GEOTRACES SCIENTIFIC STEERING COMMITTEE
ANNUAL REPORT TO SCOR 2018/2019

May 2019

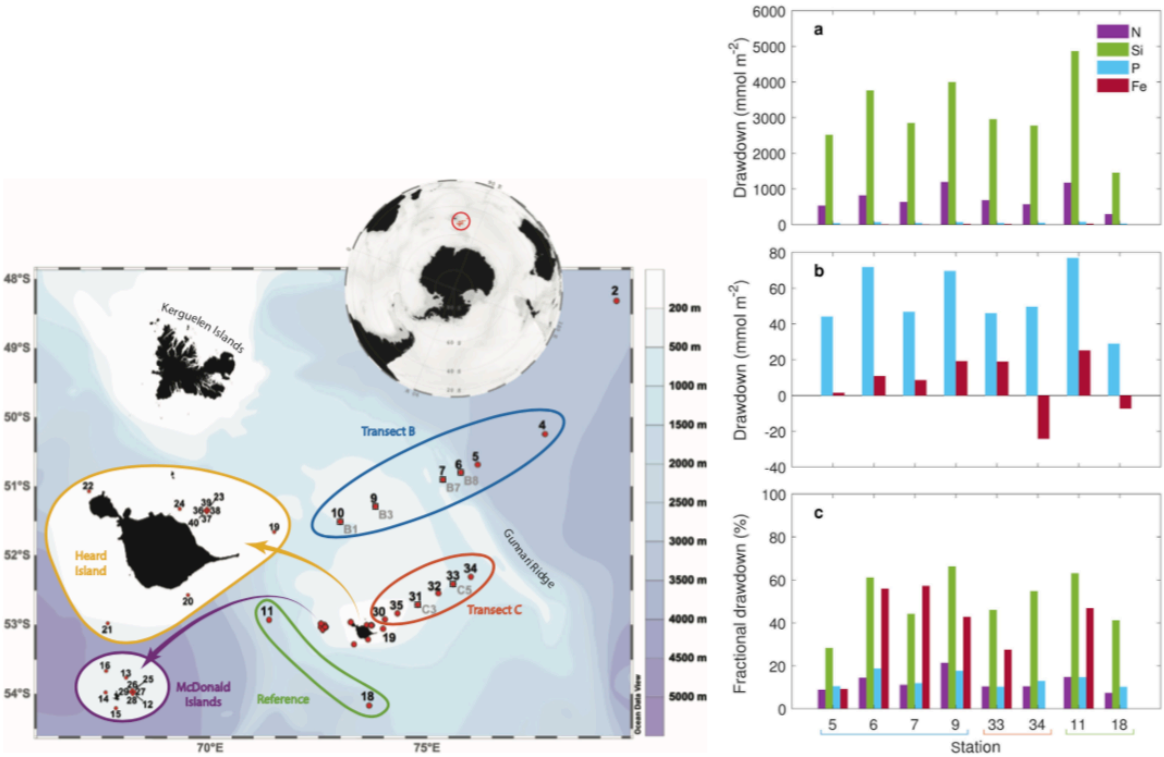
ANNEX – NATIONAL REPORTS

New scientific results

New research by Holmes et al. (2019) shows that iron availability influences nutrient drawdown in the remote Heard and McDonald Islands region of the Southern Ocean.

Highlights:

- Dissolved iron availability drives macronutrient uptake on the Kerguelen Plateau.
- Iron availability increases the ratio of silica to nitrate drawdown near islands.
- Fe* shows dissolved iron limits plankton growth over plateau, except near islands.
- Distribution of dissolved iron varies between years, highlighting dynamic processes.



At the southern part of the northern Kerguelen Plateau (Southern Ocean) is an active volcanic hotspot, hosting volcanically active Heard Island and McDonald Islands (HIMI), the former of which is largely covered by glaciers. While offshore waters are persistently Fe limited, typical of the broader Southern Ocean, near shore waters over the Kerguelen plateau show variability in Fe distributions and support a high biomass of phytoplankton during austral spring-summer. This study investigates dissolved iron (DFe) and macronutrient distributions in waters surrounding HIMI during the Heard Earth-Ocean-Biosphere Interactions (HEOBI) voyage in January–February 2016. Comparison of surface DFe with macronutrient concentrations shows that the majority of the plateau is Fe limited in late summer and, based on comparison with previous voyages, also Fe limited in different years and earlier in the bloom season. The distribution of DFe drawdown from estimated winter inventories to observed late summer inventories shows that DFe availability drives macronutrient uptake on the plateau. The drawdown of silicic acid decreases relative to nitrate drawdown in proximity

to HIMI, in agreement with classical diatom nutrient uptake behaviour under iron replete conditions. Comparison of Fe: nitrate and Fe: phosphate drawdown ratios with expected uptake stoichiometry suggest that recycling of Fe increases with distance from Fe sources on the plateau. Lastly, comparison with data from previous voyages shows that DFe distribution varies inter-annually due to complex oceanographic conditions on the plateau, with greatest variability observed over the rough bathymetry and strongly tidally influenced region closest to HIMI. Together these data highlight the central role of Fe in driving nutrient uptake and stoichiometry in the HIMI region of the Kerguelen Plateau.

Citation: *Holmes, T., Wuttig, M.K., Chase, Z., Van Der Merwe, P., Townsend, A.T., Schallenberg, C., Tonnard, M., and Bowie, A.R. 2019. Iron Availability Influences Nutrient Drawdown in the Heard and McDonald Islands Region, Southern Ocean. Marine Chemistry, doi:10.1016/j.marchem.2019.03.002.*

Cruises

- Completion of "Constraining external iron inputs and cycling in the southern extension of the East Australian Current." IN2018_V04. GEOTRACES PIs: Ellwood, Boyd, Chase, Bowie. This voyage took place in September 2018 in the Tasman Sea and the Subantarctic Southern Ocean south of Tasmania with the aim of assessing the relationships between production and nutrient supply across the southern extent of the East Australian Current (EAC) and the northern subantarctic zone.
- Completion of SOTS time series "Surface and subsurface subantarctic Biogeochemistry of Carbon and Iron, Southern Ocean Time Series site". GEOTRACES PIs: Boyd, Ellwood, Bowie. This voyage took place in March 2019 in the Subantarctic Southern Ocean south of Tasmania and follows up similar voyages in March 2016 and 2018.
- Completion of the ENRICH (Euphausiids and Nutrient Recycling in Cetacean Hotspots) voyage in the Southern Ocean. Collection of samples for Trace elements, macro-nutrients, iron binding organic ligands and biological indicators in Feb-March 2019 in the marginal ice zone of East Antarctica. The aim of the voyage was to assess the role of whales and krill in fertilising surface waters with trace elements. Several incubations and solubility experiments were carried out onboard to identify the main trace metal sources and their bio-availability.

New projects and/or funding

- ARC Discovery Grant, PIs Z. Chase, A. Bowie and P. Strutton. Dust to the ocean: Does it really increase productivity?
- UTAS-IMAS Capital Expenditure, A. Bowie, Z. Chase, P. Boyd, D. Lannuzel, New equipment for the trace element oceanography laboratory.

GEOTRACES workshops and meetings

- Water Mass Transformation for Ocean Physics and Biogeochemistry, 4 – 6 February 2019, UNSW.
- Biogeochemical-Argo float Workshop, Hobart, 5-8 November 2018, co-convenors Philip Boyd, Peter Strutton, Tom Trull.

Outreach activities conducted

- Delphine Lannuzel: Beer Aquatic, June 2018: 90 min public lecture at the Hobart Brewing Co entitled "Role of sea ice and glaciers as ocean fertilisers" (http://whysci.org.au/event/beer-aquatic-ice/)
- Delphine Lannuzel: Television interview SkyNews "Researchers discover green-coloured icebergs linked to ocean iron levels" 02/03/2019 https://www.skynews.com.au/details/_6009244572001

New GEOTRACES publications (published or in press)

- Bowie, A., and Tagliabue, A. 2018. Geotraces Data Products: Standardising and Linking Ocean Trace Element and Isotope Data at a Global Scale. Elements 14, no. 6: 436–37.
- Castrillejo, M., Casacuberta, N., Christl, M., Vockenhuber, C., Synal, H.-A., García-Ibáñez, M. I., … Masqué, P. (2018). Tracing water masses with 129I and 236U in the subpolar North Atlantic along the GEOTRACES GA01 section. Biogeosciences, 15(18), 5545–5564. https://doi.org/10.5194/bg-15-5545-2018
- Chase, Z., Ellwood, M.J., and van de Flierdt, T. 2018. Discovering the Ocean's Past Through Geochemistry. Elements 14, no. 6: 397–402. doi:10.2138/gselements.14.6.397.
- Ellwood, M.J., Bowie, A.R., Baker, A., Gault-Ringold, M., Hassler, C., Law, C.S., Maher, W.A., Marriner, A., Nodder, S., Sander, S., Stevens, C., Townsend, A., van der Merwe, P., Woodward, E.M.S., Wuttig, K., Boyd, P.W., 2018. Insights into the Biogeochemical Cycling of Iron, Nitrate, and Phosphate Across a 5,300 km South Pacific Zonal Section (153°E–150°W). Global Biogeochemical Cycles, 2017GB005736.
- Gdaniec, S., Roy-Barman, M., Foliot, L., Thil, F., Dapoigny, A., Burckel, P., Garcia-Orellana, J., Masque, P., Mörth, C.-M., Andersson, P.S., 2018. Thorium and protactinium isotopes as tracers of marine particle fluxes and deep water circulation in the Mediterranean Sea. Mar. Chem. 199, 12–23. doi:10.1016/j.marchem.2017.12.002
- George, E., Stirling, C.H., Gault-Ringold, M., Ellwood, M.J., Middag, R., 2019. Marine biogeochemical cycling of cadmium and cadmium isotopes in the extreme nutrient-depleted subtropical gyre of the South West Pacific Ocean. Earth and Planetary Science Letters 514, 84-95.
- Grand M.M., Laes-Huon A., Fietz S., Resing J.A., Obata H., Luther G.W. III, Tagliabue A., Achterberg E.P., Middag R., Tovar-Sánchez A. and Bowie A.R. 2019 Developing Autonomous Observing Systems for Micronutrient Trace Metals. Front. Mar. Sci. 6:35. doi: 10.3389/fmars.2019.00035
- Holmes, T., Wuttig, M.K., Chase, Z., Van Der Merwe, P., Townsend, A.T., Schallenberg, C., Tonnard, M., and Bowie, A.R. 2019. Iron Availability Influences Nutrient Drawdown in the Heard and McDonald Islands Region, Southern Ocean. Marine Chemistry, 1–0. doi:10.1016/j.marchem.2019.03.002.
- Lambelet, M., van de Flierdt, T., Butler, E.C.V., Bowie, A.R., Rintoul, S.R., Watson, R.J., Remenyi, T., Lannuzel, D., Warner, M., Robinson, L.F., Bostock, H.C., Bradtmiller, L.I., 2018. The Neodymium Isotope Fingerprint of Adélie Coast Bottom Water. Geophys. Res. Lett. 45, 11,247–11,256. doi:10.1029/2018GL080074
- Pérez-Tribouillier, H., Noble, T.L., Townsend, A.T., Bowie, A.R. and Chase, Z. (In Press 2019), Pre-concentration of thorium and neodymium isotopes using Nobias chelating

resin: Method development and application to chromatographic separation, Talanta doi: https://doi.org/10.1016/j.talanta.2019.03.08
- Moreau S., Lannuzel D., Janssens J. et al. Sea-ice meltwater and circumpolar deep water drive contrasting productivity in three Antarctic polynyas. Journal of Geophysical Research - Oceans, accepted March 2019
- Myriokefalitakis, S., Ito, A., Kanakidou, M., Nenes, A., Krol, M. C., Mahowald, N. M., Scanza, R. A., Hamilton, D. S., Johnson, M. S., Meskhidze, N., Kok, J. F., Guieu, C., Baker, A. R., Jickells, T. D., Sarin, M. M., Bikkina, S., Shelley, R., Bowie, A., Perron, M. M. G., and Duce, R. A., 2018. Reviews and syntheses: the GESAMP atmospheric iron deposition model intercomparison study, Biogeosciences, 15, 6659-6684, https://doi.org/10.5194/bg-15-6659-2018.
- Roy-Barman, M., Pons-Branchu, E., Levier, M., Bordier, L., Foliot, L., Gdaniec, S., Ayrault, S., Garcia-Orellana, J., Masque, P., Castrillejo, M., 2019. Barium during the GEOTRACES GA-04S MedSeA cruise: The Mediterranean Sea Ba budget revisited. Chemical Geology 511, 431–440.
- Schallenberg, C., Bestley, S., Klocker, A.,Trull, T. W., Davies, D. M.,Gault-Ringold, M., et al. 2018. Sustained upwelling of subsurface iron supplies seasonally persistent phytoplankton blooms around the southern Kerguelen plateau, Southern Ocean. Journal of Geophysical Research: Oceans,123, 5986–6003, https://doi.org/10.1029/2018JC013932.
- Schlitzer, R., et al. 2018. The GEOTRACES Intermediate Data Product 2017. Chemical Geology, 210-223.
- Sutton, J.N., André, L., Cardinal, D., Conley, D.J., de Souza, G.F., Dean, J., Dodd, J., Ehlert, C., Ellwood, M.J., Frings, P.J., Grasse, P., Hendry, K., Leng, M.J., Michalopoulos, P., Panizzo, V.N., Swann, G.E.A., 2018. A Review of the Stable Isotope Bio-geochemistry of the Global Silicon Cycle and Its Associated Trace Elements. Frontiers in Earth Science 5.
- Tang, Y., Lemaitre, N., Castrillejo, M., Roca-Martí, M., Masqué, P., & Stewart, G. (2019). The export flux of particulate organic carbon derived from 210Po/210Pb disequilibria along the North Atlantic GEOTRACES GA01 transect: GEOVIDE cruise. Biogeosciences, 16(2), 309–327. https://doi.org/10.5194/bg-16-309-2019
- Tang, Y., Castrillejo, M., Roca-Martí, M., Masqué, P., Lemaitre, N., & Stewart, G. (2018). Distributions of total and size-fractionated particulate 210Po and 210Pb activities along the North Atlantic GEOTRACES GA01 transect: GEOVIDE cruise. Biogeosciences, 15(17), 5437–5453. https://doi.org/10.5194/bg-15-5437-2018
- Wuttig, K., Townsend, A.T., Van Der Merwe, P., Gault-Ringold, M., Holmes, T. Schallenberg, C., Latour, P., Tonnard, M., Rijkenberg, M.J.A., Lannuzel, D., and Bowie, A.R. 2019. Critical Evaluation of a seaFAST System for the Analysis of Trace Metals in Marine Samples. Talanta 197: 653–68. doi:10.1016/j.talanta.2019.01.047.
- Yang, L., Nadeau, K., Meija, J., Grinberg, P., Pagliano, E., Ardini, F., Grotti, M., Schlosser, C., Streu, P., Achterberg, E.P., Sohrin, Y., Minami, T., Zheng, L., Wu, J., Chen, G., Ellwood, M.J., Turetta, C., Aguilar-Islas, A., Rember, R., Sarthou, G., Tonnard, M., Planquette, H., Matoušek, T., Crum, S., Mester, Z., 2018. Inter-laboratory study for the certification of trace elements in seawater certified reference materials NASS-7 and CASS-6. Analytical and Bioanalytical Chemistry 410, 4469-4479.
- Wang, R.M., Archer, C., Bowie, A.R. and Vance, D. Zinc and nickel isotopes in seawater from the Indian Sector of the Southern Ocean: the impact of natural iron fertilization

versus Southern Ocean hydrography and biogeochemistry. Chemical Geology, 511, 452-464, https://doi.org/10.1016/j.chemgeo.2018.09.010

Completed GEOTRACES PhD or Master theses

- Manon Tonnard, UTAS-UBO cotutelle joint student, "Biogeochemical cycle of iron: distribution and speciation in the North Atlantic Ocean (GA01) and the Southern Ocean (GIpr05) (GEOTRACES)". Supervisors: Andrew Bowie, Geraldine Sarthou, Pier van der Merwe, Helene Planquette

