations) than in winter (2.0 ± 1.0 pM, 6 stations). We hypothesize that the seasonal HgT increase is due to atmospheric deposition of particulate Hg(II) formed during atmospheric mercury depletion events (AMDEs), as well as the addition of inorganic mercury species from melting sea ice and snow. Furthermore, HgT concentrations found in this study were significantly higher than previously measured in the Southern Ocean, which was hypothesized to be due to seasonal variations in atmospheric deposition. The average water column DGM concentration in the Weddell Sea was 454 ± 254 fM in winter and 384 ± 239 fM in spring. The lowest average DGM concentration was found in summer in the Amundsen and Ross Seas (299 ± 137 fM). The highest observed concentration in winter was hypothesized to be caused by the larger sea ice coverage, which is known to reduce the evasion of Hg(0) from the sea surface. The average monomethylmercury (MMHg) concentration in the Weddell Sea was 60 ± 30 fM in winter (6 stations) and 95 ± 85 fM in spring (2 stations), showing no significant seasonal difference. In the Amundsen and Ross Seas the summer average concentration of MeHg

(MMHg and dimethylmercury; DMHg) was 135 ± 189 fM (4 stations). The highest MeHg concentration was found in modified circumpolar deep water, which is known to have high primary production.

- The changes of acetylcholinesterase activity (AChE), metallothioneins content (MTs), catalase activity (CAT) and lipid peroxidation (LPO) were assessed after 4 days exposure of mussels *Mytilus galloprovincialis* to a wide range of sublethal concentrations of chlorpyrifos (CHP, 0.03–100 μg/L), benzo(*a*)pyrene (B(*a*)P, 0.01–100 μg/L), cadmium (Cd, 0.2–200 μg/L) and copper (Cu, 0.2–100 μg/L). The activity of AChE in the gills decreased after exposure to CHP and Cu, whereas no change of activity was detected after exposure to B(*a*)P and Cd. Both induction and decrease of MTs content in digestive gland occurred after exposure to CHP and B(*a*)P, while a marked increase was evident at highest exposure concentrations of Cd. The content of MTs progressively decreased of MTs with increasing concentration of Cu. CAT activity and LPO in the gills did not change after exposure to any of the chemicals. The results demonstrate different response profile in relation to the type of chemical compound, and highlight the potential implications for evaluation of biological effect of contaminants in marine environment.
- This proof of concept study presents 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. 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 (>5m) in the water column and to produce lower chlorophyll a 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. Bayesian Network (BN) is used to predict microbial mechanisms that regulate particulate organic carbon (POC) accumulation. BN predicts POC accumulation by linking biotic factors with environmental conditions using field and experimental data. Enzymatic activity was identified by BN as to have the greatest influence on POC accumulation.
- The total activity of ^{210}Po was determined by alpha-spectrometry in various samples (matrices) collected in the Gulf of Trieste (northern Adriatic Sea) where fresh water inflows, especially from the Isonzo River in the northern part, affect water quality. In seawater and tributaries, up to 80% (mean 49%) of total ^{210}Po was found in particulate form. In sediments, slightly higher levels were encountered in the Isonzo prodelta and in the central (depocenter) part of the gulf. Lower autumn ^{210}Po levels can be a consequence of biological dilution by higher mesozooplankton biomass in the autumn compared to spring. Obtained data show higher ^{210}Po levels in all matrices analyzed in the Gulf of Trieste compared to other Adriatic (central Adriatic) and western Mediterranean areas. The ^{210}Po/^{210}Pb ratios in water, plankton and sediments were mostly below or around 1, while this ratio was much higher at higher trophic levels (up to about 50), reflecting a preferential bioaccumulation of ^{210}Po over ^{210}Pb. Comparison of the relative importance of pelagic and benthic bioaccumulation pathways, excluding the filter feeder bivalves, suggests greater accumulation in pelagic-feeding species.



• The use of stable isotopes in carbon and CO_2 has also an applied value in other field of research for example, for detecting CO_2 leakage from proposed subsea carbon capture and storage (CCS) sites, i.e. usually depleted gas and oil reservoirs or saline formations, which lie below the seabed. CCS is regarded as one of the most important long-term measures for reducing carbon globally. In collaboration with the Institute Nazionale di Oceanografia e Geofisica Sperimentale – OGS Trieste, Italy a mesocosmos experiment was performed in order to decode how different sources (natural, anthropogenic) of CO_2 influence biological systems (phytoplankton) using stable carbon isotopes. The results indicate that differences exist on phytoplankton $\delta^{13}C_{POC}$ between natural and perturbated experiment, therefore $\delta^{13}C_{POC}$ analysis could be a valid tool for measuring CO_2 leakage impacts. Further it was found that algal metabolism does not change in presence of anthropogenic CO_2 source because discrimination values tend to be similar once the system reaches stability.

New publications (published or in press)

- Živković, Igor, Fajon, Vesna, Tulasi, Delali, Obu, Kristina, Horvat, Milena. Optimization and measurement uncertainty estimation of hydride generation-cryogenic trapping-gas chromatography-cold vapor atomic fluorescence spectrometry for the determination of methylmercury in seawater. Marine Chemistry, ISSN 0304-4203. [in press] 2017, 10 str., doi: 10.1016/j.marchem.2017.03.003
- Kotnik, Jože, Horvat, Milena, Begu, Ermira, Shlyapnikov, Yaroslav, Sprovieri, Francesca, Pirrone, Nicola. Dissolved gaseous mercury (DGM) in the Mediterranean Sea: spatial and temporal trends. Marine Chemistry, ISSN 0304-4203. [in press] 2017, 12 str., doi: 0304-4420.
- Nerentorp Mastromonaco, Michelle G., Gårdfeldt, Katarina, Assmann, Karen M., Langer, Sarka, Dulali, Talasi, Shlyapnikov, Yaroslav, Živković, Igor, Horvat, Milena. Speciation of mercury in the waters of the Weddell, Amundsen and Ross Seas (Southern Ocean). Marine Chemistry, ISSN 0304-4203. [in press] 2017, 37 str., doi: 10.1016/j.marchem.2017.03.001
- Perić, Lorena, Nerlović, Vedrana, Žurga, Paula, Žilić, Luka, Ramšak, Andreja. Variations of biomarkers response in mussels Mytilus galloprovincialis to low, moderate and high concentrations of organic chemicals and metals. Chemosphere, ISSN 0045-6535. 2017, vol. 174, str. 554-562, ilustr. doi: 10.1016/j.chemosphere.2017.01.138.
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- Begu, Ermira, Shlyapnikov, Yaroslav, Stergaršek, Andrej, Frkal, Peter, Kotnik, Jože, Horvat, Milena. A method for semi-continuous measurement of dissolved elemental mercury in industrial and natural waters. International journal of environmental analytical chemistry, ISSN 0306-7319, 2016, vol. 96, no. 7, str. 609-626, doi: 10.1080/03067319.2016.1180379.
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- Hines, Mark E., Covelli, Stefano, Faganeli, Jadran, Horvat, Milena. Controls on microbial mercury transformations in contaminated sediments downstream of the Idrija mercury mine (West Slovenia) to the Gulf of Trieste (northern Adriatic). Journal of soils and sediments, ISSN 1439-0108, 2016, doi: 10.1007/s11368-016-1616-x.
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New projects and/or funding

- In November the IAEA BoG approved, the TC interregional project INT7019 "Supporting a Global Ocean Acidification Observing Network towards Increased Involvement of Developing States", where Slovenia is taking an active part. The objective of this project is to build ocean acidification observing capacity and connect countries and regions with an interest in ocean acidification to identify the most sensitive areas and inform policy measures at domestic and inter-regional level.
- European Carbon Dioxide Capture and Storage Laboratory Infrastructure (ECCSEL) project entitled: *"The application of stable isotopes to monitor CO_2 at offshore CCS sites"*. The main objective of the project is to evaluate whether carbon isotope ratios can be used to identify the origin of the CO_2 (from CCS leakage or from natural processes).

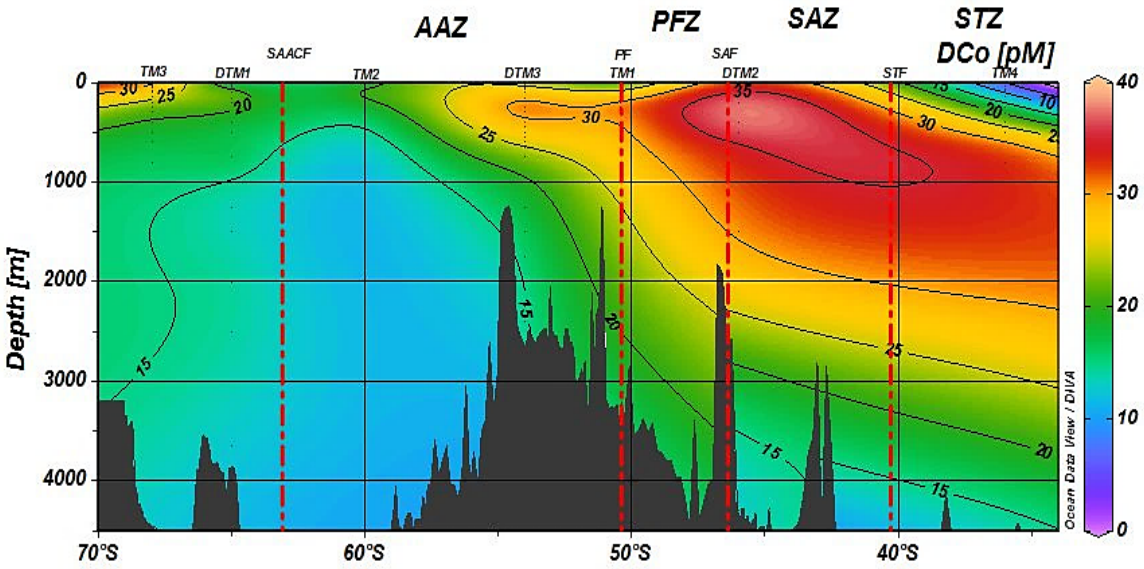
PhD theses

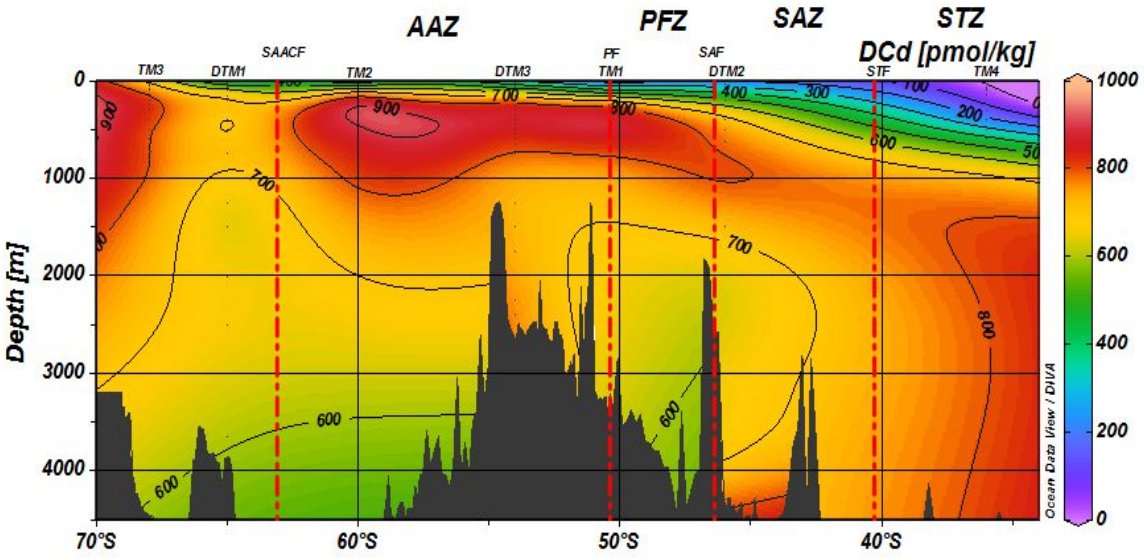
- BEGU, Ermira. *Determination of dissolved elemental mercury in surface and industrial waters: doctoral dissertation,* Ljubljana: [E. Begu], 2016. XXIII, 109 pp.