GEOTRACES presentations in international conferences

- Pérez-Tribouillier, H., Chase, Z., Noble, T.L., Townsend, A.T. and Bowie, A.R. 2018. Simultaneous Pre-Concentration of Thorium and Neodymium from Seawater: Method Development and Application to the Kerguelen Plateau. Goldschmidt Abstracts.
- Adhitya Sutresna, Bence Paul, Estephany Marillo-Sialer, Peter Rayner, Robyn Schofield, Maximilien Desservettaz, Andrew Bowie, Michal Strzelec, 2018. Characterisation of LA-ICP-MS to measure, speciate and source apportion PM2.5 in Garden Island, Western Australia. Atmospheric Composition & Chemistry Observations & Modelling Conference incorporating the Cape Grim Annual Science Meeting 2018, Aspendale VIC Dec 4-6, 2018
- Pier van der Merwe, Tom Trull, Trevor Goodwin, Peter Jansen, Andrew Bowie, 2018. Autonomous, trace metal clean, seawater sampler: AUV integration and 12 month mooring deployment. Antarctic and Southern Ocean Forum, 2. Observation Technologies. 14-17 August 2018, CSIRO Hobart. https://asof2018.ieee.org/
- Alessandro Tagliabue, Andrew Bowie, Michael Ellwood, William Landing, Angela Milne, Daniel Ohnemus, Benjamin Twining, Philip Boyd, 2018. Revealing the mechanisms shaping the internal cycling of dissolved iron across the Pacific Basin. Challenger Conference 2018 , 10th to 14th September 2018. The 18th Biennial Conference of the Challenger Society for Marine Science. Newcastle University, UK
- A. Ito, S. Myriokefalitakis, M. Kanakidou, N. Mahowald, R. A. Scanza, A. Baker, T. Jickells, M. Sarin, S. Bikkina, Y. Gao, R. Shelley, C. Buck, W. Landing, A. Bowie, M. Perron, N. Meskhidze, M. Johnson, Y. Feng, R. Duce, 2018. The GESAMP global model intercomparison: Evaluation of labile iron in aerosols. EGU General Assembly 2018 AS4.1/BG1.14/OS3.3 – Air-sea exchanges: Impacts on Biogeochemistry and Climate, 13 April
- A. Ito, S. Myriokefalitakis, M. Kanakidou, N. Mahowald, R. A. Scanza, A. Baker, T. Jickells, M. Sarin, S. Bikkina, Y. Gao, R. Shelley, C. Buck, W. Landing, A. Bowie, M. Perron, N. Meskhidze, M. Johnson, Y. Feng, R. Duce, 2018. The GESAMP global model intercomparison: Evaluation of labile iron in aerosols Japanese Geophysical Union annual meeting 2018, Chiba, Japan, May 20-24, http://www.jpgu.org/meeting_e2018/
- Ratnarajah, L, Blain, S, Bowie, AR, Catala, P, Friedlaender, AS, Holmes, TM, Lannuzel D, Obernosterer, I, Tonnard, M, van der Merwe, P, Wuttig, K, 2018. Nutrient recycling influences microbial communities in the Southern Ocean. Polar 2018, SCAR Open Science conference 2018, Davos, 15-26 June 2018
- Pier van der Merwe, Kathrin Wuttig, Thomas Holmes, Zanna Chase, Tom Trull, Andrew Bowie, 2018. High Fe lability of particles sourced from glacial erosion, Heard Island.

Session: Biogeochemical cycling in the Polar Regions: Terrestrial and Ocean interactions. Polar 2018, SCAR Open Science conference 2018, Davos, 15-26 June 2018

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

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN BELGIUM

April 1st, 2018 to March 31st, 2019

New scientific results

- Primary production rates, N2 fixation rates, 234Th export fluxes, POC export fluxes, particulate Ba profiles, trace element contents of the large (sinking) particle fraction and isotopic compositions (δ15N, δ18O) of nitrate from the GEOVIDE cruise (GA01-GEOTRACES; transect Lisbon to Newfoundland, May-July 2014).
- Primary production, N2 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).
- Reactive iron and sulfur geochemistry in the coastal Black Sea sediments.

Cruises

- 35th Chinese Antarctic cruise (November 2018 – April 2019) to Prydz Bay and Amundsen Sea. Sampling of ice cores near Zhongshan station (Prydz Bay) and water column in the Amundsen Sea collaboration with Zhan Liang, 2nd Institute SIO, Xianmen, China).
- Belgica 2018/16 cruise in the Gotland Basin of the Baltic Sea from 20 June to 4 July 2018 to study the (bio)geochemistry of nutrients and trace metals in relation with coastal hypoxia.

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).

New GEOTRACES publications

- Deman, F., Fonseca-Batista, D., Roukaerts, A., García-Ibáñez, M.I., Le Roy, E., Thilakarathne, D.N., Dehairs, F. and Fripiat, F., 2019. Nitrate isotopic composition along the GEOTRACES GA01 (GEOVIDE) section in the North Atlantic, in preparation.
- Fonseca-Batista D., X. Li, V. Riou, V. Michotey, F. Deman, F. Fripiat, S. Guasco, N. Brion, N. Lemaitre, M. Tonnard, M. Gallinari, H. Planquette, F. Planchon, G. Sarthou, M. Elskens, J. LaRoche, L. Chou and F. Dehairs, 2019. Evidence of high N2 fixation rates in the temperate Northeast Atlantic, Biogeosciences, 16, 999-1017, https://doi.org/10.5194/bg-16-999-2019.
- Tang W., S. Wang, D. Fonseca Batista, F. Dehairs, S. Gifford, A. Gonzalez, H. Planquette, G. Sarthou, M. Gallinari and N. Cassar, 2019. Revisiting the distribution of N2 fixation and contribution to marine production in the world's oceans, Nature Communications, doi:10.1038/s41467-019-08640-0.

- Sarthou, G., Lherminier, P., Achterberg, E. P., Alonso-Pérez, F., Bucciarelli, E., Boutorh, J., ... & Casacuberta, N. (2018). Introduction to the French GEOTRACES North Atlantic transect (GA01): GEOVIDE cruise. Biogeosciences, 15(23), 7097-7109.
- Fripiat F., M. Declercq, C.J. Sapart, L.G. Anderson, V. Bruechert, F. Deman, D. Fonseca-Batista, C. Humborg, A. Roukaerts, I.P. Semiletov and F. Dehairs, 2018. Influence of the bordering shelves on nutrient distribution in the Arctic halocline inferred from water column nitrate isotopes, Limnology and Oceanography, 63, 2154-2170, https://doi.org/10.1002/lno.10930, https://doi.org/10.1002/lno.10930.
- Li X., D. Fonseca-Batista, N. Roevros, F. Dehairs, L. Chou, 2018. Environmental and nutrient controls of marine nitrogen fixation, Progress in Oceanography, 167, 125-137.
- Lemaitre, N., Planchon, F., Planquette, H., Dehairs, F., Fonseca-Batista, D., Roukaerts, A., ... & Sarthou, G. (2018). High variability of particulate organic carbon export along the North Atlantic GEOTRACES section GA01 as deduced from 234Th fluxes. Biogeosciences, 15(21), 6417-6437.
- Lemaitre N., H. Planquette, F. Planchon, G. Sarthou, S. Jacquet, M. I. García-Ibáñez, A. Gourain, M. Cheize, L. Monin, L. André, P. Laha, H. Terryn, and F. Dehairs, 2018. Particulate barium tracing significant mesopelagic carbon remineralisation in the North Atlantic, Biogeosciences, 15, 2289-2307.
- Rembauville M., I. Salter, F. Dehairs, J.-C. Miquel and S. Blain, 2018. Annual particulate matter and diatom export in a high nutrient, low chlorophyll area of the Southern Ocean, Polar Biology, 41, 25-40, DOI 10.1007/s00300-017-2167-3.

Completed GEOTRACES PhD or Master theses

- Arnout Roukaerts: Novel insights in nitrogen and carbon biogeochemistry of Antarctic sea ice: the potential role of ta microbial biofilm, Vrije Universiteit Brussel, Nov. 2018, 198pp.
- Florian Deman: Sea ice primary production at the Pan-Antarctic scale and nutrient cycling in the Antarctic sea ice covered areas (sea ice and water column), Vrije Universiteit Brussel & Université de Liège, In progress.
- Audrey Plante: Study of marine benthic hypoxia and its consequences on the exchange at the sediment-water interface and diagenesis, Université libre de Bruxelles & Université de Liège, In progress.

GEOTRACES presentations in international conferences

- Deman F., Roukaerts A., Tison J.-L., Delille B., Dehairs F. and Fripiat F. (2019) High production going along with high respiration: impact of biofilm formation for sea ice biogeochemistry, IGS, Sea Ice at the Interface, Winnipeg, Canada, August 2019.
- Deman F., Roukaerts A., Vancoppenolle M., Tison J.-L., Delille B., Dehairs F. and Fripiat F. (2019) Using biomass accumulation to estimate Antarctic sea ice primary production, IGS, Sea Ice at the Interface, Winnipeg, Canada, August 2019.
- Deman F., Roukaerts A., Tison J.-L., Delille B., Dehairs F. and Fripiat F. (2019 Estimation of Antarctic sea ice primary production inferred from biomass accumulation, 51st International Liege Colloquium on Ocean Dynamics, Polar Ocean facing changes, Liège, Belgium, May 2019.

- N. Lemaitre, H. Planquette, F. Dehairs, F. Planchon, G. Sarthou, P. Lherminier, D. Vance, Trace element cycling in the North Trace element cycling in the North Atlantic, Goldschmidt, August 2019, Barcelona.
- Li X., D. Fonseca-Batista, N. Roevros, F. Dehairs and L. Chou (2019) Marine nitrogen fixation: Environmental and nutrient controls. Fourth Xiamen Symposium on Marine Environmental Sciences. Xiamen, China, 6-10 January 2019. Oral presentation given by L. Chou.
- Plante A., N. Roevros, A. Capet, M. Grégoire, N. Fagel and L. Chou (2018) Black Sea north-western shelf hypoxia: a study based on diagenetic processes and sedimentary proxies. European Geosciences Union (EGU) General Assembly 2018, Vienna, Austria, 8–13 April 2018, EGU2018-11782. Poster.
- Plante A., N. Ahmed Butt, N. Roevros, A. Capet, M. Grégoire, N. Fagel and L. Chou (2018) Coastal hypoxia in the Black Sea: Effects on diagenetic pathways and benthic fluxes. Ocean Deoxygenation Conference 2018, Kiel, Germany, 02-08 September 2018. Poster.

Submitted by Frank Dehairs (fdehairs@vub.be) and Lei Chou (lchou@ulb.ac.be).

New Scientific Results

- Rare Earth Elements are less and less natural tracers in the ocean

This verdict is well illustrated by the recent study of Rodrigo Pedreira (2018, see reference below) off the North East Brazilian coast. His Rare Earth Elements (REE) data reveal marked positive Gadolinium (Gd) anomaly which reflects the release of Gd in hospital and domestic effluents. Indeed, this element is used as contrasting agent in magnetic resonance imaging (MRI) to enhance clarity of diagnosis. The authors estimated that between 700 and 2000 g Gd d^{-1} are discharged into Tropical and South Atlantic waters due to submarine outfalls. While the Gd complex behaves conservatively and can be used as a new tracer for sewage discharges from submarine outfalls in ocean waters, it is also clear that high technology wastes are distorting the use of REE as "natural" tracers.

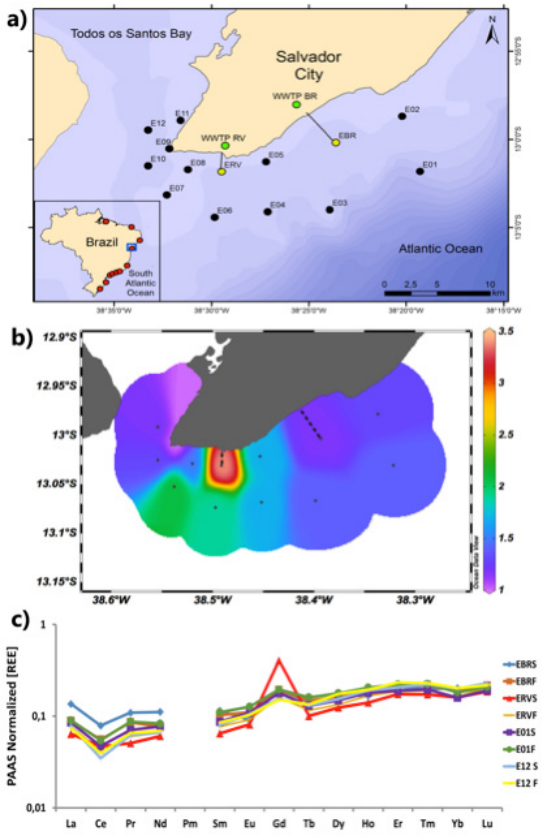


***Figure** 1: Sampling took place (a) off the northeastern coast of Brazil, whereas discharges of submarine outfalls located along the coast of Brazil (a insert) were used to estimate order-of-magnitude emissions of anthropogenic Gd to the Atlantic Ocean. A plume of Gd anomalies (Gdsn/Gdsn*) can be clearly identified for surface waters (b). Positive Gd anthropogenic anomalies are observed in shale (PAAS)-normalized REE patterns (c) for surface waters (S) in most stations in the proximity of submarine outfalls (ERVS and EBVS). (http://www.geotraces.org/science/science-highlight/1574-rare-earth-elements)*

Reference: Pedreira, R. M. A., Pahnke, K., Böning, P., & Hatje, V. (2018). Tracking hospital effluent-derived gadolinium in Atlantic coastal waters off Brazil. Water Research, 145, 62–72.

Cruises

- The PIRATA-BR XVIII cruise was performed in two legs between September and December 2018 on board the R/V Vital de Oliveira. During the first lag, surficial samples were collected using a new fishing system for speciation of dissolved metals (Cu and Fe) and particulate Al. Full depth profiles were also performed to collect waters for the analysis of nutrients, biogenic silica, and particulate carbon and nitrogen (Figure 2). Dr. Mônica Wallner-Kersanach was the researcher responsible for sample collection and analysis at Federal University of Rio Grande.
- For the leg two, water samples were collected from 8 full depth profiles along a transect from the coast of Maceio to open waters at 5°S (Figure 3). It was also planned to collect samples from a transect at 11°S. However, the very strong winds and high seas precluded us to perform this transect. The ship does not have a trace metal sampling rosette, hence water samples were collected only for the determination of REE and Nd isotopes. GEOTRACES Scientist Vanessa Hatje.

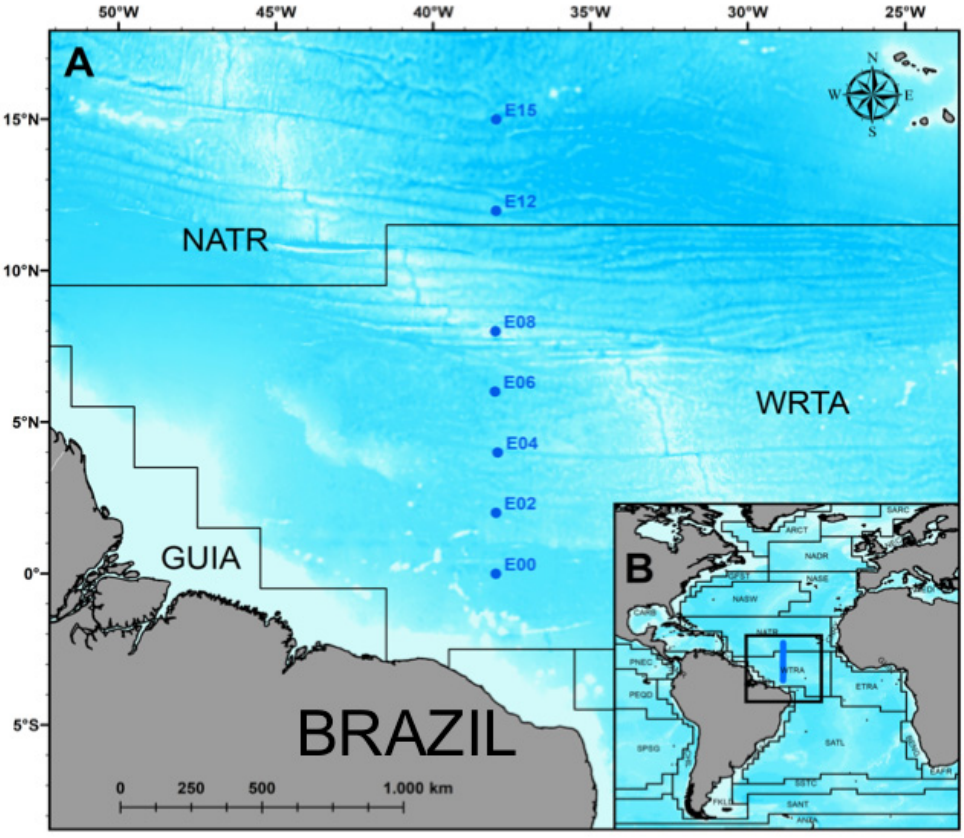


Figure 2. *Sampling stations between 0° to 15°N for the PIRATA-BR XVIII cruise (A) and the different biogeochemical provinces (B).*

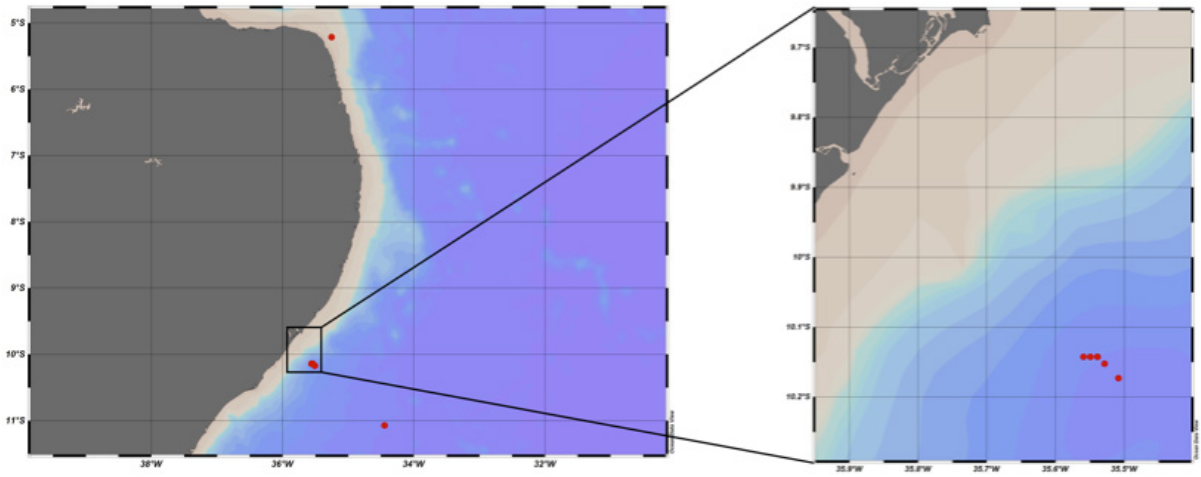


Figure 3. *Location of the full depth profiles performed during the PIRATA-Br XVIII.*

- Interactions of trace metals, DOM, and particles in the Amazon estuary and associated plume as key processes for trace metal and DOM fluxes into the Atlantic. Meteor Cruise 147 (Figure 4). Las Palmas (Gran Canaria) – Belém (Brazil). Chief scientist Andrea Koschinsky, the Brazilian scientist Carlos Eduardo Rezende was responsible for DOM and Hg measurements.

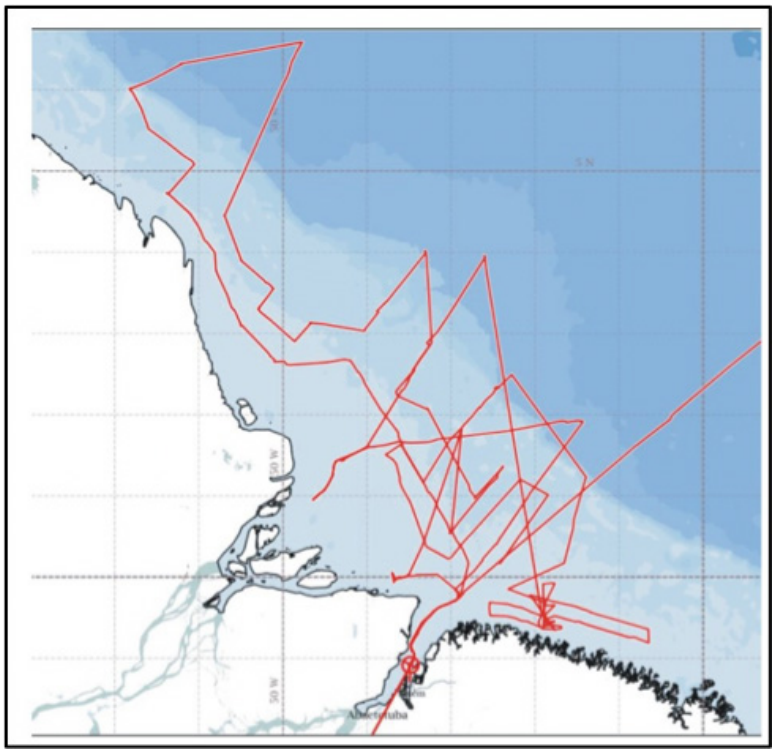


Figure 4. *Cruise track of R/V Meteor cruise 147, along which water and sediment stations and continuous monitoring of S and CO2 were carried out.*

New projects and/or funding

- Project Sources, sinks and control processes of the distribution of rare earth elements (REE) and εNd in the Tropical Atlantic (15ºN-21ºS) (PI: Vanessa Hatje) (Funding CNPq)

  This project has the following objectives: 1) Determination of REE in the western Atlantic waters between the latitudes 21ºS and 15ºN obtained in the oceanographic cruise PIRATA XVII / GEOTRACES Apr 10 ; 2) Evaluate "Boundary Exchange" processes along transects at 5ºS and 11ºS on the continental shelf during the cruise to PIRATA XVIII / GEOTRACES performed between September and October 2018 and at 34.5ºS during the SAMBAR cruise schedule for May 2019; 3) To train the members of the research group in the preparation of ocean water samples for the determination of Nd and Ba isotopes.

- Project PROVOCCAR - Processos de Ventilação Oceânica e Ciclo do Carbono no Norte da Península Antártica (Oceanic Ventilation and Carbon Cycle Processes in Northern Antarctic Peninsula) (PI: Mauricio Mata, Co-PI: Rodrigo Kerr) (Funding CNPq).

  The Project PROVOCCAR is conducted by the researchers of the Brazilian High Latitude Oceanography Group (GOAL) and was approved by the Brazilian Antarctic Program (PROANTAR) in 2018 to execute, at least, three Antarctic summer cruises between 2019-2022. The activities are planned to occur around the Northern Antarctic Peninsula, where the group will investigate the processes related with hydrographic and biogeochemical properties changes and ocean ventilation, mainly those associated with heat and carbon uptake and storage at deep and dense ocean layers.

- Project SAMBAR – Interannual variability of the meridional transports across the SAMOC basin wide array (Funding FAPESP 2017/09659-6).

  The project aims to better understand the interannual variability of heat content and the southern transport across 34.5°S, a zonal region referred to as SAMBA (the South Atlantic Meridional Overturning Circulation (SAMOC) Basin-wide Array). It will investigate the impacts of global ocean shifts and feedback on changes in the South Atlantic Circulation in the Regional Climate and in the stability of the Southern Circulation (MOC).

Outreach activities

- “Hora do Brasil” interview with Vanessa Hatje about GEOTRACES activities during the cruise PIRATA-BR XVIII.

Other GEOTRACES Activities

- V. Hatje is a Full Member of SCOR Working Group 145: Modelling Chemical Speciation in Seawater to Meet 21st Century Needs (MARCHEMSPEC).
- V. Hatje is serving as a member of the IAEA Standing Advisory Group on Nuclear Applications (SAGNA).
- The Universidade Federal da Bahia and the Scientific Committee on Oceanic Research (SCOR) sponsored a visit by the PhD candidate Raiza Andrade to visit Catherine Jeandel at Laboratoire d’Etudes en Géophysique et Océanographie Spatiales (LEGOS) at the Université Toulouse III. The student stayed in Toulouse for three weeks during November 2018 learning the water sample preparation procedures to perform Nd isotopes chemistry. The student is now preparing Atlantic Ocean samples and is applying for a scholarship to

spend 1 year at LEGOS to finish the sample preparation steps and perform the determination of the isotopes.

- Rodrigo Aguiar participate on the training course on Metal Speciation and Isotopes in the Ocean for GEOTRACES and Beyond, China, May 2018.

GEOTRACES-related articles

- Pedreira, R.M.A.; Pahnke, K.; Böning, P.; Hatje, V. Tracking Hospital Effluent-Derived Gadolinium In Atlantic Coastal Waters Off Brazil. Water Research, V. 145, P. 62-72, 2018.
- Hatje, V.; Lamborg, C.H.; Boyle, E.A. Trace-Metal Contaminants: Human Footprint On The Ocean. Elements, V. 14, P. 403-408, 2018.
- Andrade, R.L.B.; Hatje, V.; Pedreira, R.M.A.; Pahnke, K. (2019, Submitted). Ree Fractionation And Gd Human Footprint Along The Continuum Between Paraguaçu River To Coastal South Atlantic Waters.
- Hatje, V.; Cotrim Da Cunha, L.; Da Costa, M. Global Changes, Anthropogenic Impacts And The Future Of The Oceans. Revista Virtual De Química, V. 10, P. 1947-1967, 2018.
- Egres, A.G.; Hatje, V.; Miranda, D.A.; Gallucci, F.; Barros, F. Functional Response Of Tropical Estuarine Benthic Assemblages To Perturbation By Polycyclic Aromatic Hydrocarbons. -Ecological Indicators, V. 96, P. 229-240, 2019.
- Pedreira, R.M.A.; Barros, F.; Farias, C.; Wagener, A.L.; Hatje, V. A Tropical Bay As A Reference Area Defined By Multiple Lines Of Evidences. Marine Pollution Bulletin, V. 1, P. 1-14, 2017.
- Adlich, H.L.; Venturini, N.; Martins, C.C.; Hatje, V.; Tinelli, P.; Gomes, L.E.O. ; Bernardino, A.F. .Multiple Biogeochemical Indicators Of Environmental Quality In Tropical Estuaries Reveal Contrasting Conservation Opportunities. Ecological Indicators, V. 95, P. 21-31, 2018.
- Fragoso, C.P.; Bernini, E.; Araújo, B.F.; Almeida, M.G. De; Rezende, C. E. De. Mercury In Litterfall And Sediment Using Elemental And Isotopic Composition Of Carbon And Nitrogen In The Mangrove Of Southeastern Brazil. Estuarine Coastal And Shelf Science, V. 202, P. 30-39, 2018.
- Araujo, B. F.; Hintelmann, H.; Dimock, B.; De Lima Sobrinho, R.; Bernardes M.C.; De Almeida, M.G.; Krusche, Alex V.; Rangel, T.P.; Thompson, F.; De Rezende, C.E.. Mercury Speciation And Hg Stable Isotope Ratios In Sediments From Amazon Floodplain Lakes-Brazil. Limnology And Oceanography, V. 63, P. 1134-1145, 2018.
- Kerr, R.; Orselli, I.B.M.; Lencina-Avila, J.M.; Eidt, R.T.; Mendes, C.R.B.; Da Cunha, L. C.; Goyet, C.; Mata, M.M.; Tavano, V. M. Carbonate System Properties In The Gerlache Strait, Northern Antarctic Peninsula (February 2015): I. Sea-Air Co2 Fluxes. Deep-Sea Research Part Ii-Topical Studies In Oceanography, V. 1, P. 1, 2018.
- Kerr, R.; Goyet, C.; Da Cunha, L. C.; Orselli, I.B.M.; Lencina-Avila, J.M.; Borges, M.; Mendes, C.R.B.; Mata, M.M.; Tavano, V. M. Carbonate System Properties In The Gerlache Strait, Northern Antarctic Peninsula (February 2015): Ii. Anthropogenic CO 2 and Seawater Acidification. DEEP-SEA RESEARCH PART II-TOPICAL STUDIES IN OCEANOGRAPHY, v. 1, p. 1, 2018.
- Cotrim da Cunha, L.; Hamacher, C.; Farias, C.O.; Kerr, R.; Mendes, C.R.B.; Mata, M.M. Contrasting end-summer distribution of organic carbon along the Gerlache Strait,

Northern Antarctic Peninsula: Bio-physical interactions. DEEP-SEA RESEARCH PART II-TOPICAL STUDIES IN OCEANOGRAPHY, V. 149, P. 206-217, 2018.

- Santos Neves, J.M.C.O.; MARQUES, E.D.; Kutter, V.T.; LACERDA, L.D.; SANDERS, C.; SELLA, S.M.; Silva-Filho, E.V. Influence of river water diversion on hydrogeochemistry and REE distribution, Rio de Janeiro, Brazil. CARPATHIAN JOURNAL OF EARTH AND ENVIRONMENTAL SCIENCES, V. 13, P. 453-464, 2018.

GEOTRACES presentations in international conferences

- Three GEOTRACES presentations and co-authorships by Brazilian Scientists at the Aquatic Science Meeting (Porto Rico), 2019.
- One GEOTRACES presentation during the "All Atlantic Research Forum/Belem Statement", MCTIC, 2018.
- Plenary talk by Vanessa Hatje: Trace elements in the ocean: critical importance and human footprint/GEOTRACES. Jornadas Nacionales de Ciencias del Mar, Buenos Aires, September, 2018.

Submitted by Vanessa Hatje (vhatje@ufba.br).

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN LATIN AMERICA

April 1st, 2018 to March 31st, 2019

During February through March 2019 national representatives of Latin America Countries were contacted and it was requested to them to report about the GEOTRACES-related activities in their country. Representatives from Argentina and colleagues from Chile sent reports. The information sent by each Individual is summarized by below.

ARGENTINA: Flavio Emiliano Paparazzo (paparazzo@cenpat-conicet.gob.ar)

Science in Argentina

In Argentina, scientific research (and particularly marine science) is almost entirely financed by the government. This generates a great political dependence on budgets, and some instability in research projects.

During 2003-2015 there was a huge boost to science in Argentina. The number of researchers was greatly increased, for the first time a ministry of science and technology was created, and programs were developed for the orientation of research (for example, http://www.pampazul.gob.ar/) and repatriation of researchers (http://www.raices.mincyt.gov.ar/).

In 2016 the science budget was reduced drastically, which led the scientific system to a serious crisis.

Several board members of Argentina's National Council for Science and Technology (CONICET) issued an alarming document late 2018 on the financial crisis that is afflicting the central administration and its hundreds of research institutes. They offered a dark prognosis for the months to come. Budget cuts over the past three years have severely curtailed the recruitment of researchers and technical staff. The repatriation of Argentinian researchers, international collaborations, academic contacts and conferences are all affected. Infrastructure and equipment in national laboratories are deteriorating. The result is an ageing and demoralized science community. Scientific research is starting to give ground to other national interests and goals.

Nature and Science have published more than one article about it, for example:

https://www.nature.com/news/argentina-president-s-first-budget-angers-scientists-1.21013

https://www.sciencemag.org/news/2016/11/argentina-s-scientists-engulfed-budget-crisis

https://www.sciencemag.org/news/2018/09/argentina-s-economic-crisis-could-trigger-scientific-collapse-researchers-warn

New projects and/or funding

- Pampa Azul initiative

One of the great achievements of the past government was the implementation of a program for the investigation of priority areas of the Argentine and Antarctic Sea (http://www.pampazul.gob.ar/). This program put into operation a large number of vessels and set up multidisciplinary and multi-institutional commissions for each priority area. Within this program, Dr. Paparazzo was the coordinator of Chemical Oceanography of the working

group "Golfo San Jorge". GEOTRACES activities could be incorporated if this program is funded again. Unfortunately, at the moment it seems there will be no financing during 2019.

GEOTRACES related presentations in conferences

In the national framework and in the GEOTRACES topic, the following presentations can be highlighted from the X National Conference of Marine Sciences, and XVIII National Oceanography Colloquium:

- "Trace elements in the ocean: critical importance and human footprint" for Vanessa Hatje.
- "Niveles de metales en sedimentos marinos superficiales de una amplia área marina circundante a la isla 25 de mayo, Islas Shetlands del Sur" for Leonardo Spairani et al.
- "Desarrollo de electrodo para un rápido sensado de cadmio en agua de mar" for Beleiro et al.
- "Distribución espacio-temporal de metales pesados en la fracción particulada en el estuario de Bahía Blanca. Integración en un sistema información geográfco" for Fernández Severini.
- "Niveles naturales de arsénico y cadmio en un golfo norpatagónico y su posible efecto sobre marcadores de estrés oxidativo de la vieyra Tehuelche (aequipecten tehuelchus)" for Sturla Lompré.
- "Sensor electroquímico de Fe3+ en muestras de agua de mar" for Pedré and Gonzalez.

Published manuscripts and working groups

In the 20 years that Dr. Paparazzo has been working on Argentine research vessels, he does not recall any trace metal measurements performed on board. There are two papers that were carried out by Simonella et al (2014 and 2015) focused on the measurement of iron in the dust and in the volcanic ash:

- L.E. Simonella, D.M. Gaiero, Palomeque, ME. Validation of a continuous flow method for the determination of soluble iron in atmospheric dust and volcanic ash. Talanta (2014) 128:248.
- L.E. Simonella, et al. Soluble iron inputs to the Southern Ocean through recent andesitic to rhyolitic volcanic ash eruptions from the Patagonian Andes, Global Biogeochem. Cycles, 29, 1125.