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

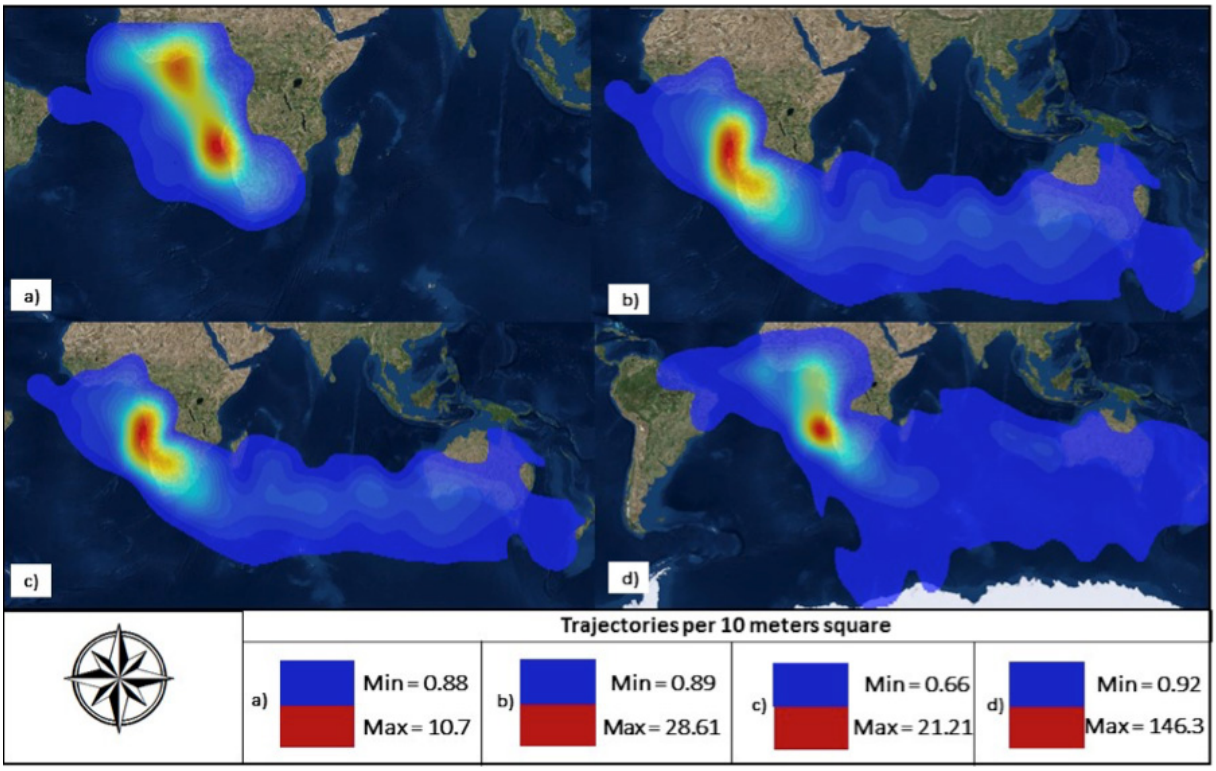
New results

- Co and Cd distribution across zero meridian (Roychoudhury et al. unpublished)





- Modelled trajectories of Southern African dust to Southern Ocean (Fietz et al, unpublished)



Meetings

- S. Fietz, R. Cloete, J. Loock, R. Philibert, A.N. Roychoudhury, N. van Horsten, T. Mtshali, S. Thomalla (2016) Response of Southern Ocean Phytoplankton to iron and light limitation 34th SCAR Biennial Meeting, Kuala Lumpur, Malaysia, August 22 – 26, 2016
- R. Cloete, J. Loock, T. Mtshali, S. Fietz, A.N. Roychoudhury (2016) The distribution and controls of bioactive trace elements (Cu and Zn) in the Atlantic Sector of the Southern Ocean. 34th SCAR Biennial Meeting, Kuala Lumpur, Malaysia, August 22 – 26, 2016 – Awarded Best Student Poster
- J. Loock, R. Cloete, T. Mtshali, S. Fietz, A.N. Roychoudhury (2016) The seasonal distribution and controls of bioactive trace elements cadmium and cobalt in the southern ocean, Atlantic sector. 34th SCAR Biennial Meeting, Kuala Lumpur, Malaysia, August 22 – 26, 2016 Awarded Best Student Oral presentation
- K. Kangueehi, F. D. Eckardt, A. N. Roychoudhury, J. Von Holdt , S. Fietz (2016) Aerosol trace metal concentration and dissolution from known dust sources in Southern Africa. SANAP Symposium, Pretoria, South Africa, July 27 – 29, 2016.
- Viljoen JJ, Fietz S and Roychoudhury AN (2016) Analysis of photosynthetic pigments and CHEMTAX determination of phytoplankton community composition in the Southern Ocean. SANAP Symposium, Pretoria, South Africa, July 27 – 29, 2016
- J. Loock, R. Cloete, S. Fietz, T. Mtshali, A.N. Roychoudhury (2016) The Seasonal Distribution and Controls of Bioactive Trace Elements Cadmium and Cobalt in the

Southern Ocean, Atlantic Sector. SANAP Symposium, Pretoria, South Africa, July 27 – 29, 2016.

Cruises

Winter cruise (Southern Ocean physics and_biogeochemistry) was undertaken along the BONUS-GOODHOPE line in the Southern Ocean to support the following projects (June/July 2016):

1. Seasonal Cycle of Carbon in Southern Ocean – SNA2011112600001
2. Fe and light limitation in Southern Ocean phytoplankton – SNA2011120600005
3. Bioactive trace elements in Southern Ocean – SNA2011110100001
4. Stratification dynamics in the Southern Ocean mixed layer: a high resolution approach – YREF 0000005441
5. Southern Ocean Phytoplankton Adaption to mimicked future changes in light and iron availability - Molecular bases and modelling – SANCOOP 234229
6. Bio-optics - SNA2011120800004

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

Theses

- Ryan Cloete (2017) Measurement and distribution of Dissolved Copper (DCu) and Zinc (DZn) in the Southern Ocean, Atlantic Sector: Validation of an improved seawater collection and ICP-MS based analytical technique. MSc Thesis
- Jean Loock (2017) The meridional biogeochemistry of bio-active trace metals cobalt and cadmium in the Southern Ocean, Atlantic Sector – A simultaneous ICP-MS quantification technique. MSc Thesis

New funding

- Roychoudhury AN (2017-2019) Nanoparticles at Air-Sea interface. NRF Competitive Rated Researcher Grant, R 1,550,000
- Roychoudhury AN (2016) TraceEx: Establishment of Center of excellence in Trace and experimental Biogeochemistry, Donor funding, R 17 Million

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

TISCH Aerosol sampler was acquired by Dr Fietz. The sampler is currently being tested for sampling atop Department of Earth Sciences, Stellenbosch University. The sampler will be installed on Agulhas II to sampling Aerosol particles in the Southern Ocean.

McLane pumps: Two McLane pumps are being acquired by Prof Roychoudhury:

1. WTS-LV08_Dual Filter Mode (4-8 l/min) – 30 Ah high capacity battery pack
2. WTS-LV04 Standard Sampler (1-4 l/min) - D cell batteries

They are expected to arrive in June 2017.

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

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN SPAIN

May 1st, 2016 to April 30th, 2017

GEOTRACES related articles

- Abdou, M., Schäfer, J., Cobelo-Garcia, A., Neira, P., Petit, J.C.J., Auger, D., Chiffoleau, J.-F., Blanc, G., 2016. Past and present platinum contamination of a major European fluvial-estuarine system: insights from river sediments and estuarine oysters. Marine Chemistry, 185: 104-110.
- Almécija, C., Cobelo-Garcia, A., Santos-Echeandía, J., M., Caetano, M., 2016. Platinum in salt marsh sediments: behavior and plant uptake. Marine Chemistry, 185: 91-103.
- Almécija, C., Cobelo-Garcia, A., Santos-Echeandía, J., 2016. Improvement of the ultra-trace voltammetric determination of Rh in environmental samples using signal transformation. Talanta, 146: 737-743.
- Álvarez-Vázquez, M.A., Prego, R., Ospina-Alvarez, N., Caetano, M., Bernárdez, P., Doval, M., Filgueiras, A.V., Vale, C., 2016. Anthropogenic changes in the fluxes to estuaries: wastewater discharges compared with river loads in small rias. Estuarine, Coastal and Shelf Science, 179: 112-123.
- Caetano, M., Raimundoa, J., Nogueira, M., Santos, M., Mil-Homens, M., Prego, R., Vale, C., 2016. Defining benchmark values for nutrients under the water Framework directive: Application in twelve portuguese estuaries. Marine Chemistry, 185: 27-37.
- 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.
- Charette M., Lamb P., Lohan M.C., Kwon E.Y., Hatje V., Jeandel C., Shiler A.N., Cutter G.A., Thomas A., Boyd P.W., Homoky W.B., Milne A., Thomas H., Andresson P., Porcelli D., Tanaka T., Geibert W., Dehairs F., Garcia-Orellana J. 2016. Coastal ocean and shelf-sea biogeochemical cycling of trace elements and isotopes: lessons learned from GEOTRACES. Philosophical Transactions A 374.
- Cerdà-Domènech M, Rodellas V, Folch A, Garcia-Orellana J. Constraining the temporal variation of Ra isotopes and Rn in the groundwater endmember: Implications on the derived SGD estimates. Science of the Total Environment, Accepted
- Mazarrasa I., Marbà N., Garcia-Orellana J., Masqué P., Arias-Ortiz A., Duarte C.M. Carbon burial in Posidonia oceánica meadows. Limnology & Oceanography. Accepted
- Mazarrasa I., Marbà N., Garcia-Orellana J., Masqué P., Arias-Ortiz A., Duarte C.M. Sources of organic carbon to Posidonia oceanica sediment stocks. Limnology & Oceanography. Accepted
- Martinez Soto M.C., Tovar- Sánchez A., Sánchez-Quiles D., Rodellas V., Garcia-Orellana J., Basterretxea G. 2016. Seasonal variation and sources of dissolved trace metal in Maó Harbor, Minorca Island. Science of the Total Environment 565, 191 – 199.
- Masferrer E, Garcia-Orellana J, Gonzalez A. 2016. El programa de investigación internacional GEOTRACES. Okeanos 3

- Rial, D., Santos-Echeandía, J., Álvarez-Salgado, X.A., Jordi, A., Tovar-Sánchez, A., Bellas, J. 2016. Toxicity of seabird guano to sea urchin embryos and interaction with Cu and Pb. Chemosphere 145: 384-393.
- Rodellas V., Garcia-Orellana J., Trezzi G., Masqué P., Stieglitz T.C., Bokuniewicz H., Cochran K.J. and Berdalet E. 2017. Using the radium quartet to distinguish sources of submarine groundwater discharge: fresh groundwater vs seawater recirculation through sediments. Geochimica et Cosmochimica Acta 196, 58 – 73.
- Tovar-Sánchez A, Basterretxea G., Ben Omar M., Jordi A., Sánchez-Quiles D., Makhani M., Mouna D., Muya C., Anglès C. Nutrients, trace metals and B-vitamins composition of the lower Moulouya River: a major North African river discharging in the Mediterranean Sea. Estuarine, Coastal and Shelf Science, 176, pp 47-57, 2016 DOI: 10.1016/j.ecss.2016.04.006
- Trezzi, G. , Garcia-Orellana, J. , Rodellas, V., Santos-Echeandia, J., Tovar-Sánchez, A., Garcia-Solsona, E., Masqué, P. 2016. Submarine groundwater discharge: A significant source of dissolved trace metals to the North Western Mediterranean Sea. Marine Chemistry 186: 90-100.
- Trezzi, G., Garcia-Orellana, J., Santos-Echeandia, J., Rodellas, V., Garcia-Solsona, E., Garcia-Fernandez, G, Masqué, P.. 2016. The influence of a metal-enriched mining waste deposit on submarine groundwater discharge to the coastal sea. Marine Chemistry 178: 35-45.
- 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.