In addition, Marcovecchio works for long time on the measurement of trace elements in the Bahía Blanca Estuary. Examples of recent publications of his group are:

- N.S. La Colla, S.E. Botté, V.L. Negrin, A.V. Serra, J.E. Marcovecchio. Influence of human-induced pressures on dissolved and particulate metal concentrations in a South American estuary. Environ Monit Assess (2018) 190:532.
- P. Simonetti, S.E. Botte, J.E. Marcovecchio. Occurrence and spatial distribution of metals in intertidal sediments of a temperate estuarine system (Bahía Blanca, Argentina). Environ Earth Sci (2017) 76:636.

Lab structure (ICP-MS and sampling systems)

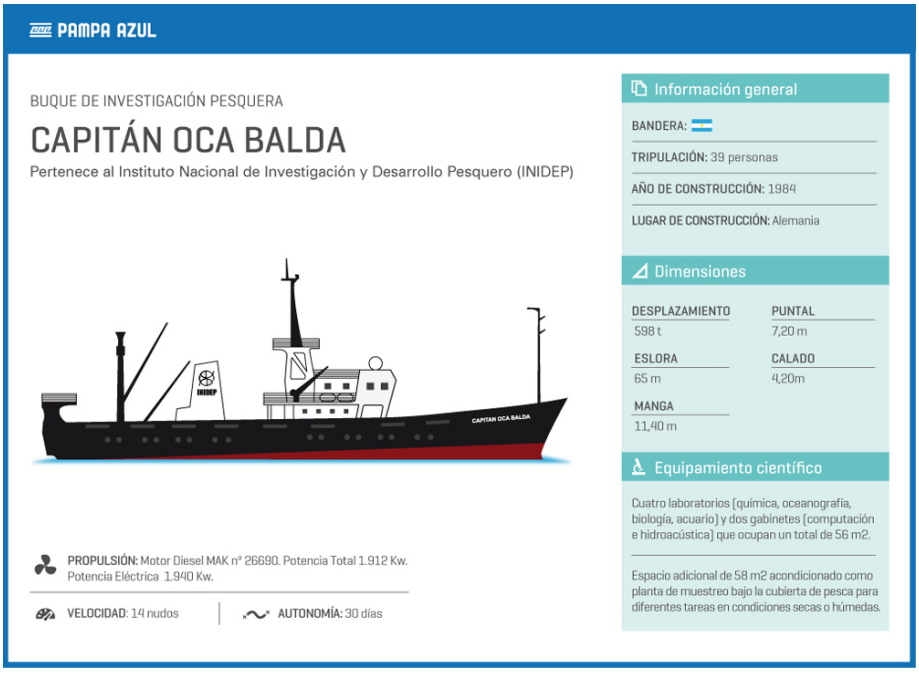
There are several ICP-MS available, although it is unknown how is the technical capacity of each laboratory to carry out trace metal measurements. Just to mention some of them:

- CONICET (Rosario): https://www.rosario-conicet.gov.ar/equipamiento/espectrometro-de-masa-con-plasma-acoplado-inductivamente-icp-ms
- CNEA: http://www.cab.cnea.gov.ar/dfc-ctp/index.php/equipamiento-y-tecnicas-de-estudios/laboratorio-de-espectrometria-de-masa-con-plasma-acoplado-inductivamente
- INTI: https://www.inti.gob.ar/quimica/equipo.htm
- Private companies (for example): https://alexstewart.com.ar/ and https://industrial.airliquide.com.ar

Recently, the Center for Photosynthetic and Biochemical Studies (CEFOBI, CONICET-UNR) acquired an ICP-MS Perkin Elmer NexION 350X. This is the first equipment of this type in the province of Santa Fe.

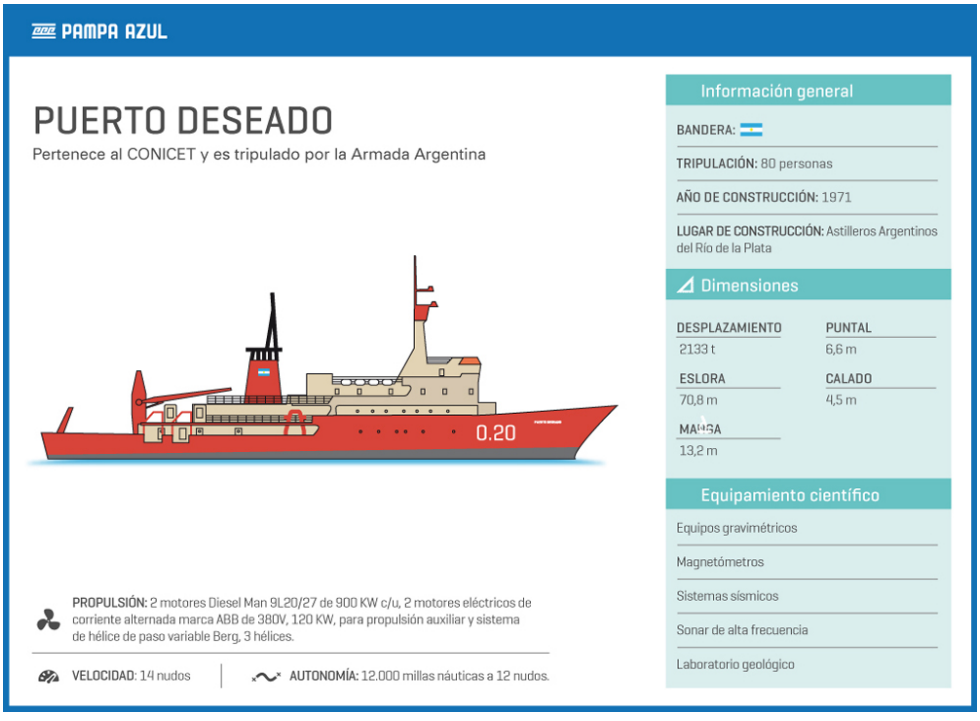
Vessels

Argentina has several vessels for scientific use. Unfortunately, due to the crisis and the lack of governmental interest, the vessels are not in good maintenance condition and are little used for lack of money to pay for fuel and crew. Below are the main vessels for scientific use in Argentina and the institutions to which they belong:

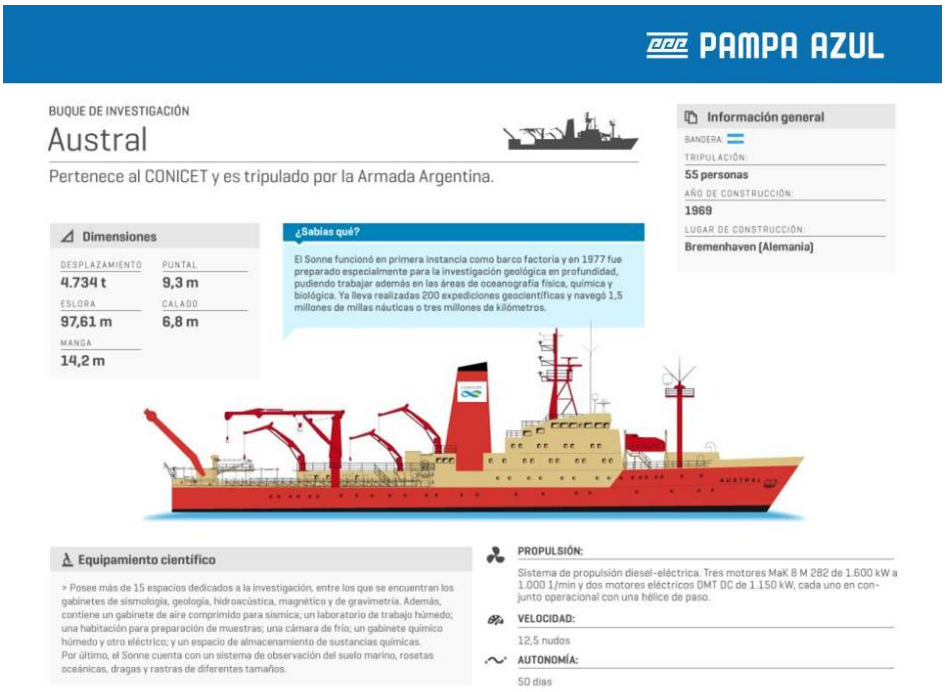


OCA BALDA - Instituto Nacional de Investigación y Desarrollo Pesquero – INIDEP *https://www.argentina.gob.ar/inidep*

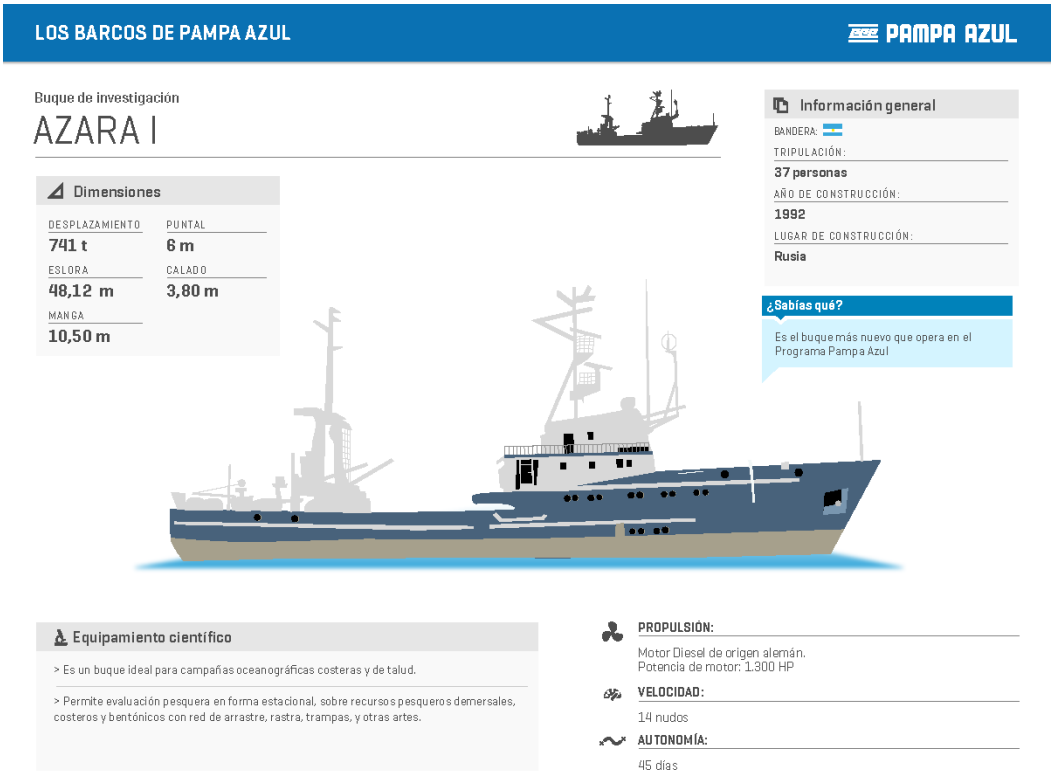
VICTOR ANGELESCU - Instituto Nacional de Investigación y Desarrollo Pesquero – INIDEP https://www.argentina.gob.ar/inidep



PUERTO DESEADO - Consejo Nacional de Investigaciones Científicas y Técnicas – CONICET https://www.conicet.gov.ar/



AUSTRAL - Consejo Nacional de Investigaciones Científicas y Técnicas – CONICET https://www.conicet.gov.ar/

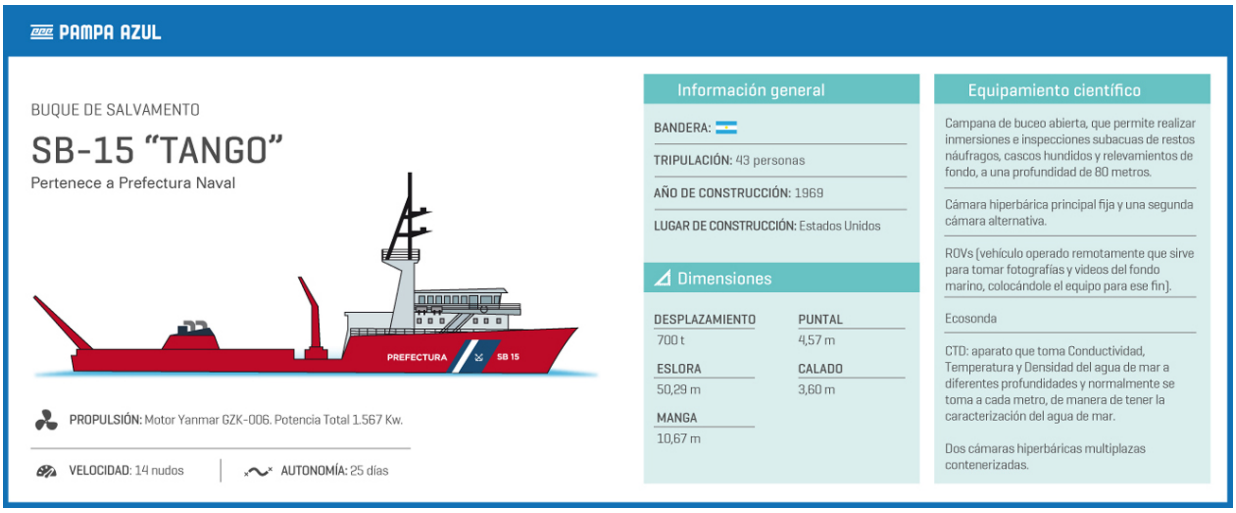


AZARA I - Consejo Nacional de Investigaciones Científicas y Técnicas – CONICET https://www.conicet.gov.ar/

ALMIRANTE IRIZAR - Consejo Nacional de Investigaciones Científicas y Técnicas – CONICET https://www.conicet.gov.ar/

COMODORO RIVADAVIA – Servicio de Hidrografía Naval – SHN http://www.hidro.gov.ar/

Dr. BERNARDO HOUSSAY – Prefectura Naval Argentina – PNA https://www.prefecturanaval.gob.ar/



TANGO – Prefectura Naval Argentina – PNA https://www.prefecturanaval.gob.ar/

Although there are some more ships, those mentioned above are the ones that are available most frequently for oceanographic cruises.

CHILE: Rodrigo Torres (rtorres@ciep.cl)

Dr. Rodrigo Torres informed that he has been collecting seawater samples using membrane pumps that have the capacity to sample the first 50m of the water column. His sampling has been performed in coastal waters and in fjords of Chile. The analyses are going to be carried out by Jonathan Hawking at the University of Florida. Currently, Dr Torres is implementing a FIA-Chemiluminoscence method to estimate DFe in a flow cell with the collaboration of Peter Croot. Besides, they are working on the effect of Fe on phytoplankton community productivity along the continent-open ocean continuum, through incubations on deck. This work, which is almost finished, summarizes the effects of additions of Fe in fjords and channels of Patagonia. Recently a German cruise (PI Doris Abele, Alfred Wegener Institute) has been approved which will visit the Strait of Magellan in 2020. Dr. Torres will perform incubations on deck to evaluate the effects of combinations of DSi, DFe and alkalinity in phytoplankton.

CHILE: Maija Heller (maija.heller@pucv.cl)

In January 2019 Dr Maija Heller got a position at the Facultad de Ciencias del Mar y Geografía, Escula de Ciencias del Mar at the Pontificia Universidad Católica de Valparaíso (PUCV) in Chile. PUCV is in the process to construct new buildings for the Escuela de Ciencias del Mar in Curauma, and in negotiation to purchase equipment of an environmental contamination laboratory from PUC (Santiago, Chile). This laboratory has a Thermo XSeries 2 ICP-MS (that need to have the working conditions of the ICP evaluated), a voltammeter, flow benches, a microwave digestion system, an acid cleaning system, MQ and further trace metal clean laboratory equipment. Another ICP-MS is been purchased by PUCV (Quimica Industrial, Instituto de Quimica) and the laboratory which is managed by Manuel Bravo has been developing research on trace metals like Arsenic for several years.

Cruises

There are no cruises approved, however, there exists a times series station which is run by PUCV and coordinated by Marcela Cornejo (marcela.cornejo@pucv.cl) in a SOLAS type of work context. The name of this station is Serie de Tiempo Oceanografica Valparaiso (STOV) and it is monthly sampled to a depth of 1000m. For chemical oceanography this station includes the analysis of nutrients, O_2, CO_2, N_2O, CH_4, POC, PON, isotopes of organic matter, pH, S, T, Fluorescence, Chl, etc. There are also additional comprehensive physical and biological analyses. As first step Dr. Heller will perform CDOM for this station.