Cruises

In the frame of the Spanish national research project MEGOCA (MINECO CTM2014-59244-C3-3-R, IP: A. Tovar-Sánchez), 10 oceanographic campaigns have been carried out in the Gulf of Cádiz (October 2014; December 2014; March 2015; September 2015; November 2015; March 2016; June 2016; September 2016; December 2016). [Fig. 17]. Surficial seawater for trace metals analysis (Ag, Cd, Co, Cu, Fe, Mo, Ni, Pb, V, Zn) were collected in all campaigns.

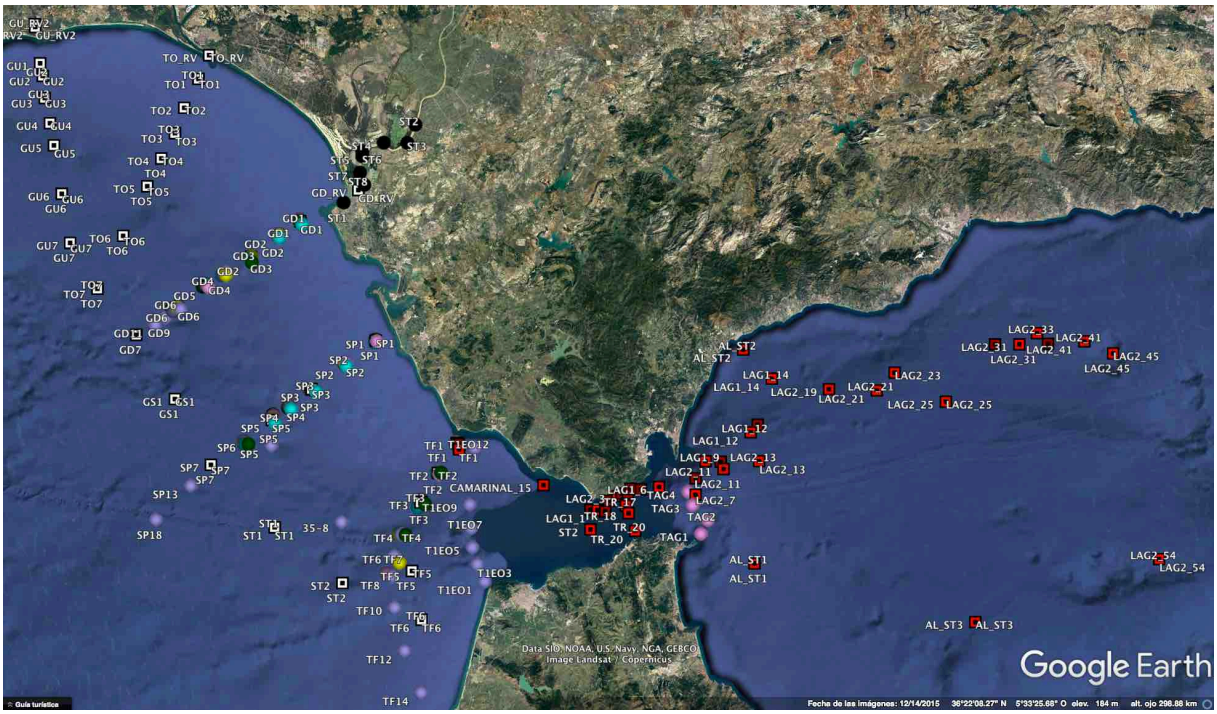


Figure 17. *Stations location of 10 campaigns in the Gulf of Cádiz (Pink dots: October 2014; Green dots: December 2014; Purple dots: March 2015; Yellow dots: September 2015; Cyan dots: November 2015; white squares: March, June, September and December 2016; Mediterranean (red squares: September 2015).*

GEOTRACES related projects

National and Regional:

- Title: Study of trace metal contents in the Golf of Cádiz: influence of Guadiana, Tinto, Odiel and Guadalquivir rivers.
IP: Antonio Tovar Sánchez (ICMAN-CSIC)
Founded by: MINECO CTM2014-59244-C3-3-R.
Period: 1/1/2015 - 31/12/2017

- Title: Recuperação e impactos dos elementos de terras raras provenientes de atividades humanas (REEuse).
IP: Dr. Miguel Caetano (IPMA, Portugal) and Dr. Ricardo Prego as Foreign Scientific Consultant (IIM, CSIC)
Founded by: Ministerio da Eduação e Ciência (Portugal) PTDC/QEQ-EPR/1249/2014
Period: 1/6/2016 – 31/5/2018

- Title: SCORE: Sediments and cold water Corals to address key questions of the Oceans in the past: two case-study Regions and one Experiment.
IP: Carles Pelejero
Founded by: Ministerio de Economía y Competitividad.
Period: 2016-2018

- Title: NUevos REtos en la investigación de cañones submarinos: Indicadores del Estado ambiental y Variabilidad espacio- temporal – El papel de los temporales (NUREIEV).
IP: Miquel Canals (U. of Barcelona).

Funded by: Ministerio de Economía y Competitividad, CTM2013-44598-R.

- Title: MEzcla y DISpersión en el TRAnsporte de Energia y Solutos (MeDistraes).
IP: Jesus Carrera y Maaten W Saaltink.
Funded by: Ministerio de Economía y Competitividad. CGL2013-48869-C2-2-R
Period: 2014-2016.

European:
- Title: COST Action. Network On Technology-Critical Elements: From Environmental Processes To Human Health Threats. http://www.costnotice.net/
IP: A. Cobelo García (IIM - CSIC)
Founded by: European Union (H2020)
Period: 2015 - 2019

- Title: MED-SGD: Submarine Groundwater Discharge, a hidden source of chemical compounds at the land-ocean interface
IP: Pieter Van Beek (University of Toulouse).
Funded by: French ANR (Agence Nationale de la Recherche) - ANR-15-CE01-0004-01

PhD theses

- Student: Maria de la Fuente García

  Title: Marine Carbon Cycle Evolution in the Eastern Equatorial Pacific over the Last Deglaciation". Universidad de Las Palmas de Gran Canaria e Instituto de Ciencias del Mar.
  Date of defense: November 2016

- Student: Giada Trezzi.

  Title: Assessing the significance of submarine groundwater discharge as source of trace metals and Sr to the Mediterranean Sea.
  Advidors: Jordi Garcia-Orellana and Pere Masqué. Universitat Autònoma de Barcelona.
  Date of defense: 29/07/2016.

Meetings

- Álvarez-Vázquez M.A., Prego R., Caetano M., De Uña-Álvarez E. River-ria fluxes of dissolved trace elements: pristine versus anthropogenic disturbed contributions. Oral. Valle, C. et al. (Ed.) 2016. Libro de Resúmenes. XVIII Seminario Ibérico de Química Marina. Universidad de Alicante, Alicante. 114 pp. ISBN pendiente, pp. 14-16.
- Bernárdez P., Prego R., Alvarez-Vazquez M.A., Ospina-Álvarez N., Santos-Echeandía J., Filgueiras Ana V. (2016). Lithogenic sources, composition and intra-annual variability of suspended organic matter and particulate metals supplied from pristine rivers to the Western Cantabrian Sea (Bay of Biscay, SW Europe). En: "Changing Ecosystems: Natural versus Anthropogenic Effects" XV International Symposium on Oceanography of the Bay of Biscay (ISOBAY 15): Programme and abstracts. Servicio Editorial de la Universidad del País Vasco. Depósito legal BI-865-2016, p. 136.
- Brito P., Caçador I., Prego R., Mil-Homens M., Caetano M. Distribution of rare earth elements in estuarine sediments from the Tagus Estuary (Portugal): Evidence of anthropogenic contamination. Poster. Valle, C. et al. (Ed.) 2016. Libro de Resúmenes.

XVIII Seminario Ibérico de Química Marina. Universidad de Alicante, Alicante. 114 pp. ISBN pendiente, pp. 28-29.

- Cobelo-García, A., Neira, P., Santos-Echeandía, J., Besada, V., Bellas, J. Time-series (1991-2014) trends of technology-critical elements accumulation in mussels from an urban coastal área (Vigo Ria, NW Iberian Peninsula). Oral. 32nd International Conference on Environmental Geochemistry and Health. Universite Libre de Bruxelles (Bélgica), 4-8 Julio 2016
- Cobelo-García A., Moran P., Almécija C., Caballero P. 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 and estuary, NW Iberian Peninsula). Oral. XVIII Seminario Ibérico de Química Marina. Universidad de Alicante. Alicante, 20-22 July 2016.
- Cobelo-García A., Tovar-Sánchez A. Dissolved rare earth elements in estuarine and coastal waters of the Gulf of Cadiz (South Spain). Workshop on Environmental Concentrations, Cycling and Modeling of Technology Critical Elements. Rehovot (Israel), 18-19 Enero 2017. (Póster presentation).
- de la Fuente, M., Calvo, E., Skinner, L., Pelejero, C., Müller, W., Evans, D., Povea, P. and Cacho, I. (2016) The evolution of deep ocean chemistry in the Eastern Equatorial Pacific over the last deglaciation. 12th International Conference on Paleoceanography, 28 August - 2 September, Uthrecht, The Netherlands
- Pelejero, C., Sherrell, R.M., Fuertes, S., Kozdon, R., López-Sanz, A., Gagnon, A.C. and Calvo, E. (2016) Experimental proxy calibration in cold water corals. 12th International Conference on Paleoceanography, 28 August - 2 September, Uthrecht, The Netherlands
- Tovar-Sánchez A., Sánchez-Quiles D., Roque D., Cobelo A., Laiz I., Sánchez R., Bruno M.. Distribution and transport of dissolved trace metals in the Gulf of Cádiz, Spain. XVIII SIQM, Alicante: 20-22 July, 2016, Spain (Poster communication).
- A. Tovar-Sánchez, M. C. Martínez-Soto, D. Sánchez-Quiles, J. García-Orellana, A. Jordi, M. A. Huerta-Diaz, G. Basterretxea. Historical record and sources of metals in core sediments from Maó Harbour, Minorca, Spain. XVIII SIQM, Alicante: 20-22 July, 2016, Spain (Poster communication).

Teaching

- Máster Universitario en Oceanografía. Reactividad Química en los Océanos
Professor: Dr. Antonio Tovar-Sánchez
Facultad de Ciencias del Mar, Universidad de Cádiz (España).
Academic years: 2015-16

- Máster Universitario en Oceanografía. Reactividad Química en los Océanos
Professor: Dr. Antonio Cobelo García
Facultad de Ciencias del Mar, Universidade de Vigo (España).
Academic years: 2015-16

- Tovar-Sánchez A. *The role of the sea surface microlayer in the biogeochemcial cycles of trace elements*. Ponencia - Seminario Postgrado y Oceanografía. Universidad Autónoma de Baja California. 31 de Agosto de 2016. Ensenada. México

Other activities

- Acquisition of an autonomous rosette equipped with ultra clean bottles (PVDF and POM), hydrographic sensors (pressure and temperature) and an electro-hydraulic bottle firing module. Configuration of the system is made via a wireless network through a graphic interface on a remote device. The system is designed with closed-Inyection: bottles keep closed during deployment and are activated to suction water at the target depths selected in the configuration.

  The rosette is operated by a portable electric winch equipped with a drum and cable guide system made of POM and 600 m of Kevlar rope.

- New Clean room. The Institute of Marine Sciences of Andalusia (ICMAN –CSIC) has included a Clean Room as a new facility for environmental studies involving trace elements analysis.

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

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN SWEDEN

May 1st, 2016 to April 30th, 2017

This report covers activities led by Per Andersson. David Turner's work has focused on SCOR WG145, for which a separate report is included as Appendix I.

New scientific results

- Preliminary data on 232Th, 230Th and 231Pa from the Arctic Ocean (R/V Polarstern 2015 cruise ARK XXIX/3, PS94) are assembled and quality checked during 2016. Preliminary sections are shown at the end of the report on courtesy by Sandra Gdaniec.

Intercalibration

- Participated in the GEOTRACES Si isotope intercalibration led by Mark Brzezinski UC Santa Barbara, USA, and during 2016 the results were evaluated and published.