New projects and/or funding

- The PUCV, as part of the Escuela de Ciencias del Mar, will soon be an official member of the Millenium Institute of Oceanography (IMO) in Chile. There is high interest and also need for Chile to work on trace metals, especially in coastal areas and several scientists already offered support to Dr. Heller work in Chile. The potential collaborators, to name just a few, are:

    - PUCV (Valparaiso, Curauma): Samuel Hormazabal, Marcela Cornejo, Manuel

- BravoPUC (Santiago): Juan Correa, Peter von Dassow
- UCSC (Conception): Sergio Contreras
- UdeC (Conception) Osvaldo Ulloa, Carmen Morales
- UAdeC (Valdivia/ Coyhaique): Rodrigo Torres

Originally four topics were investigated by IMO, however, it was recently decided to focus the investigation now on i) the changing ocean and ii) the deep ocean. Germany got funding to also study the deep ocean and Dr. Heller is in the process to identify cooperation partners who are interested to study Latin American countries and/ or the Pacific. There is also a strong scientific alliance between Chile and Canada to be explored.

GEOTRACES articles

Please note that the work on these manuscripts was not performed in Chile.

- Bolster K. M., Heller, M. I., Moffett, J.W., "Determination of iron(II) by chemiluminescence using masking ligands to distinguish interferences", Limnology and Oceanography: Methods, DOI: 10.1002/lom3.10279, (2018).
- Schlitzer et al., "The GEOTRACES Intermediate Data Product 2017.", Chemical Geology, 493, 210-223, doi.org/10.1016/j.chemgeo.2018.05.040, (2018).
- Hoffman, C. L., Nicholas, S. L., Ohnemus, D.C., Fitzsimmons, J. N., Sherrell, R. M., German, C. R., Heller, M. I., Lee, J.-M, Lam, P. J., Toner, B. M., "Near-field iron and carbon chemistry of non-buoyant hydrothermal plume particles, Southern East Pacific Rise 15oS", Marine Chemistry, 201, 183-197, doi.org/10.1016/j.marchem.2018.01.011, (2018).
- Ho, P, Lee, J.-M., Heller, M. I., Lam, P. J., Shiller, A. M., "The distribution of dissolved and particulate Mo and V along the U.S. GEOTRACES East Pacific Zonal Transect (GP16): the roles of oxides and biogenic particles in their distributions in the oxygen deficient zone and the hydrothermal plume", Marine Chemistry, 201, 242-255, doi.org/10.1016/j.marchem.2017.12.003, (2018).
- Lee, J.-M., Heller, M.I., Lam, P.J., "Size-fractionated distributions of particulate trace elements from the U.S. GEOTRACES Eastern Pacific Zonal Transect (GP16).", Marine Chemistry, 201, 108-123, doi.org/10.1016/j.marchem.2017.09.006, (2018).
- Lam, P.J., Lee, J.-M., Heller, M.I., Mehic S., Xiang Y., Bates. N., "Size-fractionated distributions of suspended particle concentration and major phase composition from the U.S. GEOTRACES Eastern Pacific Zonal Transect (GP16).", Marine Chemistry, 201, 90-107, doi.org/10.1016/j.marchem.2017.08.013 , (2018).
- Marsay, C.M., Lam, P.J., Heller, M.I., Lee, J. M, John, S.G., "Distribution and isotopic signature of ligand-leachable particulate iron along the GEOTRACES GP16 East Pacific Zonal Transect.", Marine Chemistry, 201, 198-211, doi: 10.1016/j.marchem.2017.07.003, (2018).
- Horak, R. E. A., Qin, W, Bertagnolli, A., Nelson, A., Heal, K. R., Han H., Heller, M.I., Schauer, A., Jeffrey, W., Armbrust, V. E., Moffett, J. W., Ingalls, A. E., Stahl D. A., Devol, A. H. "Relative impacts of light, temperature, and reactive oxygen on thaumarchaeal ammonia oxidation in the North Pacific Ocean", Limnology and Oceanography, 63 (2), 741-757, doi: 10.1002/lno.10665, (2018).

GEOTRACES presentations in international conferences

- Heller, M.I., Lam, P.J., Moffett, J.W., Till, C.P., Lee, J.-M., Marcus, M.A., "Surprises in the westward penetration of iron and its redox cycling at the Peru Margin", Ocean Deoxygenation Conference, SFB 754, Kiel, Germany, September 3-7, 2018

Submitted by Vanessa Hatje (vhatje@ufba.br).

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN CANADA

May 1, 2018 – April 1, 2019

Accomplishments

Canadian GEOTRACES activities continue to be organised around the 2015 multi-leg expedition in the Arctic Ocean and ongoing process study work in the northeast subarctic Pacific through the Line P Time Series Program. Canadian PI's continue to work closely with US colleagues on Arctic GEOTRACES synthesis projects and a number of jointly authored manuscripts are planned, in progress or published at this point. The Canadian GEOTRACES community continues to support an ongoing process study making observations of bioactive trace elements and trace element-microbe interactions on time-series cruises completed along Line P in the northeast Pacific. The September expedition of 2018 was extended using a NSERC Ship Time grant to Roberta Hamme (UVic) and colleagues to allow support of the US EXPORTS project at Ocean Station PAPA. Cullen is coordinating US colleagues to qualify the trace element sampling program for EXPORTS as a GEOTRACES compliant activity.

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

Jay T. Cullen, University of Victoria

Refereed Journal Publications *(* denotes HQP)*

- Schlitzer, R., et al. (2018) The GEOTRACES Intermediate Data Product 2017. Chemical Geology.
- *Jackson, S.L., J. Spence, *D.J. Janssen, A.R.S. Ross and J.T. Cullen. (2018) Determination of Mn, Fe, Ni, Cu, Zn, Cd and Pb in seawater using offline extraction and triple quadrupole ICP-MS/MS. Journal of Analytical Atomic Spectroscopy, DOI: 10.1039/C7JA00237H
- Nixon, R.L., S.L. Jackson, J.T. Cullen, A.R.S. Ross (in review). Distribution of copper-complexing ligands in the Canadian Arctic waters as determined by immobilized copper(II)-ion affinity chromatography. Marine Chemistry.
- Whitby H., E. Bucciarelli, G. Sarthou, N. Cassar, C.L. Osburn, *D.J. Janssen, J.T. Cullen, A. Gonzalez, M. Tonnard, H. Planquette. (2018). Relationship between -HS functional groups and iron in the northeast Pacific. Nature Geoscience.
- *Janssen D.J., W. Abouchami, S. Galer, J.T. Cullen. (in press). Particulate cadmium stable isotopes in the subarctic northeast Pacific reveal dynamic Cd cycling and a new isotopically light Cd sink. Earth and Planetary Science Letters
- Rosario Lorenzo M., M. Segovia, J.T. Cullen, M.T. Maldonado MT. (in press). Particulate trace metal dynamics in response to increased CO_2 and iron availability in a coastal mesocosm experiment. Biogeosciences.

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

Research Activities

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

Refereed Journal Publications *(HQP in Bold)*

- Wang K., Munson K.M., Beaupré-Laperrière A., Mucci A., Macdonald R.W. and Wang F. (2018) Subsurface methylmercury maximum explains biotic mercury levels in the Canadian Arctic. Nature Scientific Reports 8: 14465, pp. 1-5. doi.org/10.1038/s41598-018-32760-0
- Granger J., Sigman D.M., Gagnon J., Tremblay J.-É. and Mucci A. (2018) On the properties of the Arctic Halocline and deep water masses of the Canada Basin from nitrate isotope ratios. JGR-Oceans 123: 5443-5458. doi.org/10.1029/2018JC014110
- Mol J., Thomas H., Myers P.G., Hu X. and Mucci A. (2018) Inorganic carbon fluxes on the Mackenzie Shelf of the Beaufort Sea. Biogeosciences 15: 1011-1027. https://doi.org/10.5194/bg-15-1011-2018.
- Beaupré-Laperrière A. and Mucci A. (in preparation) The state and variability of the carbonate system of the Canadian Arctic in the context of ocean acidification: 2003 – 2016.

Conference Presentations

- Wang K., Munson K., Beaupré-Laperrière A., Mucci A., Macdonald R. and Wang F. (2018) Methylmercury distribution in the sub-surface seawater explains the spatial trend of biotic mercury in the Canadian Arctic Ocean. Contributed oral presentation. ASLO Meeting, June 10-15, 2018, Victoria, BC.
- Beaupré-Laperrière A., Mucci A. and Thomas H. (2018) Time series of ocean acidification in the Canadian Arctic Ocean. Contributed poster. Joint CMOS-MEOPAR Meeting, June 10-14, 2018, Halifax, NS.

- Mol J., Thomas H., Myers P.G., Hu X. and Mucci A. (2018) Inorganic carbon fluxes on the Mackenzie Shelf of the Beaufort Sea. Contributed poster. EGU General Assembly, April 8-13, 2018, Vienna, Austria.
- Mol J., Thomas H., Myers P.G., Hu X. and Mucci A. (2018) Inorganic carbon fluxes on the Mackenzie Shelf of the Beaufort Sea. Contributed poster. EGU General Assembly, April 8-13, 2018, Vienna, Austria.

Thesis

- Beaupré-Laperrière A. (2019) The state and variability of the carbonate system of the Canadian Arctic in the context of ocean acidification. M.Sc. Thesis, McGill University, 101 pp.

Other tangible results

- Based on measured conservative (e.g., δ18O(H2O), SP, TA) and non-conservative (DIC, dissolved oxygen, nutrients) tracers we have reconstructed the structure of the water column based on the properties of the source-water types delivered at the study sites. This product was delivered to our collaborators and partners, which allowed them to more readily interpret the vertical and horizontal distributions of the geochemical and isotopic tracers measured throughout the water column at the Canadian Geotraces sampling sites (Thomas, Wang, Granger, Orians, Maldonado). In one case (Wang et al., 2018), we have been able to explain the differential bioaccumulation of Hg in marine mammals between the eastern and western Canadian Arctic and identify the probably source of the sub-surface methyl-mercury in the Canada Basin and eastern Beaufort Sea.
- In collaboration with Prof. Helmuth Thomas, we measured 3 of the measurable carbonate system parameters (TA, DIC, pH) throughout the water column in the study area in order to investigate carbon export, estimate CO2 fluxes at the air-sea interface, as well as determine the loci and progressive acidification of the water column.

Training of Highly Qualified Personnel

- Alexis Beaupré-Laperrière was an undergraduate student in the Department of Earth and Planetary Sciences at McGill University and processed (carbonate chemistry and quality control) and mined the data collected prior to, during and after the Canadian Geotraces/ArcticNet cruise. He started this work in the context of an "Introduction to Research" course-for-credit in January 2016. He pursued this work and initiated the source-water mass OMP analysis during the summer of 2016 while he held an NSERC SURA. He pursued this work on an ad-hoc basis during the fall of 2016 until he was admitted to the M.Sc. graduate student in the summer of 2017. During his M.Sc., he synthesized 13 years of data and documented the temporal, vertical migration of the aragonite compensation depth and the acidification of Arctic waters by absorption of anthropogenic CO2 from the atmosphere as well as the lateral intrusion below the surface of pre-acidified waters (Pacific and Atlantic) into the Canada Basin, the eastern Beaufort Sea and the Canadian Arctic Archipelago.

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

Refereed Journal Publications

- Grivault N., X. Hu, P.G. Myers. (2018). Impact of the Surface Stress on the Volume and Freshwater Transport Through the Canadian Arctic Archipelago From a High□Resolution Numerical Simulation. Journal of Geophysical Research: Oceans 123 (12), 9038-9060
- Dmitrenko I.A., S. A. Kirillov, P.G. Myers, A. Forest, B. Tremblay, J. V. Lukovich, Y. Gratton, S. Rysgaard, D.G. Barber. (2018). Wind-forced depth-dependent currents over the eastern Beaufort Sea continental slope: Implications for Pacific water transport. Elem Sci Anth 6 (1)
- Hu X., J. Sun, T. O. Chan, P. G. Myers. (2018). Thermodynamic and dynamic ice thickness contributions in the Canadian Arctic Archipelago in NEMO-LIM2 numerical simulations. Cryosphere 12 (4)
- Mol J., T. Helmuth, P. G. Myers, X. Hu, A. Mucci. (2018). Inorganic carbon fluxes on the Mackenzie Shelf of the Beaufort Sea. Biogeosciences 15 (4), 1011

Thesis

N. Grivault PhD September 2018

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)

Publications (in review)

- Nixon, R.L, Jackson, S.L, Cullen, J.T., Ross, A.R.S. Distribution of copper-complexing ligands in the Canadian Arctic as determined using immobilized copper(II)-ion affinity chromatography. Marine Chemistry (submitted November 27, 2018; revisions due April 30, 2019).

Presentations

- Ross, A.R.S., Janssen, D.J., Cullen, J.T., Spence, J., Simpson, K., Robert, M. Nemcek, N., Pena, A. 2018. Depletion of micronutrient trace metals in Line P surface waters during the 2014 warming anomaly: implications for marine ecosystems and climate change. North Pacific Marine Science Organization (PICES) 2018 Annual Meeting, Yokohama, Japan, 25 October-4 November.
- Ross, A.R.S., Nixon, R.L. 2018. Characterization of marine organic ligands using Cu(II)-IMAC and mass spectrometry. 53rd Canadian Trace Organics Workshop, Vancouver BC, 14-15 May.

HQP Training

- 1 PhD student (Richard Nixon; University of Victoria Department of Biochemistry and Microbiology)
- 1 BSc co-op summer student (Jacob Davies; University of Victoria Department of Chemistry)

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

Refereed Journal Publications

- Nina Schuback and Philippe D. Tortell. 2019. Diurnal regulation of photosynthetic light absorption, electron transport and carbon fixation in two contrasting oceanic environments. Biogeosciences, in press
- Alysia Herr, John W. Dacey, Ron Kiene and Philippe D. Tortell. 2019. Patterns and drivers of dimethylsulfide concentrations in the northeast Subarctic Pacific across multiple spatial and temporal scales. Biogeosciences, In press
- Hermann W. Bange, Damian L. Arévalo-Martínez, Mercedes de la Paz, Laura Farias, Jan Kaiser, Annette Kock, Cliff S. Law, Andrew Paul Rees, Gregor Rehder, Philippe D. Tortell, Robert C. Upstill-Goddard, Samuel T Wilson. 2019. A harmonized nitrous oxide (N2O) ocean observation network for the 21st century. Frontiers in Marine Science, in press
- William J. Burt and Philippe D. Tortell. 2018. Observations of Zooplankton Diel Vertical Migration from High-Resolution Surface Ocean Optical Measurements. Geophysical Research Letters, 45. https:// doi.org/10.1029/2018GL079992
- Samuel Wilson, Hermann Bange, Damian Arévalo-Martínez, Jonathan Barnes, Alberto Borges, Ian Brown, John Bullister, Macarena Burgos, David Capelle, Michael Casso, Mercedes de la Paz, Laura Farías, Lindsay Fenwick, Sara Ferrón, Gerardo Garcia, Michael Glockzin, David Karl, Annette Kock, Sarah Laperriere, Cliff Law, Cara Manning, Andrew Marriner, Jukka-Pekka Myllykangas, John Pohlman, Andrew Rees, Alyson Santoro, Mabel Torres, Philippe Tortell, David Wisegarver, Robert Upstill-Goddard, Guiling Zhang, and Gregor Rehder. 2018. An intercomparison of oceanic methane and nitrous oxide measurements. Biogeosciences, Volume: 15 Issue: 19 Pages: 5891-5907
- WJ Burt, Z. Chen, T Westberry, M Behrenfeld, J Graff, B Jones, and PD Tortell. 2018. Carbon to Chlorophyll ratios and net primary productivity of Subarctic Pacific surface waters derived from autonomous shipboard sensors. Global Biogeochemical Cycles, Volume: 32 Issue: 2 Pages: 267-288,doi.org/10.1002/2017GB005783.
- Jarnikova T., Dacey J., Lizotte M., Levasseur, M. and P. Tortell. 2018. The distribution of methylated sulfur compounds, DMS and DMSP, in Canadian Subarctic and Arctic waters during summer, 2015. Biogeoscience. 15, 2449–2465, doi.org/10.5194
- Izett R., C. Manning, R. Hamme and PD Tortell. 2018. Refined estimates of net community production in the Subarctic Northeast Pacific derived from ΔO2/Ar measurements with N2O-based corrections for vertical mixing. Global Biogeochemical Cycles. doi:10.1002/2017GB005792
- Chen Zeng, Sarah Z. Rosengard, William Burt, Angelica Peña, Nina Nemcek, Tao Zeng, Kevin R. Arrigo, and Philippe D. Tortell. 2018. Optically-derived estimates of phytoplankton size class and taxonomic group biomass in the Eastern Subarctic Pacific Ocean. Deep-Sea Research Part I 136 (2018) 107–118
- Fenwick, L. and P. Tortell. 2018. Methane and nitrous oxide distributions in coastal and open waters of the Northeast Subarctic Pacific during 2015-2016. Marine Chemistry, volume 200 (20) Pages 45-56