New publications (published or in press)

- Grasse P., Brzezinski M.A., Cardinal D., F. de Souza G., Andersson P., Closset I., Cao Z., Dai M., Ehlert E., Estrade N., François R., Frank M., Jiang G., Jones J.L., Kooijman E., Liu Q., Lu D., Pahnke K., Ponzervera E. Schmitt M., Sun X., Sutton J.N., Thil F., Weis D., Wetzel F., Zhang A. and Zhang J. (2017) GEOTRACES Intercalibration of the Stable Silicon Isotope Composition of Dissolved Silicic Acid in Seawater. http://doi.org/10.1039/C6JA00302H *Journal of Analytical Atomic Spectrometry* 32(3), 562-578.
- Trezzi G., Garcia-Orellana J., Rodellas V., Masqué P., Garcia-Solsona E. and Andersson P.S. (2017). Assessing the role of submarine groundwater discharge as a source of Sr to the Mediterranean Sea. http://dx.doi.org/10.1016/j.gca.2016.12.005 *Geochimica et Cosmochimica Acta*, 200, 42-54.

PhD theses

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

Meetings

- Workshop in Biogeochemical cycling of trace elements within the ocean 1 – 4 August 2016, Lamont-Doherty Earth Observatory, Palisades, NY, USA. Sandra Gdaniec, PhD-student participated in the workshop at LDEO in New York presenting her project: "Total and particulate 231Pa, 230Th and 232Th distributions in the Mediterranean Sea".

Abstract

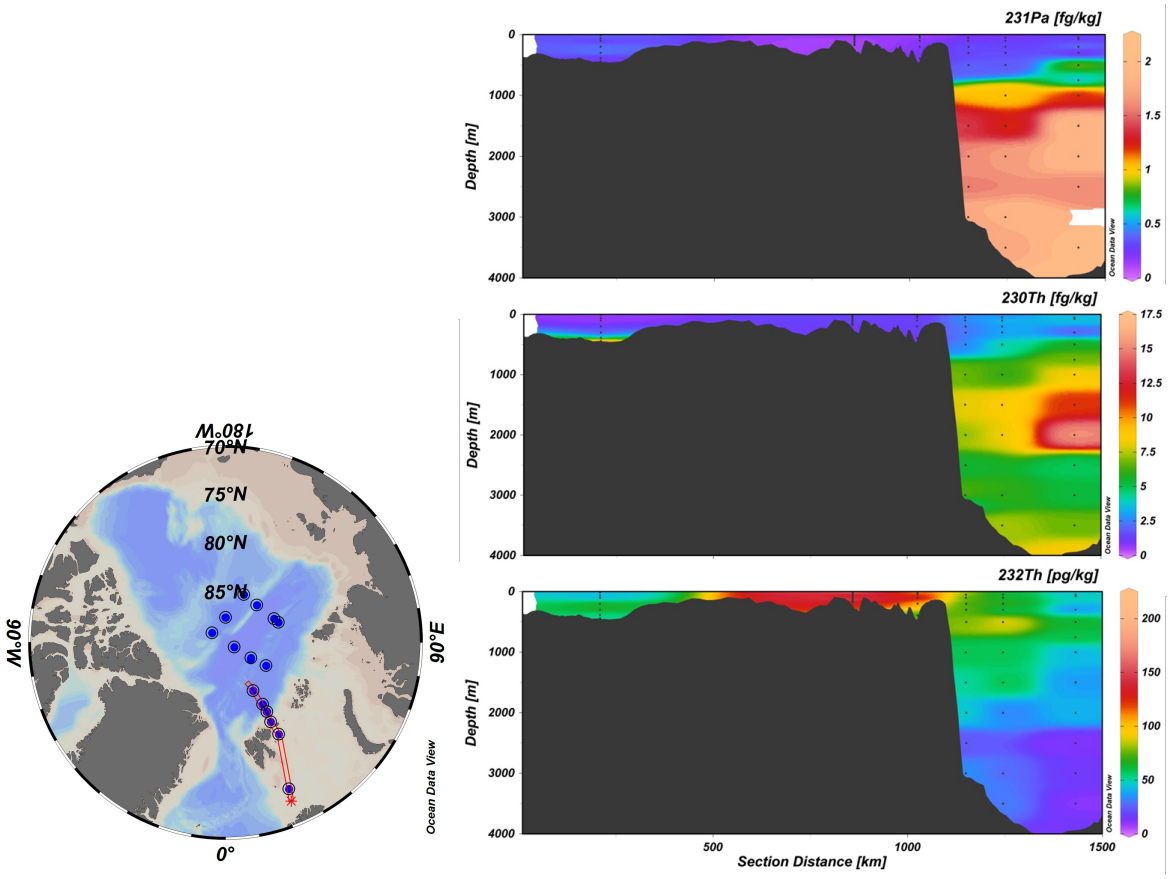
- Gdaniec S., Roy-Barman M., Levier M., Messiaen L., Foliot L., Dapoiggny A., Valk O., Rugers van der Loeff M. and Andersson P.S. (2017). 231Pa and 230Th in the Barents Sea and the Nansen basin: implications for shelf-basin interactions and changes in particle flux Goldschmidt Conference, August 2017, Paris

Outreach activities

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

  http://www.nrm.se/en/besokmuseet/utstallningar/expeditioner.9003720.html

Preliminary data on ^{232}Th, ^{230}Th and ^{231}Pa from the Barents Sea-Nansen Basin, Arctic Ocean (*R/V Polarstern* 2015 cruise ARK XXIX/3, PS94)



(Unpublished, preliminary data from Sandra Gdaniec)

Submitted by David Turner (david.turner@marine.gu.se).

New scientific results

- Bloom and Bust! 2016-7 was the year in which the key role of Southern Ocean diatoms in coupling the global ocean nutrient distributions of silicon and zinc was demonstrated. Published in Nature Geoscience, this new study resolved a long-standing puzzle in ocean biogeochemistry, and serves to reemphasize the importance of the Southern Ocean in whole ocean carbon cycling.

  Vance, D., Little, S.H. et al. (2017), Nature Geoscience.

  http://www.geotraces.org/science/science-highlight/1353-the-coupled-zinc-silicon-cycle-paradox-solved

- New insights into the functioning of the ocean iron cycle made in recent years has led to a revised view of the controls on the oceanic cycling of iron. This new vision places unique constraints on the ocean biogeochemical models we rely on for exploring hypotheses and projecting the impacts of change. A set of priorities for furthering our understanding in the coming years were articulated that can set the agenda for transformation in understanding that can allow us to ultimately place iron within the context of a unifying theory of resource cycling in the ocean.

  Tagliabue, A et al. (2017), Nature.

  http://www.geotraces.org/science/science-highlight/1372-iron-oceanic-cycle

- The spring-time growth and decomposition of ocean phytoplankton enhances the consumption of oxygen and the release of an important nutrient, dissolved iron, by shelf sediments. Klar and co-workers found dissolved iron that escaped the seafloor was unusually persistent in oxygen-rich shelf seawater of the UK, and suggest it results from the supply of organic compounds from the sediments, which can bind iron and enhance its solubilty in the ocean.

  Klar, J.K. et al. (2017), Biogeochemistry.

- Following the near complete global cessation of leaded petrol use, Bridgestock and colleagues have found that up to 30-50% of natural Pb, derived from mineral dust, can now be found in tropical Atlantic surface waters. By measuring the Pb isotope signature of surface waters and aerosols, the success of the phase out of leaded gasoline could be documented. The tropical Atlantic is however an area of particularly high mineral dust flux, and overall anthropogenic activities will remain the dominant source of Pb to most other areas in the global ocean.

  http://www.geotraces.org/science/science-highlight/1291-testament-of-environmental-policies

  Bridgestock et al., (2016), Nature Communications.

- What constraints the hydrothermal dissolved iron isotopic signature?

  http://www.geotraces.org/science/science-highlight/1360-what-constrains-hydrothermal

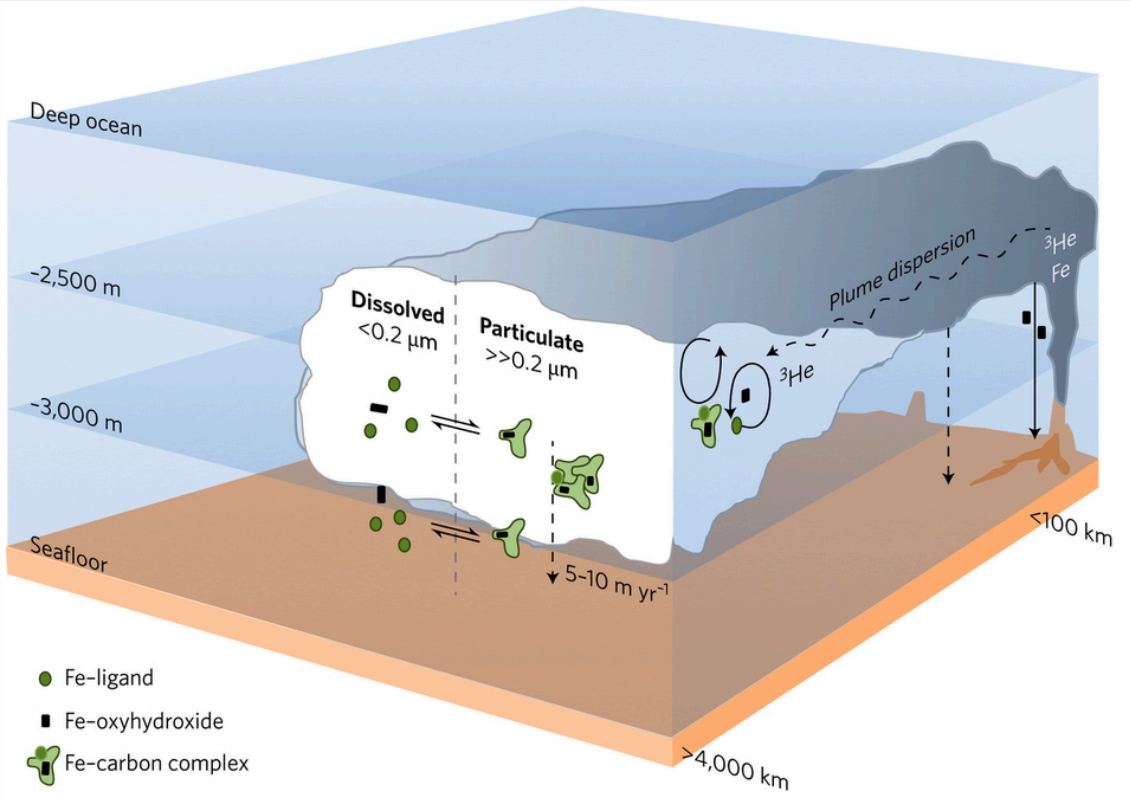
  Lough, A.J.M. et al. (2017), Geochimica et Cosmochimica Acta.

- What controls hydrothermal plume transport of iron over 4000 km in the deep Pacific Ocean?

  Homoky, W.B. (2017), Nature Geoscience, News and Views.

  http://www.geotraces.org/science/science-highlight/1375-hydrothermal-plume-transport

From
Biogeochemistry: Deep ocean iron balance
William B. Homoky
Nature Geoscience **10**, 162–163 (2017) | doi:10.1038/ngeo2908
Published online 20 February 2017



Helium (^{3}He) and iron (Fe) are injected into the Pacific Ocean by hydrothermal venting along the mid-ocean ridge (back right corner). The inert tracer helium and residual iron that is not precipitated near the vent site are dispersed westwards in the neutrally buoyant plume. Fitzsimmons *et al.*[2] find that dissolved iron persists in the plume as ligand-bound iron and nanoscale iron oxyhydroxide minerals, which can form larger organic complexes. Unlike helium, these large complexes or small particles sink slowly in the plume. Fitzsimmons *et al.* contend that dissolved iron continually forms and desorbs and/or disaggregates from particulate iron–carbon complexes rapidly enough for it to seem to sink in tandem with iron particles, suggestive of an equilibrium state for dissolved and particulate forms in the ocean.

Figures index

Figure 18. *The dynamic balance of iron dispersed in a hydrothermal plume.*

New publications (published or in press)

- Baker, A.R. & Jickells, T.D. (2016). Atmospheric deposition of soluble trace elements along the Atlantic Meridional Transect (AMT). Progress in Oceanography, doi:10.106/j.pocean.2016.10.002.
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- Boyd, P.W., Ellwood, M., Tagliabue, A. & Twining, B.S. (2017). Biotic and abiotic retention, recycling, and remineralisation of metals in the ocean. Nature Geoscience, doi:10.1038/ngeo2876.
- Bridgestock, L., van de Flierdt, T., Rehkämper, M., Paul, M., Middag, R., Milne, A., Lohan, M.C., Baker, A.R., Chance, R., Khondoker, R., Strekopytov, S., Humphreys-Williams, E., Achterberg, E.P., Rijkenberg, M.J.A., Gerringa, L.J.A. & de Baar, H.J.W. (2016), Return of naturally sourced Pb to Atlantic surface waters. Nature Communications, 7, doi:10.1038/ncomms12921.
- Bridgestock, L., Rehkämper, M., van de Flierdt, T., Murphy, K., Khondoker, R., Baker, A.R., Chance, R. & Achterberg, E.P (2017), The Cd isotope composition of atmospheric aerosols from the Tropical Atlantic Ocean. Geophysical Research Letters, 44, doi:10.1002/2017GL0272748.
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- Charette, M.A, Lam, P.J., Lohan, M.C., Kwon, E.Y., Hatje. V., Jeandel, C., Shiller, A.M., Cutter, G.A., Thomas, A., Boyd, P.W., Homoky, W.B., Milne, A., Andersson, P.S., Porcelli, D., Geibert, W. & Orellana, J.G. (2016). Coastal ocean and shelf-sea biogeochemical cycling of trace elements and isotopes: lessons learnt from GEOTRACES. Phil. Trans. R. Soc. A, 374 (2081), doi:10.1098/rsta.20160076.
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- Henderson, G M. (2016). Ocean Trace Element Cycles. Phil. Trans. R. Soc. A, 374 (2081), doi:10.1098/rsta.2015.0300.
- Homoky, W.B. (2017). Biogeochemistry: Deep ocean iron balance. Nature Geoscience, 10, 162-163, doi:1038/ngeo2908.
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- van Hulten, M., Middag, R., Dutay, J.-C., de Baar, H., Roy-Barman, M., Gehlen, M., Tagliabue, A. & Sterl, A. (2017). Manganese in the west Atlantic Ocean in the context of the first global ocean circulation model of manganese, Biogeosciences, 14, 1123-1152, doi:10.5194/bg-14-1123-2017.
- Zheng, X.Y., Plancherel, Y., Saito, M.A., Scott, P.M. & Henderson, G.M. (2016). Rare Earth Elements (REEs) in the tropical South Atlantic and quantitative deconvolution of their non-conservative behavior. Geochimica et Cosmochimica Acta, 177, doi:10.1016/j.gca.2016.01.018.

Cruises

- ZIPLOc (Zinc Iron Phosphorus co-limitation in the Ocean).
  21/6/2017 to 12/8/2017, Guadalupe to Tenerife.
  GEOTRACES process study.
  Co-I's: Claire Mahaffey, Alessandro Tagliabue & Maeve Lohan.
- FRidge (The impact of mid-ocean ridges on the ocean's Iron Cycle).
  20/12/17 to 2/2/17, Southampton to Guadalupe.
  GEOTRACES section cruise, GA13.
  Co-I's: Maeve Lohan and Alessandro Tagliabue.

New projects and/or funding

- Amber Annett has won a 5 year NERC Independent Research Fellowship to join the team in Southampton and work on '*Radium in changing Environments: A novel tracer of iron fluxes at Ocean Margins*'. She will be participating in GA13 and in ORCHESTRA Southern Ocean cruises.
- Susan Little has won a 5 year NERC Independent Research Fellowship to stay at Imperial College London and work on '*Beyond Iron in the Ocean: Trace metal micronutrients and the carbon cycle (BIOTrace)*'. She will be involved in the upcoming ZIPLOC cruise and in ORCHESTRA Southern Ocean cruises, as well as in other expeditions with international GEOTRACES scientists.
- Alessandro Tagliabue won an ERC Consolidator grant on '*Role of micronutrients in shaping biological productivity*'.
- Alessandro Tagliabue won funding from the directed NERC Arctic programme for a project entitled '*Can we detect changes in Arctic ecosystems*?'.

PhD theses

- Alistair Lough (2016). '*Trace metal chemistry of hydrothermal plumes*'. University of Southampton. Co-supervisors: Rachel Mills (Soton), Dough Connelly (NOC), Will Homoky (Oxford).
- Katy Murphy (2016). '*Isotopic Studies in Marine Geochemistry*'. Imperial College London. Co-supervisors: Mark Rehkämper, Tina van de Flierdt.

Meetings

- Goldschmidt conference, Yokohama, June 2016
  - Susan Little co-convened session 12f: 'Marine Biogeochemistry at a Range of Scales: The Global Ocean and Polar Atmosphere-Sea Ice-Ocean Systems'.
  - Tina van de Flierdt co-convened session 16a: 'Tracing ocean circulation – past and present'.
  - C. Archer, D. Vance, M. Lohan. 'Zinc and Nickel isotope systematics in the South Atlantic.'
  - A. Bowie, M. Ellwood, P. van der Merwe, K. Wuttig, A. Townsend, A. Baker, M. Thomas & C. Hassler. The distribution of dissolved trace lements across a zonal section of the Southwest Pacific Ocean.
  - A. Bryan, F. Dowdall, G.M. Henderson, D. Porcelli, A. Dickson & S. van den Boorn. Cd isotope signatures of seawater, suspended particulate matter, and surface sediments from the UK GEOTRACES 40°S transect.
  - L. Bridgestock, Y.-T. Hsieh, G.M. Henderson, D. Porcelli, W. Homoky, & A. Bryan. 'Isotopic constraints on the biogeochemical cycle of Ba in the South Atlantic'.
  - S. Little, T. van de Flierdt, D. Wilson, M. Rehkämper, P. Spooner, J. Adkins & L. Robinson. 'Zinc isotopes in deep-sea corals'.
  - H. Goring-Harford, R. James, D. Connelly. Seasonal variations in the chromium isotopic composition of seawater in the Celtic Sea.
  - S. Myriokefalitakis, A. Nenes, N. Mihalopoulos, A.R. Baker & M. Kanakidou. Human-driven changes in dissolved phosphorus deposition to the ocean.
  - Y. Plancherel, X. Zheng, P. Scott, A. Osborne, E. Hathorne, M. Frank & G.M. Henderson. New Insights into ocean circulation and particle interaction from a global dissolved Rare Earth Element dataset.
  - T. van de Flierdt, A.M. Griffiths, M. Lambelet, S.H. Little, T. Stichel & D. Wilson. 'Neodymium in the Oceans: Assessment of a Modern Tracer and Implications for Paleoceanography'.
- International Conference on Paleoceanography, Utrecht, August/September 2016
  - Tina van de Flierdt served on the international organising committee
  - S. Little, T. van de Flierdt, D. Wilson, M. Rehkämper, P. Spooner, J. Adkins & L. Robinson. 'Exploring the potential of Zinc isotopes in deep-sea corals as a palaeo-proxy'.
  - T. van de Flierdt, A.M. Griffiths, M. Lambelet, S.H. Little, T. Stichel & D. Wilson. 'Neodymium in the Oceans: Assessment of a Modern Tracer and Implications for Paleoceanography'.
- Challenger Society Conference, Liverpool, September 2016
  - Susan Little, Will Homoky and Torben Stichel co-convened session S18: Trace element and isotope exchange at ocean boundaries
  - A.J. Birchill, A. Milne, S.J. Ussher, P.J. Worsfold, M. Woodward, C. Harris & M.C Lohan. 'Seasonal cycling of dissolved and colloidal iron in the Celtic Sea'.
  - W.B. Homoky, T. Weber, W.M. Berelson, T.M. Conway, G.M. Henderson, M. van Hulten, C. Jeandel, S. Severmann & A. Tagliabue. 'Highlights from an assessment of trace element and isotope exchange at the ocean–sediment boundary'.
  - A. Milne, A J. Birchill, S. J. Ussher & M. C. Lohan. 'Seasonal changes in the distribution of particulate and dissolved iron in the Celtic Sea'.
- UK Earth System iron-modelling workshop, London, 2016

- W.B. Homoky et al. (NERC SSB: WP3 and collaborators). 'Sediments as a source of iron to the water-column'.

- Aquatic Sciences meeting, Honolulu, February/March 2017
  - W.B. Homoky, T.M. Conway, S.G. John, E.M.S. Woodward & R.A. Mills. 'Model evaluations of pore water iron isotope signatures in the South Atlantic Ocean - implications of benthic exchange'.

- Geochemistry in Progress Meeting (GGRiP), Bristol, April 2017
  - Presentations by A. Griffiths, M. Lambelet and S. Little (Imperial College London)

Outreach activities

- Magazine article targeted a GCSE-educated general public with an interest in ocean science:

  Homoky, W.B. (2016). Elements for life: efforts to measure iron release from the seafloor. Ocean Challenge 21(2), 20-27.

- Blog piece covering conference/field-trip designed to 'hook' new audiences to GEOTRACES activities:

  Homoky, W.B. (2017). Ocean science meets lava in Hawaii, Challenger Society for Marine Science.

  https://challengercaptainsblog.wordpress.com/2017/03/29/ocean-science-meets-lava-in-hawaii-will-homoky/

Other activities

- Tina van de Flierdt hosted the annual Standards and Intercalibration (S&I) committee meeting in January 2017 in London, and Maeve Lohan co-chaired the meeting. Both attended/co-chaired an additional five virtual S&I meetings in the reporting period in order to get ready for the release of IDP2017. Maeve Lohan attended additional meetings with the Data Management Committee (DMC), co-chaired by Alessandro Tagliabue. Both attended the annual DMC and Science Steering Committee (SSC) meeting in Toulouse.

- Together with other international GEOTRACES scientists, Gideon Henderson and Maeve Lohan co-edited a volume of the Philosophical Transactions of the Royal Society A. The volume contains results from the Royal Society discussion meeting on 'Biological and climatic impacts of ocean trace element chemistry' hold in December 2015 in London (see list of publications).

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

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN UNITED STATES

May 1st, 2016 to April 30th, 2017

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

1) Preparing manuscripts manuscripts from Pacific section (GP16),
2) Analyzing samples from the Arctic (GN01),
3) Submitting a management proposal for a Pacific Meridional Section (GP15), and 4) Hosting a synthesis workshop on the internal cycling of TEIs in the ocean.

Cruise-related Activities

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

Eastern Tropical Pacific The deadline to submit manuscripts for a special issue of Marine Chemistry with results from GP16 has been extended until Spring 2017. An absolute deadline has not been announced, but several additional manuscripts have been added to the volume as a result of the deadline extension.

Meanwhile, other papers from GP16 have been published already. Among the novel and exciting results from GP16 that we highlight here is the work from the PhD dissertation of Rene Boiteau at the Woods Hole Oceanographic Institution (see publication list). He has isolated and identified the molecular structures of organic ligands that bind Fe, Cu and Ni in seawater. In a paper in PNAS he showed that marine microbes produce different sets of ligands to bind Fe depending on (a) the availability of Fe and (b) the availability of macro nutrients. In a paper in Frontiers in Marine Science he presented structures of ligands that bind Cu and Ni.

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). Many preliminary results from this cruise, as well as from other arctic sections, were presented during a special session at the 2017 meeting of the Associated Sciences of Limnology and Oceanography held in Honolulu, Hawaii (28 February – 3 March 2017). Investigators involved in GN01 plan to hold a data workshop to be hosted by David Kadko in Miami, Florida, USA from 23 to 26 October, 2017.

Pacific Meridional Section The US GEOTRACES SSC has designated GP15 to be the next section to be carried out by the U.S. program, conditional on funding. A team led by Greg Cutter (Chief Scientist) as well as Phoebe Lam and Karen Casciotti (co-Chief Scientists) submitted a proposal to the US NSF Chemical Oceanography program for its 15 August 2016 proposal deadline to secure ship time and cover major logistics costs (e.g., operation of the trace metal clean sampling system and operation of the in situ pumps) of the expedition. The proposal was recommended for funding. However, funding for science in the U.S. is uncertain at this time. Major cuts to funding have been threatened by the new administration. At the time this report was written, a federal budget for the next fiscal year has not been proposed.

If funding materializes, then the dates of the cruise have been delayed from the proposed target of July – September until later in the year, September – November, 2018. This is later than desired, but the delay was obligated by competing demands for ship time.