- Capelle, D. W., Hallam SW and P. Tortell. 2018. A Multi-year time-series of N2O dynamics in a seasonally anoxic fjord: Saanich Inlet, British Columbia. Limnology and Oceanography, Volume 63 (2), Pages 524-539
- Hoppe, CJM; Schuback, N; Semeniuk,; Giesbrecht, K; Mol, J; Thomas, H; Maldonado, MT; Rost, B; Varela, DE; Tortell, PD. 2018. Resistance of Arctic phytoplankton to ocean acidification and enhanced irradiance. Polar Biology Volume 41(3) p. 399-413.
- Hoppe, C, Schuback, N, Seminuik D., Giesbrecht K., Mol J., Thomas H., Maldonado M., Rost B., Tortell P. Compensation of Ocean Acidification effects in Arctic phytoplankton assemblages. 2018. Nature Climate Change, accepted, NCLIM-17081528B

Conference Presentations

- 2019, European Geophysical Union General Assembly. Repeat measurements of methane and nitrous oxide distributions across the North American Arctic Ocean from 2015–2018. Cara C Manning, Zhiyin Zheng, Victoria L Preston, Annie Bourbonnais, Kevin Manganini, Anna PM Michel, David P Nicholson, Scott D Wankel, and Philippe D Tortell
- 2018, ArcticNet Conference, (Ottawa) Characterisation of a High Arctic seabed hydrocarbon seep at Scott Inlet, Baffin Bay. Margaret Cramm et al., includingRobert Izett and Philippe Tortell.
- 2018, ALSO / AGU Ocean Sciences Meeting (Portland, Oregon). Influence of mixing dynamics on net community production and CO2 uptake in Canadian Arctic and Subarctic ocean waters: P D Tortell, R Izett, M Chanona, J L Thibault, P G Myers.
- 2018, ALSO / AGU Ocean Sciences Meeting (Portland, Oregon). Biogeochemical and physical controls on interannual and spatial variability in CH4 and N2O distributions across the North American Arctic Ocean: C C Manning, D W Capelle, L Fenwick, E Damm, P D Tortell.
- 2018, ALSO / AGU Ocean Sciences Meeting (Portland, Oregon). Carbon : Chlorophyll ratios and net primary productivity of Subarctic Pacific surface waters derived from autonomous shipboard sensors: W Burt, T Westberry, M Behrenfeld, C Zeng, R Izett, P D Tortell.
- 2018, ALSO / AGU Ocean Sciences Meeting (Portland, Oregon). Refined estimates of net community production in the Subarctic Northeast Pacific derived from ΔO2/Ar measurements with N2O-based corrections for vertical mixing: R Izett, C C Manning, R C Hamme, P D Tortell.
- 2018, ALSO / AGU Ocean Sciences Meeting (Portland, Oregon). Diurnal variability in surface chlorophyll-a, phytoplankton carbon and particle size distribution in two contrasting biomass regimes of the coastal Northeast Pacific Ocean: S Rosengard, P D Tortell, N Schuback, W Burt, C Zeng.
- 2018, ALSO / AGU Ocean Sciences Meeting (Portland, Oregon). The Biogeochemistry of Methanethiol in Nearsurface Waters of the Northeastern Pacific Ocean: T E Williams, R P Kiene, K Esson, P D Tortell, J W H Dacey.
- 2018, ALSO / AGU Ocean Sciences Meeting (Portland, Oregon). Examining the concentrations and dynamics of DMS, DMSP and DMSO across oceanographic regimes of the subarctic Pacifc: A E Herr, P D Tortell.
- 2018, ALSO / AGU Ocean Sciences Meeting (Portland, Oregon). Extremely Fast Turnover of Dissolved Dimethylsulfoniopropionate (DMSP) Sustains High

Concentrations of Dimethylsul¬de and Methanethiol in the NE Subarctic Pacific: R P Kiene, K Esson, T E Williams, P D Tortell, J W H Dacey.
- 2018, ALSO / AGU Ocean Sciences Meeting (Portland, Oregon). From Fjords to Open Seas: A Decade of Geochemical and Multi-Omic Time Series Observations From the Saanich Inlet Redoxcline: S J Hallam, A K Hawley, M Torres-Beltrán, S Crowe, F A Whitney, P D Tortell.
- 2018, American Society of Mass Spectrometry (San Diego) Ross D McCulloch, Alysia Herr, John H Dacey, Phillipe D Tortell. An Automated, Sea-going Purge & Trap APCI-MS/MS for the Detection of Trace Dimethyl Sulfide in Ocean Waters.

HQP trained

- Zarah Zang, B.Sc.
- Alysia Herr, M.Sc.
- Nina Schuback
- Ana Franco
- Cara Manning
- Sarah Rosengard
- William Burt

Feiyue Wang, University of Manitoba

List of publications

- Wang K., Munson, K.M., Beaupré-Laperrière A., Mucci A., Macdonald R.W., and Wang F. 2018. Subsurface seawater methylmercury maximum explains biotic mercury concentrations in the Canadian Arctic. Sci. Rep. 8:14465, doi: 10.1038/s41598-018-32760-0.
- Wang K. 2019. Methylmercury in Seawater and Its Bioaccumulation in Marine Food Webs of the Canadian Arctic. Ph.D. Dissertation, University of Manitoba, Winnipeg, MB.

Presentations

- Munson, K.M., Singer, J. Gao Z., Chaudhuri P., Huyghe S., Ciastek S., Kuzyk Z.Z., Stern G.A., and Wang F. 2018. Mercury and methylmercury in the Hudson Bay system: an update. ArcticNet Annual Scientific Meeting, December 9–14, 2018, Ottawa, ON.
- Wang K., Munson K., Beaupré-Laperrière A., Mucci A., Macdonald R., and Wang F. 2018. Subsurface seawater methylmercury maximum explains biotic mercury levels in the Canadian Arctic. Association for the Sciences of Limnology and Oceanography (ASLO) 2018 Summer Meeting. June 10–15, 2018, Victoria, BC.

Media & Outreach

- Wang F. 2018. How we solved an Arctic mercury mystery. The Conversation. October 18, 2018. https://theconversation.com/how-we-solved-an-arctic-mercury-mystery-103963.

HQP Training

- Kang Wang, Ph.D. Thesis defended in March 2019.
- Kathleen Munson.

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN CHINA-BEIJING

May 1st, 2018 to April 30th, 2019

New scientific results

The $^{224}Ra/^{228}Th$ disequilibrium method is extended to quantify benthic fluxes of Fe from coastal sediments. Benthic Fe flux estimates along the China coastal seas are compiled and a correlation of benthic Fe fluxes and water depth in China coastal seas is identified.

Seasonal hypoxia proxy on benthic foraminifera shells: the possible use of Mn/Ca ratios in benthic foraminifera as a proxy for hypoxia have been examined, which has increasingly become a serious environmental issue in many coastal zones. Results showed that a relatively simple physical cleaning approach coupled to LA-ICP-MS provided excellent results on single specimens. Using the LA methodology, Mn/Ca ratios from living Florilus decorus (F. decorus) specimens from stations in the Yangtze River Estuary are analyzed, and Mn/Ca ratios in penultimate chambers of living benthic foraminifera are found to be sensitive to bottom water DO concentrations. Significant variations of both Mn/Ca and Mg/Ca ratios from different chambers within foraminiferal shell specimens are observed. These fluctuations are likely a response to changing ambient water DO and temperature during the specimen's growth history. Combined use of foraminiferal Mn/Ca ratios together with other proxies could provide a powerful tool for historical reconstruction of low oxygen conditions in seasonal hypoxia areas.

Multi radium isotopes to assess hydrodynamics and retention effect of river-reservoir systems: Radioactive tracer techniques may be useful for assessing water transport and the overall effects of concurrent biogeochemical processes in river-reservoir systems. Results show that radium isotopes can assess the hydrodynamics and sediment/nutrient retention in the Xiaolangdi Reservoir, the largest impoundment along the Yellow River, China. Activity ratios of $^{224}Ra/^{226}Ra$ and $^{223}Ra/^{226}Ra$ were used for water mass 'age' calculations in the riverine, transition and lentic reaches of the reservoir. Water ages were combined with the length scale of three river-reservoir zones to determine water transport rates of 3.6±1.2, 1.3±0.3, and 0.16±0.14 km/day, respectively. Radium ages were also used to quantify the net retention of sediment and nutrients in different parts of the river-reservoir system. Suspended sediment was removed at a rate of 1.4±0.6 g/m3/day, mainly in the riverine zone. Nutrient dynamics were more complicated, with addition or removal at different rates within the three zones.

New publications (published or in press)

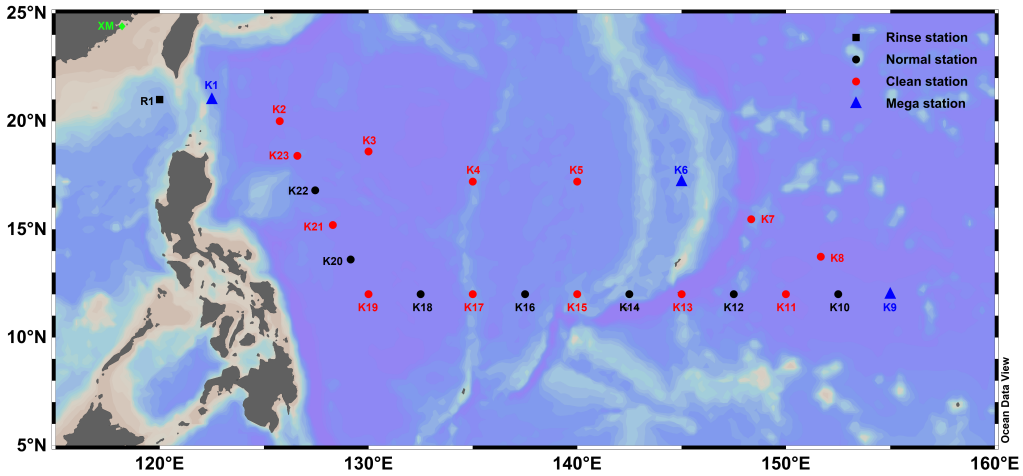
- Guo, X.Y., Xu, B.C., Burnett, W.C., Yu, Z.G., Yang, S.Y., Huang, X.T., Wang, F.F., Nan, H.M., Yao, P., Sun, F.L. A potential proxy for seasonal hypoxia: LA-ICP-MS Mn/Ca ratios in benthic foraminifera from the Yangtze River Estuary. Geochimica et Cosmochimica Acta, 2019, 245: 290-303.
- Hong, Q.Q., Cai, P.H., Geibert, W. Zhimian Cao, Ingrid Stimac, Lingfeng Liu, Qing Li (2018), Benthic fluxes of trace metals into the Pearl River Estuary based on 224Ra/228Th disequilibrium: From alkaline earth elements (Ba) to redox sensitive metals (U, Mn, and Fe). Geochimica et Cosmochimica Acta, 237, 223-239.
- Li, L., Li, F.M., Wang, Z.W., Zhao, M.X., Zhang, J., & Ren, J.L. Factors influencing the use of dissolved aluminum as a source tracer in the East China Sea and adjacent waters, Marine Chemistry, 2018, 204, 133–143.

- Shi, X.M., Mason, R.P., Charette, M.A., Mazrui, N.M., Cai, P.H. (2018), Mercury flux from salt marsh sediments: Insights from a comparison between 224Ra/228Th disequilibrium and core incubation methods. Geochimica et Cosmochimica Acta 222, 569-583.
- Wang, J.L., Fan, Y.K., Liu, D.T., Lu, T., Hou, X.L., Du, J.Z. Spatial and vertical distribution of 129I and 127I in the East China Sea: Inventory, source and transportation. Science of the Total Environment, 2019 652, 177–188.
- Wang, Z.W., Ren, J.L., Xuan, J.L., Li, F.M., Yang, T.T., & Guo, Y. Processes controlling the distribution and cycling of dissolved manganese in the northern South China Sea. Marine Chemistry, 2018, 204, 152–162.
- Wang, Z.W., Ren, J.L., Zhang, R.F., Xu, D.F., & Wu, Y. Physical and biological controls of dissolved manganese on the northern slope of the South China Sea. Deep Sea Research Part II, 2018. http://doi.org/10.1016/j.dsr2.2018.07.006
- Xu, B.C., Yang, D.S., Yao, P., Burnett, W.C., Ran, X.B., Charette, M., Huang, X.Y., Sumei Liu, X.M., Yu, Z.G. A new perspective for assessing water transport and associated retention effects in a large reservoir. Geophysical Research Letters. 2018, DOI:10.1029/2018GL079687.
- Yang, D.S., Xu, B.C., Burnett, W., Yu, Z.G., Jiang, X.Y., Zhang, X.J., Zhao, S.B. & Xia, X. Radium isotopes-suspended sediment relationship in a muddy river. Chemosphere, 2019, 214, 250-258.
- Zhang, J., Liu, Q., Bai, L.L., & Matsuno, T. Water mass analysis and contribution estimation using heavy rare earth elements: Significance of Kuroshio intermediate water to Central East China Sea shelf water, Marine Chemistry, 2018, 204, 174–180.
- Zhang, R., Zhu, X., Yang, C., Ye, L., Zhang, G., Ren, J., Wu, Y., Liu, S., Zhang, J., Zhou, M., 2018. Distribution of dissolved iron in the Pearl River (Zhujiang) Estuary and the northern continental slope of the South China Sea. Deep Sea Res. Part II Top. Stud. Oceanogr. https://doi.org/10.1016/J.DSR2.2018.12.006.

Cruises

- Two cruises in Xiaoliangdi Reservoir in May and September 2018.
- One cruise in Yellow Sea and East China Sea in June 2018.
- Three cruises in the Yangtze River estuary in March, July and August 2018.
- GEOTRACES-China Testing Cruise II, *R/V TAN KAH KEE*, Chief Scientist: Yihua Cai, March 9-18, 2018.
- GEOTRACES-China Testing Cruise III, *R/V TAN KAH KEE*, Chief Scientist: Yihua Cai, February 27 - March 2, 2019.

First GEOTRACES-China Section Cruise (GP09): 25 April -10 June 2019. Cruise chief scientists: Yihua Cai and Kuanbo Zhou (Xiamen University). Departed from Xiamen, China. R/V “TAN KAH KEE” (Jia-Geng). The major objectives are (1) To investigate the horizontal and vertical distribution of trace elements and their isotopes (e.g., Fe, Cu, Ni, REEs, etc) in the western North Pacific (wNP); (2) To identify the source/sink and internal cycle of trace elements/micro-nutrients in the wNP and their coupling with macro-nutrients; and (3) To examine the relation of trace element cycling in the wNP to the oceanic carbon cycle and global environmental and climatic change. Cruise website: http://geotraces.xmu.edu.cn



New projects and/or funding

- NSFC project, Using multi-isotopes to study the contribution of Submarine Groundwater Discharge to hypoxia formation off the Yangtze River Estuary, 41876075, 2019.01-2022.12.

PhD theses

- LI Huanxin. The geochemical characteristic and application of rare earth elements in the marginal seas of China Meetings. PhD thesis, 2019, Ocean University of China.