Research objectives for GP15 include:

1) Boundary exchange with volcanic margin waters; TEI supply to Subarctic HNLC region
2) TEI distribution within the ocean's oldest water mass
3) TEI distributions within distal portions of hydrothermal plumes of Juan de Fuca Ridge and East Pacific Rise
4) TEI distributions within distal portions of oxygen deficient zones
5) TEI distributions in equatorial zonal jets and upwelling regime
6) Ultra-oligotrophic waters of the southern subtropical gyre
7) Baseline TEIs in western sector of planned sea-bed mining.

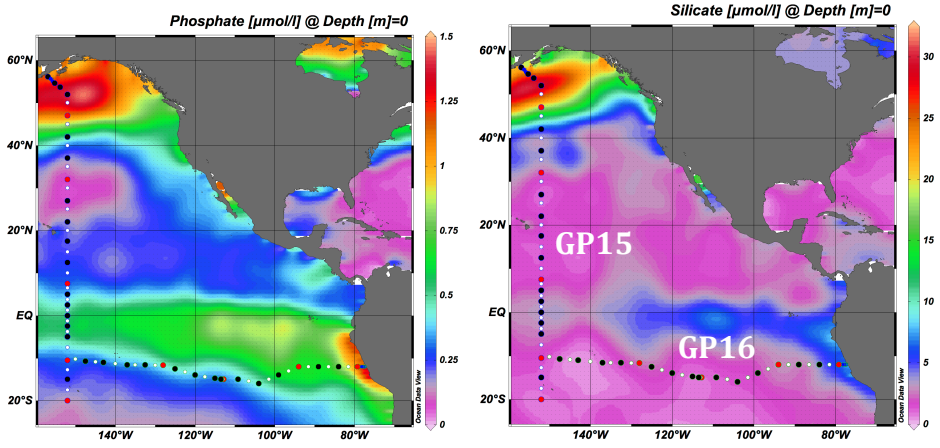

Figure 19. *Station locations proposed for GP15 (along 152°W) and previously occupied on GP16 (along ~12°S) with climatological surface phosphate and silicic acid concentrations (World Ocean Atlas, figures in Ocean Data View).*

Although funding for GP15 is by no means guaranteed, the U.S. GEOTRACES community met 5 - 7 October, 2016, in La Jolla, California, to refine the goals laid out in the U.S. GEOTRACES Pacific Plan (2008) and set scientific priorities for the section. The workshop allowed individual investigators to coordinate their planned research for GP16 well in advance of the 15 February 2017 proposal deadline.

Hoping for a positive outcome of federal budget negotiations, individual investigators submitted proposals to the US NSF Chemical Oceanography program on 15 February, 2017, requesting support for investigation of specific TEIs and groups of TEIs along GP15. Decisions on these proposals should be released in June or July.

Compliant data A cruise aboard the U.S. research ice breaker Nathaniel B Palmer (NBP1702) was carried out between Antarctica and New Zealand during January through March 2017. Station work was concentrated within the Antarctic Circumpolar Current, along 170°W, following the track of the U.S. JGOFS Antarctic Environment and Southern Ocean Process Study (AESOPS) in the late 1990's. Chief Scientist Rebecca Robinson (University of Rhode Island) sampled for nitrogen isotopes to study nitrogen isotope fractionation during biological utilization of upwelled nitrate. Mark Brzezinski (University of California Santa Barbara) collected samples to study silicon isotope fractionation during biological utilization of silicic acid. The group of Robert Anderson (Lamont-Doherty Earth Observatory) sampled

for dissolved ^{230}Th, ^{232}Th and ^{231}Pa. Paulina Pinedo-Gonzalez, a post doc working with Seth John at the University of Southern California, sampled for concentrations and isotopic compositions of dissolved Fe, Zn and Cd. Sampling for N, Si and U-series radionuclides was confined to the upper 1500 m of the water column. Sampling for Fe, Zn and their isotopes was limited to surface waters. Station locations are shown in Figure 2. A cruise report will be provided to the IPO when it is available.

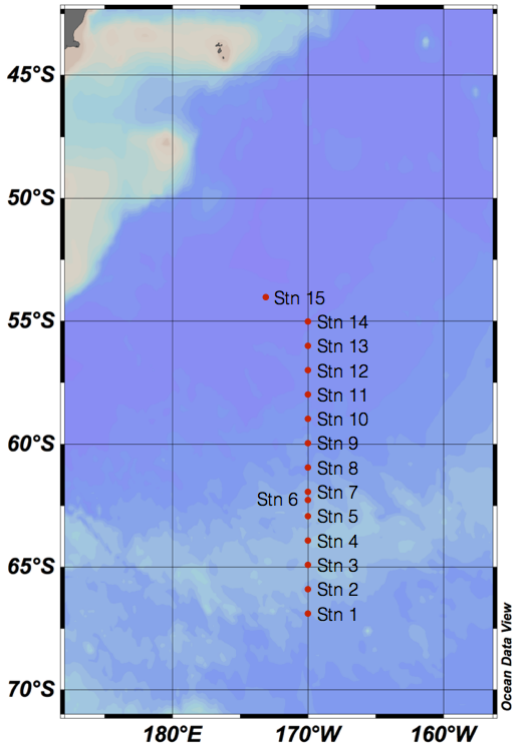

Figure 20. *Station locations proposed for cruise NBP1702 along 170°W crossing the Antarctic Circumpolar Current between Antarctica and New Zealand.*

New Funding

Although no new funding was secured during the past year, as noted above, the management proposal for GP15 was recommended for funding by the US NSF Chemical Oceanography program. The management proposal will support cruise logistics, such as nutrient analyses and hydrography as well as the sampling systems to be shared by all investigators (Niskin rosette, trace metal clean rosette, in situ pumps). Funding decisions on the proposals to support research on TEIs, which were submitted 15 February 2017, are anticipated in June or July of 2017.

Presentation of results

A large number of presentations based on results from the GN01 section were made at the 2017 meeting of the Associated Sciences of Limnology and Oceanography, Honolulu, Hawaii, USA, as described above. The session, number 17 in the program, was entitled "Biogeochemical Cycling of Trace Elements and Isotopes in the Arctic Ocean."

Additional GEOTRACES presentations were given in Session 25 "Linking Atmospheric Deposition to the Biogeochemistry of Aquatic and Marine Systems" and in session 29 "REE Marine Geochemistry in the 21st Century- A Tribute to the Pioneering Research of Henry Elderfield (1943 – 2016)."

U.S. GEOTRACES Meetings

As noted above, 62 investigators from the US GEOTRACES community with an interest in participating in GP15 assembled for a cruise planning workshop held in La Jolla, California from 5 - 7 October 2016. Plenary speakers were invited to discuss hydrography and circulation in the North Pacific as well as primary productivity, nutrient dynamics and particle dynamics, all of which are thought to influence the distributions of trace elements and their isotopes along the GP15 section.

Members of the US GEOTRACES SSC also attended the workshop, and held a closed meeting during the afternoon of 7 October to finalize priorities for the GP15 section. These priorities were announced to the US GEOTRACES community and posted, along with other information to aid in preparing proposals, on the US GEOTRACES web site: http://usgeotraces.org/USGEOTRACES_website/documents/pacificDOC/WSPac2016/WSPAC%202016Proposal_Prep_Docs.html

Synthesis Meetings

The second foundational workshop in support of international GEOTRACES synthesis activities was held at the Lamont-Doherty Earth Observatory, Palisades, New York, USA from 1-4 August, 2016. The workshop, entitled "Biogeochemical cycling of trace elements within the ocean: A synthesis workshop" was sponsored jointly by US GEOTRACES and by the Ocean Carbon and Biogeochemistry Program. More than 100 investigators from 12 nations participated in the workshop.

Plenary talks were streamed live on the web, and videos are available on the workshop web site along with the slides from the plenary presentations and from the working group summaries: http://web.whoi.edu/geotraces-synthesis/

The workshop was organized around three themes related to the internal cycling of trace elements and their isotopes within the ocean:

- Biological uptake and trace element bioavailability
- Abiotic cycling and scavenging, including particulate and dissolved speciation
- Export, recycling and regeneration

Working groups formed around specific topics related to each of the themes above and developed recommendations for future work on each topic. From these recommendations, 12 specific topics were identified for further development as synthesis papers. Workshop participants then reformed new working groups to establish a strategy for preparation and publication of these synthesis papers.

As of the time this report is written, several manuscripts are in progress, but none are ready for submission. The internal cycling workshop will provide an empirical comparison of two fundamentally different approaches to synthesis. The first GEOTRACES synthesis workshop, on the supply and removal of trace elements at ocean boundaries (December, 2015, London UK), required invited speakers to prepare manuscripts for publication in a special volume of the Philosophical Transactions of the Royal Society (Henderson, G M. Ocean trace element cycles. 2016. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences* 374: DOI: 10.1098/rsta.2015.0300). The internal cycling workshop, with its bottom-up approach to the selection of synthesis papers, will provide an

interesting contrast to the first workshop. We look forward to compiling the lessons learned from these experiences.

A summary of the anticipated products of the internal cycling workshop is provided in Appendix I of this report.

Outreach Activities

The most noteworthy outreach activity of the past year was the successful publication of a children's book illustrating the experiences of US GEOTRACES Scientists in the Arctic Ocean aboard HLY1502 (GN01).

The book, by Katlin Bowman and Elizabeth Saito, entitled "To the Top of the World" is featured on the GEOTRACES web site: http://www.geotraces.org/outreach/other-outreach-materials/educational-initiatives/1293-geotraces-expedition-children-book-2

Although it is scheduled after the nominal annual cycle covered by this report, we note that Chris Measures and Mariko Hatta of the University of Hawaii will share a public presentation entitled "Oceanography in the Arctic and the Disappearing Sea Ice" on 16 May 2017. See http://hi-sci.org/Meetings/May2017.shtml

Data Management

A summary of GEOTRACES data management at the Biological and Chemical Oceanography – Data Management Office (BCO-DMO) is provided in Appendix II.

Publications (GEOTRACES, GEOTRACES Compliant and GEOTRACES-related)

During the past year US GEOTRACES investigators published a total of 30 peer-reviewed journal articles, including papers published by lead authors in other nations for which U.S. GEOTRACES investigators serve as co-authors.

- Anderson, R.F., Cheng, H., Edwards, R.L., Fleisher, M.Q., Hayes, C.T., Huang, K.F., Kadko, D., Lam, P.J., Landing, W.M., Lao, Y., Lu, Y., Measures, C.I., Moran, S.B., Morton, P.L., Ohnemus, D.C., Robinson, L.F., Shelley, R.U., 2016. How well can we quantify dust deposition to the ocean? Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 374, DOI: 10.1098/rsta.2015.0285.
- Baker, A.R., Landing, W.M., Bucciarelli, E., Cheize, M., Fietz, S., Hayes, C.T., Kadko, D., Morton, P.L., Rogan, N., Sarthou, G., Shelley, R.U., Shi, Z., Shiller, A., van Hulten, M.M.P., 2016. Trace element and isotope deposition across the air–sea interface: progress and research needs. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 374, DOI: 10.1098/rsta.2016.0190.
- Bates, S.L., Hendry, K.R., Pryer, H.V., Kinsley, C.W., Pyle, K.M., Woodward, E.M.S., Horner, T.J., 2017. Barium isotopes reveal role of ocean circulation on barium cycling in the Atlantic. Geochimica et Cosmochimica Acta, 204, 286-299.
- Behrens, M.K., Muratli, J., Pradoux, C., Wu, Y., Böning, P., Brumsack, H.-J., Goldstein, S.L., Haley, B., Jeandel, C., Paffrath, R., Pena, L.D., Schnetger, B., Pahnke, K., 2016. Rapid and precise analysis of rare earth elements in small volumes of seawater - Method and intercomparison. Marine Chemistry, 186, 110-120.