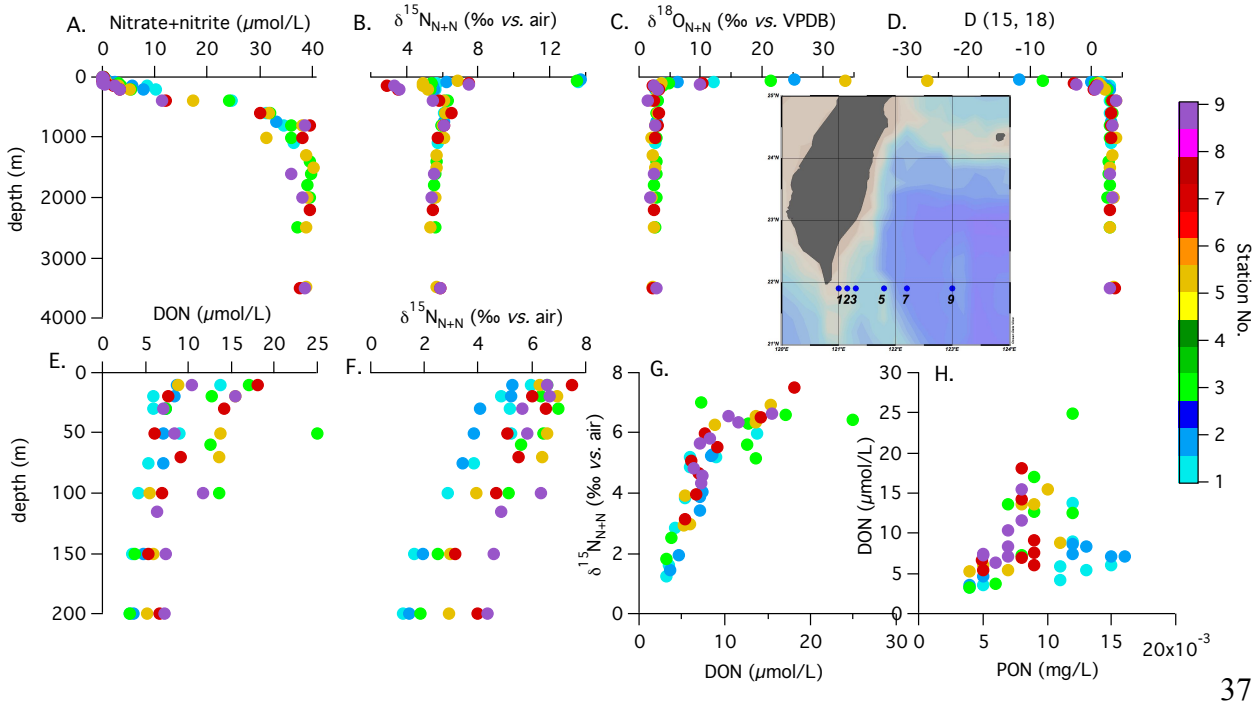
Meetings

- 2019 GEOTRACES-CHINA Cruise Planning Workshop, May 5-6, 2018, Xiamen China. Participants: Robert Anderson, Ken Buesseler, Greg Cutter, Liping Zhou, Jing Zhang, Jingling Ren, Fei Chai, Minhan Dai, Yihua Cai, Kuanbo Zhou, Zhimian Cao.
- A Training Workshop on Metal Speciation and Isotopes in the Ocean for GEOTRACES and Beyond, May 12-17, 2018□Xiamen□China. Lecturers and instructors: George Luther III, Edward Boyle, William Sunda, Mustafa Yucel, Xiangkun Zhu, Yihua Cai, Zhimian Cao, Minhan Dai, Kunming Xu, Deli Wang, Xinyuan Zheng, Kuanbo Zhou.
- The Fourth Xiamen Symposium on Marine Environmental Sciences, Xiamen, China, January 6th-9th, 2019 with C3-Bio-GEOTRACES: Trace metals & microbes: The role of trace metals in controlling structure and function of microbial communities in contemporary oceans. The conveners are Punyasloke Bhadury (Indian Institute of Science Education and Research Kolkata, India), Yeala Shaked (The Hebrew University of Jerusalem, Israel), Maria Maldonado (The University of British Columbia, Canada), Yihua Cai (Xiamen University, China), Chris Bowler (Ecole Normale Supérieure, France).
- 4th International Conference on Po and Radioactive Pb Isotopes (INCO-PoPb-2019) East China Normal University, Shanghai, April 8th-11th, 2019.

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

New scientific results

Dr. Tung-Yuan Ho's group in Research Center of Environmental Changes at Academia Sinica lead a cruise across the Kuroshio current to the east of Taiwan in from Apr. 23 to 17, 2018. In collaboration with Dr. Ho, Dr. Abby Ren's group at National Taiwan University analysed seawater samples for the concentrations and nitrogen isotopic composition on dissolved inorganic nitrogen and dissolved organic nitrogen as well as the oxygen isotopic composition of nitrate in the water column across this transect. The nitrogen isotopic composition of nitrate+nitrite shows the typical North Pacific intermediate and deep water nitrate value (~6‰). But in the shallow thermocline centered around 200m, the $\delta^{15}N$ of nitrate+nitrite decreases to around 3‰ (B), yet the $\delta^{18}O$ remains deep nitrate value (C), and the difference between $\delta^{15}N$ and $\delta^{18}O$ clearly decreases above this depth (D). These observations clearly support the input of nitrogen by nitrogen fixation, and are also supported by the upward increase in N*. The two stations away from Luzon Strait show stronger decrease in $\delta^{15}N$ in the shallower thermocline relative to the other stations. This may be explained by mixing shallow seawater outflow from the South China Sea with higher $\delta^{15}N$ value and open Pacific seawater with lower $\delta^{15}N$ value or different signatures of Kuroshio current versus the open Pacific seawater. On the other hand, the concentration and $\delta^{15}N$ of dissolved organic nitrogen both increase upward in the above 200m, and the two show strong positive correlation. Previous studies on dissolved organic nitrogen from other regions (e.g. BATS, HOTS) show invariant DON concentrations and isotopic values, which have been taken as evidence to support the refractory characteristics of the DON pool. The data from the Northwest Pacific including Kuroshio current reported here may be explained by (1) two end member mixing in this upper water depth between the high DON flux with an elevated $\delta^{15}N$ value from the top and the low DON flux with a low $\delta^{15}N$ value near the base of the euphotic zone; and/or (2) uptake of DON pool with higher $\delta^{15}N$ values. And the positive correlation between the concentrations of particulate organic nitrogen and dissolved organic nitrogen suggests an active cycle between the two pools.



Dr. Ho's group has had the following three new TEI related studies. (1) We investigated the cycling processes of aerosol Fe in the surface water of the NWPO region through Taiwan GEOTRACES cruises by analyzing aerosols, seawater, suspended and sinking particles during the periods of high and low aerosol deposition seasons. With one order of magnitude higher aerosol Fe deposition flux during high deposition period than low deposition period, the elevated aerosol Fe input was not reflected in the dissolved form but in the suspended particulate pool. Elemental ratios indicate that biotic and abiotic suspended particulate Fe exhibited size-dependent distribution patterns. Lithogenic particles originating from aerosol deposition were mainly in the particles with sizes ranging from 2 to 25 μm in the surface water. Biotic particles smaller than 2 μm were the major carriers of intracellular, precipitated and aggregated Fe, possessing longer residence time and higher bioavailability than the large and dense lithogenic particles in the euphotic zone (Wang and Ho under review). (2) We determined $\delta^{66}Zn$ in the water column of the NWPO and its marginal seas to investigate the processes causing the vertical and spatial variations. Comparable to previous studies, dissolved $\delta^{66}Zn$ was relatively light in the top 200 m and increased with depths toward to an averaged value (+0.38±0.10‰) in the deep water. We found that the $\delta^{66}Zn$ observed in the deep water were much lighter than the NEPO. Box model approaches suggest that the spatial variations in the deep water may be attributed to isotopically light Zn input originated from anthropogenic aerosols or benthic sediments. In terms of the surface water, the fractionation factors derived from either close or open system fractionation models supported that scavenging is the dominant process regulating Zn cycling in the surface water. However, either closed or open system models exhibits relatively poor fitting with the measured data. We proposed a conceptual model to include the effect of external input on [Zn] and $\delta^{66}Zn$ values in the surface water. Our model was supported by a significant correlation between Zn fractionation factors and aerosol optical depths we observed globally, implying that external aerosol deposition is an important process causing the variations of [Zn] and $\delta^{66}Zn$ in the global oceanic surface water. (Liao et al. under review). (3) We investigated the effect of Ni supply on H_2 production and N_2 fixation by using a model marine cyanobacterial diazotroph, *Cyanothece* (Tuo et al. under review). Ni is an essential cofactor in NiFe-uptake hydrogenase, an enzyme regulating H_2 metabolism in diazotrophic cyanobacteria, the major H_2 producers in the surface ocean globally. By mediating total dissolved Ni concentrations, we demonstrated that Ni deficiency would result in H_2 accumulation and diminution of N_2 fixation, coupling with decreasing growth rates and Ni quota. These results indicate that Ni deficiency limits the growth of the *Cyanothece* to some extent, considerably decreases H_2 uptake by hydrogenase and leads to H_2 accumulation and N_2 fixation reduction in the diazotroph. These findings show that Ni availability is a critical environmental factor on controlling H_2 production and N_2 fixation in marine diazotrophic cyanobacteria.

New projects and/or funding

- In continuation of Dr. Abby Ren and Dr. Tung-Yuan Ho's MOST funded projects, the two teams conducted another spring cruise in this region during March 1 to 10, 2019. To address the above described findings on the DON sources and recycling in the upper ocean, they have collected aerosol samples and PON samples in addition to the seawater samples in order to quantify atmospheric source of DON in this region, and address the cycling between PON and DON pool using their δ15N values.
- Dr. Tung-Yuan Ho's has submitted two new proposals, including the one entitled "Marine biogeochemical cycling of anthropogenic aerosol Fe" to MOST, Ministry of Science and Technology, 2019/08-2022/07 (under review); and the other pre-proposal entitled "PM2.5

trace metal biogeochemistry in the Northwestern Pacific Ocean" to Academia Sinica, 2020/01/01-2024/12/31 (under review).

GEOTRACES workshops and meetings

- 2018 GEOTRACES SSC meeting and training workshop were held in Taipei from July 23 to 26, 2018, which was hosted by Tung-Yuan Ho. A GEOTRACES training workshop was held on 26th at Academia Sinica with topics including the introduction of GEOTRACES and IDP2017, TEI sampling and analysis, and Ocean Data View application and operation.
- Dr. Abby Ren participated in the joint GEOTRACES-PAGES workshop in Aix-en-Provence from Dec. 3-5 2018. She joined the Paleo-Productivity work group, and is actively involved in the intercalibration of methods used to analyze core-top sediments and sediment trap samples for foraminifera-based proxies.

Outreach activities

- "Learning Oceanography by cartoon posters & Q&A with gifts", October 26, 2018, Academia Sinica Open house, https://openhouse.sinica.edu.tw/event/detail/65

New publications

- Liao, W.-H. and T.-Y. Ho (2018) Particulate trace metal composition and sources in the Kuroshio adjacent to the East China Sea: the importance of aerosol deposition. Journal of Geophysical Research: Oceans doi: 10.1029/2018JC014113.
- Lee, C.-P., Wen, L.-S., (2018) Physical and chemical characterization of dissolved arsenic in the South China Sea. Marine Chemistry doi.org/10.1016/j.marchem.2019.02.001.

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

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN CROATIA

April 1st, 2018 to March 31st, 2019

New scientific results

The Croatian GEOTRACES activities were mainly related to: 1) application of improved electrochemical methods (which in combination with ICPMS) are used for trace metals speciation (mostly Zn, Cd, Pb, Cu, Fe, Ni, Co; including interaction with organic matter and sulfur species) in natural waters; 2) development of analytical methods for technology critical elements (Pt, Ga, Ge, Nb, Te, Tl, W) determination in natural waters and sediments; 3) development of electroanalytical methods for determination of metal sulphide and colloidal S species, including nanoparticles, in natural waters; 4) assessment of metal bioavailability in aquatic environment using passive samplers for metals (DGT) and cytosolic metal levels in tissues of aquatic organisms, 5) characterization of marine aerosolos (PM2.5) regarding presence of organic matter, sulfur species and trace metals; 6) development of a new samplers for seawater sampling, including sea-surface microlayer; 7) geochemical research in different environmental samples, and systems; 8) study of trace elements as indicators of environmental changes in lakes;

New projects and/or funding

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

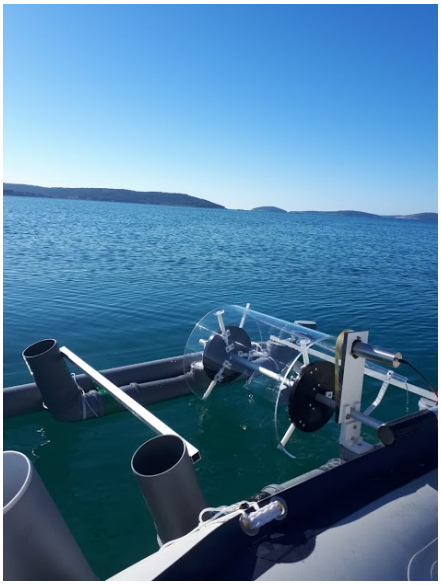
- 2014-2018 CSF project: “Appearance and interaction of biologically important organic molecules and micronutrient metals in marine ecosystem under environmental stress”, AMBIOMERES (PI: B.Gašparović).
- 2014-2018 CSF project: “The Sulphur and Carbon dynamics in the Sea- and Fresh-water EnviRonment“, SPHERE 1205 (PI: I.Ciglenečki).
- 2015-2019 CSF projekt: “New methodological approach to biogeochemical studies of trace metal speciation in coastal aquatic ecosystems“ (MEBTRACE) (PI: D. Omanovic).
- 2015-2019 CSF project "Accumulation, Subcellular Mapping and Effects of Trace Metals in Aquatic Organisms" (AQUAMAPMET) (PI: M. Erk).
- 2015-2017: National Monitoring program of coastal Adriatic Sea (Croatian side) (trace metals, organic matter, organic pollutants).
- 2018-2020: MedPAN project: NaTEF – Nautical Tourism Ecological Footprint in MPAs (PI: Dario Omanović).
- 2018-2020: Chinese/Croatian project: The speciation of trace metals in seawater at phase boundaries - implementation of advanced methodologies (PI: Dario Omanović).
- 2019-2022: MARine lake (Rogoznica) as a model for EcoSystem functioning in a changing environment (PI. I. Ciglenečki-Jušić).
- 2018-2022: Geochemistry and Records of Redox Indicators in Different Environmental Conditions: Towards a better understanding of redox conditions in the past (PI: E. Bura-Nakić).
- Collaboration on VALSE project (2017-2020) ”Nouvelles ressources transfrontalières : vers une validation de scenarii de valorisation de sédiments et autres matériaux” INTERREG France - Wallonie – Vlaanderen (PI: M.Marguš).

Outreach activities

New samplers:

- 4.5L or 12 L "Butterfly" water sampler - rope or rosette mounting (https://sites.google.com/site/daromasoft/home/sampler)

- Cheap and efficient SeaSurface Microlyaer "drum" sampler (https://sites.google.com/site/daromasoft/home/sml-sampler)



Other activities

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

New publications (published or in press)

- Pošćić, Filip, Furdek Turk, Martina, Bačić, Niko, Mikac, Nevenka, Bertoldi Daniela, Camin, Fedrica, Jukić Špika, Maja, Žanetić, Mirella, Rengel, Zed, Perica, Slavko, Removal of pomace residues is critical in quantification of element concentrations in extra virgin olive oil // Journal of food composition and analysis, 77 (2019), 39-46
- Fiket, Željka; Fiket, Tomislav; Ivanić, Maja; Mikac, Nevenka; Kniewald, Goran, Pore water geochemistry and diagenesis of estuary sediments – an example of the Zrmanja River estuary (Adriatic coast, Croatia) // Journal of soils and sediments, 19 (2019), 4; 2048-2060
- Ivanić, Maja; Fiket, Željka; Medunić, Gordana; Furdek Turk, Martina; Marović, Gordana; Senčar, Jasminka; Kniewald, Goran, Multi-element composition of soil, mosses and mushrooms and assessment of natural and artificial radioactivity of a pristine temperate rainforest system (Slavonia, Croatia) // Chemosphere, 215 (2019), 668-677
- Ivanić, Maja; Lojen, Sonja; Grozić, Dino; Jurina, Irena; Škapin, Srečo D.; Troskot-Čorbić, Tamara; Mikac, Nevenka; Juračić, Mladen; Sondi, Ivan, Geochemistry of sedimentary organic matter and trace elements in modern lake sediments from transitional karstic land-sea environment of the Neretva River delta (Kuti Lake, Croatia) // Quaternary international, 494 (2018), 286-299
- Lučić, Mavro; Jurina, Irena; Ščančar, Janez; Mikac, Nevenka; Vdović, Neda, Sedimentological and geochemical characterization of river suspended particulate matter (SPM) sampled by time-integrated mass flux sampler (TIMS) in the Sava River (Croatia) // Journal of soils and sediments, 18 (2018), 1-16
- Fiket, Željka; Mlakar, Marina; Kniewald, Goran, Distribution of rare earth elements in sediments of the marine lake Mir (Dugi otok, Croatia) // Geosciences, 8 (2018), 8; 301, 18
- Pošćić, Filip; Runjić, Marko; Jukić Špika, Maja; Mikac, Nevenka; Rengel, Zed; Romić, Marija; Urlić, Branimir; Bačić, Niko; Lučić, Mavro; Bakić, Helena et al. Nutrient deficiencies in olives grown on typical Mediterranean soils (Terra rossa, Rendzina, Lithosol) // Archives of Agronomy and Soil Science, 64 (2018), 13; 1777-1790
- Fiket, Željka; Ivanić, Maja; Furdek Turk, Martina; Mikac, Nevenka; Kniewald, Goran, Distribution of trace elements in waters of the Zrmanja River estuary (eastern Adriatic coast, Croatia) // Croatica chemica acta, 91 (2018), 1; 29-41
- L. Cotte, D. Omanović, M. Waeles, A. Laës, C. Cathalot, P.M. Sarradin and R.D. Riso, On the nature of dissolved copper ligands in the early buoyant plume of hydrothermal vents. Environmental Chemistry (2017). 15 (2018) 58-73
- Clément Coclet, Cédric Garnier, Gaël Durrieu, Dario Omanović, Sébastien D'Onofrio, Christophe Le Poupon, Jean-Ulrich Mullot, Jean-François Briand, Benjamin Misson, Changes in bacterioplankton communities resulting from direct and indirect interactions with trace metal gradients in an urbanized marine coastal area. Frontiers in Microbiology, 10 (2019) 1–14.
- Huy Dang, Duc; Evans, R. Douglas; Wang, Wei; Omanović, Dario; El Houssainy, Amonda; Lenoble, Véronique; Mullot, Jean-Ulrich; Mounier, Stéphane; Garnier, Cédric. Uranium isotope geochemistry in modern coastal sediments: insights from Toulon Bay, France. Chemical geology. 481 (2018) 133-145.