- Boiteau, R.M., Mende, D.R., Hawco, N.J., McIlvin, M.R., Fitzsimmons, J.N., Saito, M.A., Sedwick, P.N., DeLong, E.F., Repeta, D.J., 2016a. Siderophore-based microbial adaptations to iron scarcity across the eastern Pacific Ocean. Proceedings of the National Academy of Sciences, 113, 14237-14242.
- Boiteau, R.M., Till, C.P., Ruacho, A., Bundy, R.M., Hawco, N.J., McKenna, A.M., Barbeau, K.A., Bruland, K.W., Saito, M.A., Repeta, D.J., 2016b. Structural Characterization of Natural Nickel and Copper Binding Ligands along the US GEOTRACES Eastern Pacific Zonal Transect. Frontiers in Marine Science, 3, 10.3389/fmars.2016.00243.
- Bowman, K.L., Hammerschmidt, C.R., Lamborg, C.H., Swarr, G.J., Agather, A.M., 2016. Distribution of mercury species across a zonal section of the eastern tropical South Pacific Ocean (U.S. GEOTRACES GP16). Marine Chemistry, 186, 156-166.
- Boyd, P.W., Ellwood, M.J., Tagliabue, A., Twining, B.S., 2017. Biotic and abiotic retention, recycling and remineralization of metals in the ocean. Nature Geosci, 10, 167-173.
- Casciotti, K.L., 2016. Nitrite isotopes as tracers of marine N cycle processes. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 374, DOI: 10.1098/rsta.2015.0295.
- Charette, M.A., Lam, P.J., Lohan, M.C., Kwon, E.Y., Hatje, V., Jeandel, C., Shiller, A.M., Cutter, G.A., Thomas, A., Boyd, P.W., Homoky, W.B., Milne, A., Thomas, H., Andersson, P.S., Porcelli, D., Tanaka, T., Geibert, W., Dehairs, F., Garcia-Orellana, J., 2016. Coastal ocean and shelf-sea biogeochemical cycling of trace elements and isotopes: lessons learned from GEOTRACES. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 374, DOI: 10.1098/rsta.2016.0076.
- Chen, M., Boyle, E.A., Lee, J.-M., Nurhati, I., Zurbrick, C., Switzer, A.D., Carrasco, G., 2016. Lead isotope exchange between dissolved and fluvial particulate matter: a laboratory study from the Johor River estuary. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 374, DOI: 10.1098/rsta.2016.0054.
- Conway, T.M., John, S.G., Lacan, F., 2016. Intercomparison of dissolved iron isotope profiles from reoccupation of three GEOTRACES stations in the Atlantic Ocean. Marine Chemistry, 183, 50-61.
- Fitzsimmons, J.N., John, S.G., Marsay, C.M., Hoffman, C.L., Nicholas, S.L., Toner, B.M., German, C.R., Sherrell, R.M., 2017. Iron persistence in a distal hydrothermal plume supported by dissolved-particulate exchange. Nature Geosci, 10, 195-201.
- German, C.R., Casciotti, K.A., Dutay, J.C., Heimbürger, L.E., Jenkins, W.J., Measures, C.I., Mills, R.A., Obata, H., Schlitzer, R., Tagliabue, A., Turner, D.R., Whitby, H., 2016. Hydrothermal impacts on trace element and isotope ocean biogeochemistry. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 374, DOI: 10.1098/rsta.2016.0035.
- Grand, M.M., Chocholouš, P., Růžička, J., Solich, P., Measures, C.I., 2016. Determination of trace zinc in seawater by coupling solid phase extraction and fluorescence detection in the Lab-On-Valve format. Analytica Chimica Acta, 923, 45-54.
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J.N., Thil, F., Weis, D., Wetzel, F., Zhang, A., Zhang, J., Zhang, Z., 2017. GEOTRACES inter-calibration of the stable silicon isotope composition of dissolved silicic acid in seawater. Journal of Analytical Atomic Spectrometry, 32, 562-578.

- Hawco, N.J., Ohnemus, D.C., Resing, J.A., Twining, B.S., Saito, M.A., 2016. A dissolved cobalt plume in the oxygen minimum zone of the eastern tropical South Pacific. Biogeosciences, 13, 5697-5717.
- Hayes, C.T., Rosen, J., McGee, D., Boyle, E.A., 2017. Thorium distributions in high- and low-dust regions and the significance for iron supply. Global Biogeochemical Cycles, 31, 328-347.
- Homoky, W.B., Weber, T., Berelson, W.M., Conway, T.M., Henderson, G.M., van Hulten, M., Jeandel, C., Severmann, S., Tagliabue, A., 2016. Quantifying trace element and isotope fluxes at the ocean–sediment boundary: a review. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 374, DOI: 10.1098/rsta.2016.0246.
- John, S.G., Kunzmann, M., Townsend, E.J., Rosenberg, A.D., 2017. Zinc and cadmium stable isotopes in the geological record: A case study from the post-snowball Earth Nuccaleena cap dolostone. Palaeogeography, Palaeoclimatology, Palaeoecology, 466, 202-208.
- Kadko, D., 2017. Upwelling and primary production during the U.S. GEOTRACES East Pacific Zonal Transect. Global Biogeochemical Cycles, 31, 218-232.
- Kim, J.-M., Baars, O., Morel, F.M.M., 2016. The effect of acidification on the bioavailability and electrochemical lability of zinc in seawater. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 374, DOI: 10.1098/rsta.2015.0296.
- Lamborg, C.H., Hammerschmidt, C.R., Bowman, K.L., 2016. An examination of the role of particles in oceanic mercury cycling. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 374, DOI: 10.1098/rsta.2015.0297.
- Mason, R.P., Hammerschmidt, C.R., Lamborg, C.H., Bowman, K.L., Swarr, G.J., Shelley, R.U., 2017. The air-sea exchange of mercury in the low latitude Pacific and Atlantic Oceans. Deep Sea Research Part I: Oceanographic Research Papers, 122, 17 - 28.
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- Swarr, G.J., Kading, T., Lamborg, C.H., Hammerschmidt, C.R., Bowman, K.L., 2016. Dissolved low-molecular weight thiol concentrations from the U.S. GEOTRACES North Atlantic Ocean zonal transect. Deep Sea Research Part I: Oceanographic Research Papers, 116, 77-87.
- Tagliabue, A., Aumont, O., DeAth, R., Dunne, J.P., Dutkiewicz, S., Galbraith, E., Misumi, K., Moore, J.K., Ridgwell, A., Sherman, E., Stock, C., Vichi, M., Völker, C., Yool, A., 2016. How well do global ocean biogeochemistry models simulate dissolved iron distributions? Global Biogeochemical Cycles, 30, 149-174.
- 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.

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Books and Book Chapters

- Radon: A Tracer for Geological, Geophysical and Geochemical Studies – Springer, M. Baskaran – August 2016 (Book DOI: 10.1007/978-3-319-21329-3; ISBN: 978-3-319-21328-6; ISBN 978-3-319-213329-3 eBook).
- Baskaran, M., 2017a. Applications of Radon Progeny in Atmospheric studies. In: "Radon: A Tracer for Geological, Geophysical and Geochemical Studies" pp. 85-117, Book DOI: 10.1007/978-3-319-21329-3.
- Baskaran, M., 2017b. Radon: A Geochemical and Geophysical Tracer in Marine System. In: "Radon: A Tracer for Geological, Geophysical and Geochemical Studies" pp. 119-144, Book DOI: 10.1007/978-3-319-21329-3.

Dissertations

- Boiteau, R., 2016. Molecular determination of marine iron ligands by mass spectrometry. Vol. PhD (p. 230): Massachusetts Institute of Tecnology - Woods Hole Oceanographic Institution.
- DiMento, B., 2017. An investigation of the major transformations and loss mechanisms of mercury and selenium in the surface ocean. Vol. PhD (p. 181): University of Connecticut.
- Hawco, N.J., 2017. The Cobalt Cycle in the Tropical Pacific Ocean. Vol. PhD (p. 217): Massachusetts Institute of Technology - Woods Hole Oceanographhic Institution.
- Peters, B., 2016. Stable isotope measurements from a cold polar desert and marine oxygen deficient zone reveal clues about the global nitrogen cycle. Earth System Science, Vol. PhD Dissertation (p. 261): Stanford University.

Submitted by Bob Anderson (boba@ldeo.columbia.edu).

APPENDIX I. SWEDEN GEOTRACES

SCOR WG 145

New publications (published or in press)

- Turner, D.R., E.P. Achterberg, C.-T.A. Chen, S.L. Clegg, V. Hatje, M.T. Maldonado, S.G. Sander, C.M.G. van den Berg, M. Wells. 2016. Toward a Quality-Controlled and Accessible Pitzer Model for Seawater and Related Systems. *Frontiers in Marine Science* 3: doi:10.3389/fmars.2016.00139.

New projects and/or funding

- A NERC/NSF project "A Thermodynamic Chemical Speciation Model for the Oceans, Seas, and Estuaries has been funded for 3 years with expected start date 1 July 2017 (PI:s are Simon Clegg, Andrew Dickson and Heather Benway). This project has been designed to provide the research effort needed to address the WG objectives. The WG will also be supported by complementary experimental work carried out at GEOMAR and at the national standards laboratories in France, Germany and Japan.

Meetings

- The WG has not met during this period since the necessary research funding was in doubt before the decision on the NERC/NSF grant. The next meeting will take place in conjunction with Ocean Sciences 2018.

Outreach activities

- The WG is gathering information on user needs for chemical speciation models. A Survey Monkey questionnaire for academic users has been completed and gave valuable information. A complementary Survey Monkey questionnaire for users outside the academic sector has been generated and is now being circulated. Many thanks to Ed Urban for help with these surveys. A publication presenting the two survey results is planned.

APPENDIX II. US GEOTRACES

SUMMARY OF ANTICIPATED PRODUCTS

Synthesis workshop: Biogeochemical Cycling of Trace Elements within the Ocean

Lamont-Doherty Earth Observatory in Palisades New York, USA, 1 – 4 August 2016

Jointly sponsored by GEOTRACES and by the Ocean Carbon and Biochemistry program

Workshop themes:

1) Biological uptake and trace element bioavailability,
2) Abiotic cycling and scavenging, including particulate and dissolved speciation,
3) Export, recycling and regeneration

Recommendations and anticipated products (TEI = trace element and isotope):

Micronutrient group

1) *Estimate Bioavailability of Fe with oceanographic data using the "bioavailability envelope" concept of Lis et al., (ISME Journal, 2015) using GEOTRACES data sets [dissolved Fe from GEOVIDE, KEOPS, NEOPS, (Geraldine), FeCYCLE (Andrew Bowie), and HOT and BATS; as well as single cell Fe quotas (SXRF) and cell surface area data (Ben Twining)]*
Heroes: Yeala Shaked, Maite Maldonado (Ben Twining, Mark Moore, Dan Repeta, Seth John, Adrian Marchetti, Mak Saito, Alessandro Tagliabue, Bill Sunda, Geraldine Sarthou, Bethany Jenkins)

2) Estimate bioavailability of Fe in natural systems by examining phytoplankton single cell Fe quotas across concentration gradients of dissolved and (labile) particulate TEIs, using data from NAZT, GeoMICS, EPZT, IRONBRU cruises on SXRF, dissolved Fe, soluble and colloidal Fe, Fe voltammetry/speciation, total particulate and labile particulate Fe.
Heroes: Ben Twining (Kristen Buck, Randie Bundy, Mark Moore, Jessica Fitzsimmons, Claire Till, Jim Moffett, Mak Saito, Jingfeng Wu, Kathy Barbeau, Maite Maldonado)

3) *Test the hypothesis for light and Fe co-limitation in deep chlorophyll maxima (DCM) using GEOTRACES dissolved Fe data sets. Explore also TARA molecular data sets (and possibly those from GEOMICs & Malaspina-2010 Expedition) to look for iron stress metagenomics markers in the world's DCMs*
Heroes: Bill Sunda (Dreux Chappell, Pete Sedwick, Mak Saito, Kathy Barbeau, Alexandra Bausch, Adrian Marchetti, Jessica Fitzsimmons, Seth John, Dan Ohnemus, Bethany Jenkins).

4) *Explore Redfieldian concepts of elemental stoichiometry using dissolved and particulate GEOTRACES TEs data and ocean models*
Heroes: Mak Saito, Ben Twining (Dan Ohnemus, Mark Moore, Clare Davis, Amber Annett, Alyson Santoro, Bill Sunda, Alessandro Tagliabue, Alexandra Bausch, Maite Maldonado)

5) O*rganismal quota approach to calculate community trace metal demand and compare to trace metal inventories and relative resource supply (linking TEs data sets to hydrography, aeolian deposition information…). This aims to ultimately address controls on biogeography. The derived organismal trace metal quotas are based on biochemistry concepts of cell metabolism (Raven's estimates of trace metal quotas based on proteins trace metal content and metabolic rates)*
Heroes: Maite Maldonado, Al Tagliabue (Ben Twining, Mark Moore, Mak Saito, Adrian Marchetti, Alyson Santoro, Tung-Yuan Ho, Clare Davis, Susanna Fitz, Amber Annett, Mark Brzezinski)

> **NOTE:** To achieve 5 and 3, and maybe 1, it would be nice, but not required, to find oceanic transect where there are GEOTRACES TE data and complementary "omics data" (e.g., from TARA Ocean Expeditions (to contact Colomban de Vargas), GEOMICs, or Malaspina-2010 Expedition (to contact Mart Estrada). We will then have to mine through the massive sequence databases to link metrics from sequences (e.g, taxonomic composition, presence/absence or gene expression of particular genes or pathways, etc.) with the GEOTRACES data. The *molecular jockeys* helping with this are Adrian Marchetti, Alyson Santoro, Bethany Jenkins, Dreux Chappell, Mak Saito, Geraldine Sarthou, and Dan Repeta

Abiotic cycling and scavenging (including particulate and dissolved speciation group)

6) *A Synthesis Paper on "Paradigms of ligand composition and cycling and the degree of confidence in them" will be produced*
Heroes: Kristen Buck, Randie Bundy (John Dunne, Geraldine Sarthou, Jessica Fitzsimmons, Maeve Lohan, Alessandro Tagliabue, Tim Conway, Julia Gauglitz, Dan Repeta, Elliot Sherman and Kazuhiro Misumi)

Export, recycling and regeneration group

7) *Compare radionuclide-based methods ($^{234}Th/^{238}U$; $^{228}Th/^{228}Ra$; $^{230}Th/^{234}U$; $^{210}Po/^{210}Pb$; Pu/Np) to estimate the downward flux of particulate C, N, P, ^{232}Th, Al, Cd, Fe, Co, Cu, and Mn from the surface mixed layer to the sea bed*.
Heroes: Chris Hayes, Erin Black (Gideon Henderson, Ken Buesseler, Frank Pavia, Bob Anderson, Mark Baskaran, Tim Kenna, Patrick Fitzgerald, Kirk Cochran)

8) Modes of regeneration: desorption/dissolution vs. biotic respiration. *Combine measured TEI distributions with calculated AOU, depth-dependent OURs, and preformed TEI concentrations to discriminate among effects of abiotic scavenging, biotic uptake and regeneration, and physical transport*.
Heroes: Bill Jenkins (Greg Cutter, Nick Hawko, Bob Anderson, Keith Moore, Bill Smethie, Yi Tang, Rana Fine, Francois Primeau, Tom Weber, Molly Martin, Susan Little, Xin-Yuan Zheng, Yves Plancherel, Ed Boyle, Maureen Conte, Max Grand, Alan Shiller, Mariko Hatta, Ken Buesseler, Erin Black, Maeve Lohan, Dave Kadko)

Corollary: Greater attention needs to be afforded to defining end-member TEI concentrations of major water masses.

Hybrid products derived from the abiotic cycling and scavenging and the export and regeneration groups

9) *Improve simple models for particle aggregation and disaggregation by adding 2nd order rate kinetics for aggregation, and by including the aggregation of small and large particles.*
Heroes: Adrian Burd (Rob Sherrell, Paul Lerner, Francois Primeau, Phoebe Lam)

10) *Kd for the spectrum of elements. Estimate relative scavenging of an element for which we can derive an absolute Kd, like Th, when their concentrations are measured concurrently with* ^{230}Th *and* ^{232}Th.
Heroes: Chris Hayes (Seth John, Xin-Yuan Zheng)

11) *Compare beam transmission measured concurrently with abundance and composition of particles measured on GEOTRACES will lead to new algorithms to interpret beam transmission in terms of particle distributions that affect TEI scavenging as well as the optical properties of nepheloid layers.*
Heroes: **Chris Hayes** (Rob Sherrell, Dan Ohnemus, Wilf Gardner, Mary Jo Richardson, Phoebe Lam, Jessica Fitzsimmons, Frankie Pavia, Bob Anderson)

12) *Prepare a synthesis paper on the distribution of nepheloid layers, the abundance and composition of particles within them, differences in the scavenging intensity, sorption coefficients of particle-reactive radionuclides, and their impact on dissolved TEI distributions*.
Heroes: Rob Sherrell (Chris Hayes, Dan Ohnemus, Wilf Gardner, Mary Jo Richardson, Phoebe Lam, Jessica Fitzsimmons, Frankie Pavia, Bob Anderson, Mark Baskaran)

APPENDIX III. US GEOTRACES

DATA MANAGEMENT ACTIVITIES AT BCO-DMO

website: http://www.bco-dmo.org
email: info@bco-dmo.org
U.S. GEOTRACES: http://www.bco-dmo.org/program/2022

Overview

The Biological and Chemical Oceanography Data Management Office (BCO-DMO), based at Woods Hole Oceanographic Institution, manages GEOTRACES data from U.S. investigators. Serving as the U.S. GEOTRACES Data Assembly Center (DAC), BCO-DMO provides data management services at no cost to NSF-funded investigators. The BCO-DMO data managers work closely with contributing investigators to ensure the quality and completeness of data and metadata. Additionally, BCO-DMO is responsible for transferring the U.S. data to the GEOTRACES International Data Assembly Centre (GDAC). GDAC staff archive the data long-term, and they help prepare data for inclusion in the GEOTRACES Intermediate Data Product (IDP).

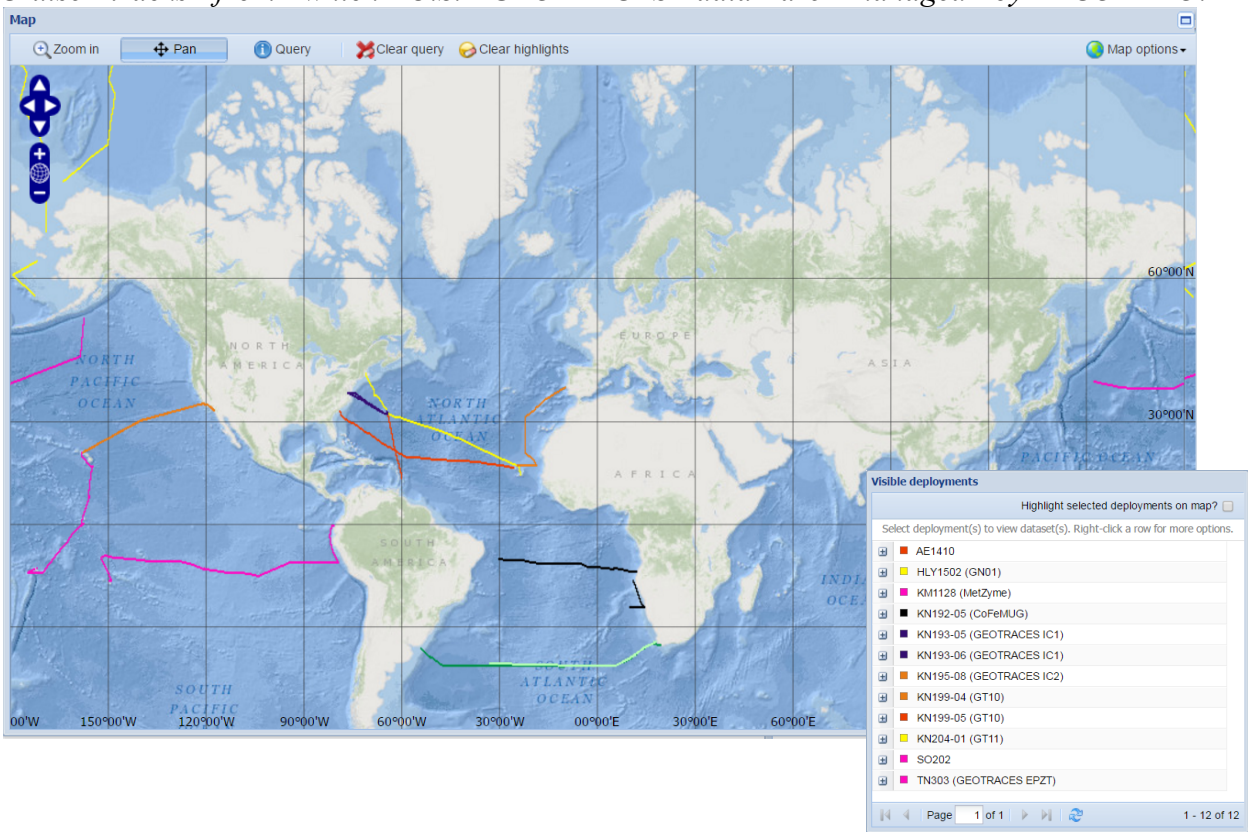
Available Data

Summary of U.S. GEOTRACES Data Available from BCO-DMO as of April 2017.

Cruise ID	Chief Sci	Dates	# of Datasets
GEOTRACES-Compliant			
KN192-05 (CoFeMUG, GAc01)	Mak Saito	2007-11-16 to 2007-12-13	10
SO202-INOPEX (GPc01, INOPEX)	Rainer Gersonde	2009-07-08 to 2009-08-28	1
KM1128 (MetZyme)	Carl Lamborg	2011-10-01 to 2011-10-25	4
AE1410 (GAc02)	Maureen Conte	2014-05-31 to 2014-06-08	1
Intercalibration Cruises			
KN193-05 (InterCal 1 Leg 1)	Greg Cutter	2008-06-08 to 2008-06-27	3
KN193-06 (InterCal 1 Leg 2)	Greg Cutter	2008-06-29 to 2008-07-12	6
KN195-08	Greg Cutter	2009-05-06 to 2009-05-29	3
International GEOTRACES Cruises from which U.S. PIs have contributed data			

RRS Discovery D357 (GA10)	Gideon Henderson	2010-10-18 to 2010-11-22	1
RRS James Cook JC068 (GA10)	Gideon Henderson	2011-12-24 to 2012-01-27	1
North Atlantic Transect (NAT)			
KN199-04 (GA03 Leg 1)	William Jenkins	2010-10-15 to 2010-11-04	72
KN199-05 (GA03 Leg 2)	William Jenkins	2010-11-08 to 2010-11-26	6
KN204 (GA03)	Ed Boyle	2011-11-06 to 2011-12-11	67
East Pacific Zonal Transect (EPZT)			
TN303 (EPZT, GP16)	Jim Moffett	2013-10-25 to 2013-12-20	65
Arctic			
CGC Healy HLY1502 (GN01)	David Kadko	2015-08-09 to 2015-10-12	8

Cruise tracks from which U.S. GEOTRACES data are managed by BCO-DMO.



Current Status

Most of the data submitted to BCO-DMO since the last IDP was released has been from the East Pacific Zonal Transect (EPZT) cruise, along with some data from the North Atlantic Transect (NAT) and Arctic cruises. Data that were submitted to BCO-DMO by the IDP

deadlines have been contributed to GDAC for inclusion in the 2017 IDP, due to be released in August. BCO-DMO data managers have been in frequent communication with GDAC as part of this process to ensure that U.S. data are included in the IDP.

We expect to see more Arctic data coming in as samples are processed, and we're also ready to provide data management support for the upcoming Pacific Meridional Transect cruise. We encourage PIs to contact us (info@bco-dmo.org) with questions or concerns about their data. When contributing datasets, we strongly suggest including complete sample metadata with each record (sample ID number, event number, station number, cast number, bottle number, depth, latitude, longitude, and date-time). PIs may opt to restrict their data for a specified time period, though we encourage open sharing of data as early as possible to foster collaboration and data re-use.

The BCO-DMO Team includes: Hannah Ake, Nancy Copley, Cyndy Chandler, David Glover, Bob Groman, Danie Kinkade, Shannon Rauch, Adam Shepherd, Amber York, and Peter Wiebe.

Questions/comments should be directed to info@bco-dmo.org and/or the main point of contact at BCO-DMO for U.S. GEOTRACES, Shannon Rauch (srauch@whoi.edu).