Presentations in international conferences

- S. Marcinek, N. Layglon, J. Pađan, A-M. Cindrić, C. Santinelli, M. Gonnelli, C. Garnier, S. Mounier and D. Omanović, UV-Vis spectroscopic study of coloured dissolved organic matter (CDOM) in the pristine Krka River estuary (Croatia), International Workshop on Organic Matter Spectroscopy 2018 (WOMS 2018), 23-27. October, 2018, Carqueiranne, France.
- D. Omanović, C. Santinelli, S. Marcinek, ASFit - an all-inclusive tool for analysis of UV-Vis spectra of colored dissolved organic matter (CDOM), International Workshop on Organic Matter Spectroscopy 2018 (WOMS 2018), 23-27. October, 2018, Carqueiranne, France.
- J. Pađan, S. Marcinek, A.M. Cindrić, N. Layglon, G. Durrieu, C. Garnier, D. Omanović, Determination of sub-pico-molar levels of platinum in the Krka river estuary (Croatia), 40th International Conference on Environmental & Food Monitoring, Santiago de Compostela (Spain), 19-22.06.2018.
- S. Marcinek, C. Garnier, J. Pađan, A.M. Cindrić, I. Pižeta, D. Omanović, Segmented multi–detection window approach for organic speciation of trace metals – a model and experimental study in estuarine system, 40th International Conference on Environmental & Food Monitoring, Santiago de Compostela (Spain), 19-22.06.2018.
- I. Ciglenecki, N. Mikac, G. Helz, M.Marguš, M.Čanković, Rogoznica Lake as a proxy for biogeochemical processes in euxinic marine environment, Goldschmidt conference, Boston, August 2018.

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

New scientific results

- More realistic oceanic particle field improved the ^{230}Th and ^{231}Pa modeling

  ^{230}Th and ^{231}Pa are frequently used tracers to investigate particle transport in the ocean and past ocean circulation rate. In order to correctly reproduce their distribution by modelling, it is crucial to use realistic particle field. This point was challenged using the NEMO-PISCES model by adding dust lithogenic particles (van Hulten et al., 2018). The GEOTRACES field database allows comparison of the simulated and the measured distributions. The result show improved match between them (Figure 5). The next step is the integration of nepheloid and hydrothermal particles to go further to this direction.

  van Hulten, M., Dutay, J. C., and Roy-Barman, M., 2018. Geosci. Model Dev. ***11****, 3537-3556.*

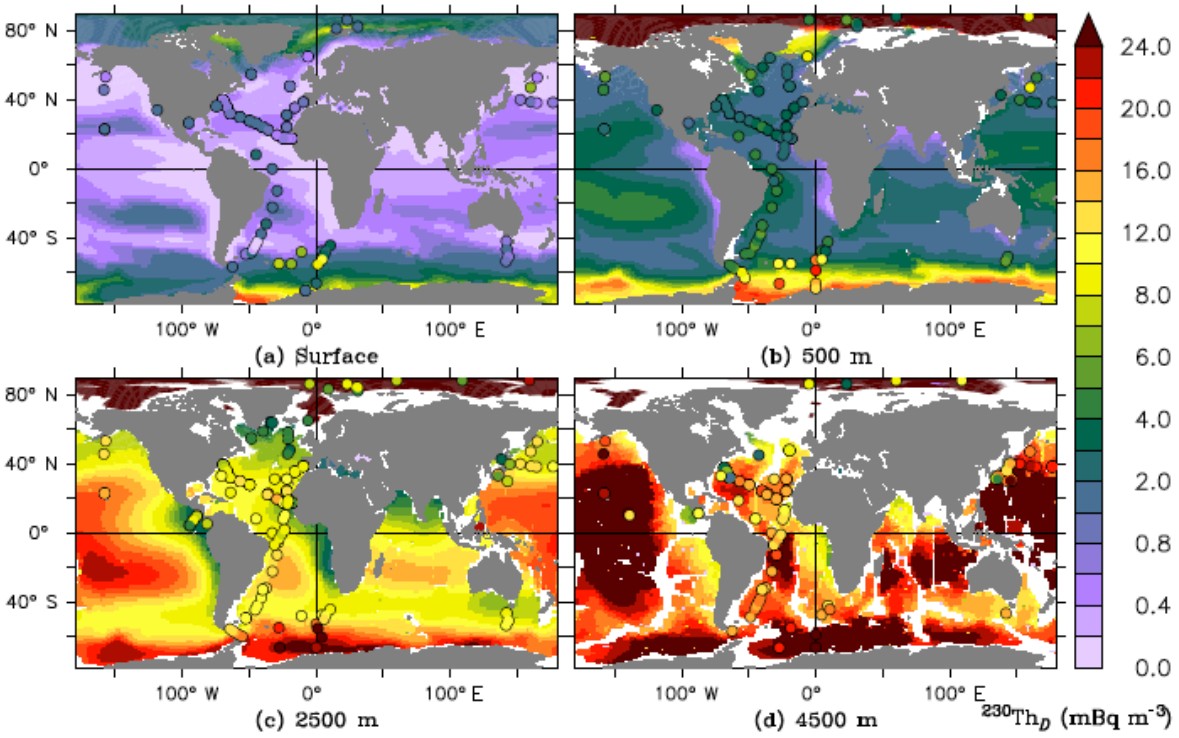


Figure 5*. Modeled dissolved ^{230}Th activity (mBqm^{-3}) at four depth levels (colored background) and GEOTRACES field database (circles). (a) Surface, (b) 500 m, (c) 2500 m and (d) 4500 m.*

- The Mediterranean Sea Ba budget revisited: more intense mean particulate Ba cycling than previously estimated

  The distribution of dissolved Ba in the Mediterranean Sea water (GEOTRACES GA-04S MedSeA cruise) and concentration of Ba and ^{226}Ra in groundwater discharge were determined to revisit Ba budget. Dissolved Ba concentration increases from the inflowing Atlantic surface water to the intermediate/deep Mediterranean waters (Figure 5a). This increase cannot be explained by evaporation and river discharge. Dust deposition is

estimated to be a negligible source. Submarine discharge can significantly contribute to the Ba budget but large uncertainty exists. The correlation between dissolved Ba and Apparent Oxygen Utilization (AOU) supports that organic matter remineralization drives the release of Ba (Figure 5b). Therefore, higher Ba concentration at deeper water depths suggests active particulate Ba cycling and/or Ba dissolution in the sediment.

Roy-Barman, M., Pons-Branchu, E., Levier, M., Bordier, L., Foliot, L., Gdaniec, S., Ayrault, S., Garcia-Orellana, J., Masque, P., and Castrillejo, M., 2019. Chem. Geol. 511, 431-440.

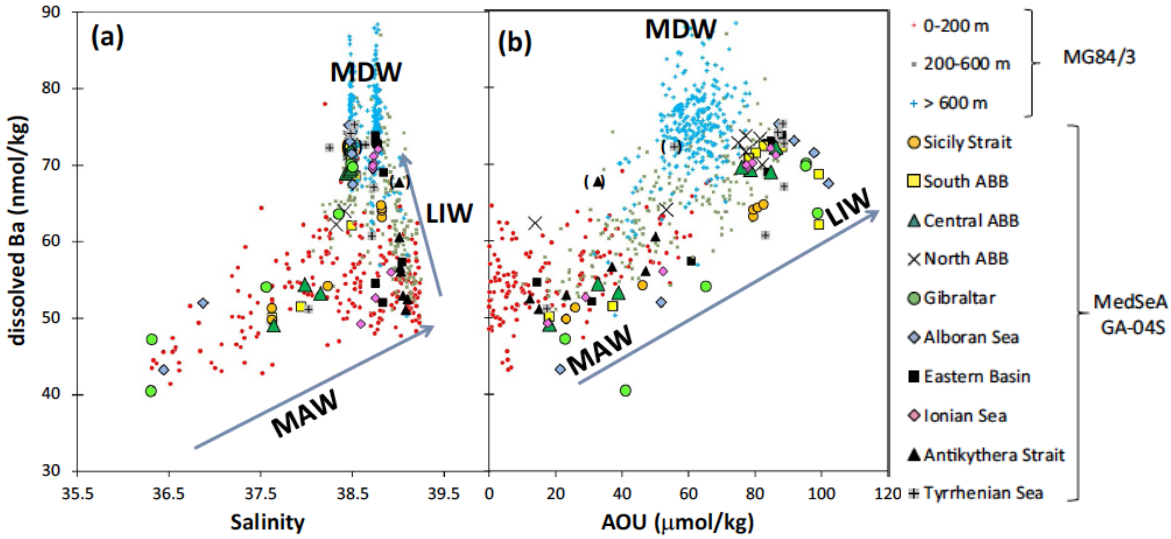


Figure 6. *Dissolved Ba in the Mediterranean Sea during the GA-04S MedSeA and the M84/3 cruises. (a) Relationship with salinity and (b) with AOU. MAW: Modified Atlantic Water. LIW: Levantine Intermediate Water. MDW: Mediterranean Deep Water. ABB: Algero Balearic Basin.*

Cruises

- SWINGS cruise (PIs: C. Jeandel and H Planquette). The ship time is secured on the Marion-Dufresne for early 2021. To raise the funds for works at sea and in the lab, ANR project was submitted (result will be published in July 2019).
- GEOTRACES Amazon M147 cruise (PIs: Andrea Koschinsky and Martin Frank, 19/04/2018 - 21/05/2018): involvement of LEMAR in this project for the measurements of humic-like substances.
- TONGA cruise (PIs C. Guieu and S. Bonnet): Cruise planned in November 2019.
- GLACE cruise (PI M. Lehmann): cruise planned August-September 2019
- SCALE cruises (PI: T. Mtshali, CSIR, South Africa): Southern Ocean Winter (July-Aug 2019) and Spring (Oct-Nov 2019) cruises. Participation of the LEMAR Trace Metal Team for the analyses of DFe, SFe, PFe and humics / Funding form PHC PROTEA and Isblue (PI: E. Bucciarelli).
- Not GEOTRACES-labelled but potentially interesting for the community: Opportunity Cruise on OISO transect on-board R/V Marion Dufresne from La Réunion to Kerguelen

Island in the South-West Indian Ocean and Southern Ocean (Jan – Feb. 2019) to perform processes studies on the impact of atmospheric aerosols (dust and volcanic ashes) on phytoplankton productivity (Project ITALIANO).

New projects and/or funding

- Co-funding for French clean sampling container (10k€ LEGOS).
- LEFE-INSU project INTERFERIC for Fe isotope measurements of PANDORA and GEOVIDE samples (17k€ for 3 years).

GEOTRACES workshops and meetings organised

- Joint Workshop GEOTRACES-PAGES in 3-5 December 2018 in Aix-Marseille (64 participants). We were local organizers. Eleven French participants.
- C. Jeandel, and E. Masferrer participated at the DMC, and C. Jeandel, K. Tachikawa and E. Masferrer participated at the SSC in Taiwan.
- Participation at the Awesome OCIM workshop, 1 2 August 2018, Boston, USA (David Gonzalez-Santana, PhD student). http://www.geotraces.org/meetings/meetings-by-year/eventdetail/331/-/introduction-to-the-awesome-ocim
- During the 2019 IMBeR Open Science Conference in Brest (15-21 June 2019) (Géraldine Sarthou is member of the scientific Committee), there will be a Town Hall (Wednesday, lunch time) dedicated to Biogeoscape (convenors Alessandro Tagliabue (Univ Liverpool, UK), Ingrid Obernosterer (LOMIC, Banyuls/mer, France), and Géraldine Sarthou (LEMAR, Brest, France).
- K. Pahnke and M. Behrens (Oldenburg Univ, G), visited LEGOS researchers to go further on the collaborations around the SW Pacific activities. M. Behrens and F. Lacan plan to share particle samples collected during EUC-Fe.

Outreach activities conducted

- The highlights on articles related to GEOTRACES are written by C. Jeandel and E. Masferrer.
- C. Jeandel co-edited the ELEMENTS special issue on GEOTRACES with V. Hatje (UFB, Brasil) and Z. Chase (UTAS, Hobart).

Other GEOTRACES activities

- Collaborations with S. Michael and J. Resing, from WU (USA). Susanna has got a Chateaubriand French funding.
- Collaboration with R. Francois (C. Jeandel via Marie Curie return post-doc of M. Grenier)
- Collaboration with M. Charette (E. Le Roy, GEOTRACES Pacific cruise).
- Collaboration with University of La Palmas: Ana del Carmen Arriola Velasquez at LEGOS Jan-Mar 2019 Erasmus).
- Collaboration with J. Garcia-Orellana, UAB on SGD (PhD thesis Simon Bejannin).

Status of clean sampling equipment or in situ pumps

Acquisition of a new clean sampling container: 70 k€ (CEELT project).

New GEOTRACES or GEOTRACES-related publications (published or in press) 28 peer-reviewed journal articles (France GEOTRACES investigators are lead authors or co-authors).

- Castrillejo, M., Casacuberta, N., Christl, M., Vockenhuber, C., Synal, H. A., García-Ibáñez, M. I., Lherminier, P., Sarthou, G., Garcia-Orellana, J., and Masqué, P., 2018. Tracing water masses with 129I and 236U in the subpolar North Atlantic along the GEOTRACES GA01 section. Biogeosciences 15, 5545-5564.
- Chavagnac, V., Saleban Ali, H., Jeandel, C., Leleu, T., Destrigneville, C., Castillo, A., Cotte, L., Waeles, M., Cathalot, C., Laes-Huon, A., Pelleter, E., Nonnotte, P., Sarradin, P.-M., and Cannat, M., 2018. Sulfate minerals control dissolved rare earth element flux and Nd isotope signature of buoyant hydrothermal plume (EMSO-Azores, 37°N Mid-Atlantic Ridge). Chem. Geol. 499, 111-125.
- Cheize, M., Planquette, H. F., Fitzsimmons, J. N., Pelleter, E., Sherrell, R. M., Lambert, C., Bucciarelli, E., Sarthou, G., Le Goff, M., Liorzou, C., Chéron, S., Viollier, E., and Gayet, N., 2018. Contribution of resuspended sedimentary particles to dissolved iron and manganese in the ocean: An experimental study. Chem. Geol. https://doi.org/10.1016/j.chemgeo.2018.10.003.
- Cossa, D., Heimbürger, L. E., Pérez, F. F., García-Ibáñez, M. I., Sonke, J. E., Planquette, H., Lherminier, P., Boutorh, J., Cheize, M., Menzel Barraqueta, J. L., Shelley, R., and Sarthou, G., 2018. Mercury distribution and transport in the North Atlantic Ocean along the GEOTRACES-GA01 transect. Biogeosciences 15, 2309-2323.
- Fonseca-Batista, D., Li, X., Riou, V., Michotey, V., Deman, F., Fripiat, F., Guasco, S., Brion, N., Lemaitre, N., Tonnard, M., Gallinari, M., Planquette, H., Planchon, F., Sarthou, G., Elskens, M., LaRoche, J., Chou, L., and Dehairs, F., 2019. Evidence of high N2 fixation rates in the temperate northeast Atlantic. Biogeosciences 16, 999-1017.
- Gdaniec, S., Roy-Barman, M., Foliot, L., Thil, F., Dapoigny, A., Burckel, P., Garcia-Orellana, J., Masqué, P., Mörth, C.-M., and Andersson, P. S., 2018. Thorium and protactinium isotopes as tracers of marine particle fluxes and deep water circulation in the Mediterranean Sea. Marine Chemistry 199, 12-23.
- González, A. G., Cadena-Aizaga, M. I., Sarthou, G., González-Dávila, M., and Santana-Casiano, J. M., 2018. Iron complexation by phenolic ligands in seawater. Chem. Geol. https://doi.org/10.1016/j.chemgeo.2018.10.017.
- Grenier, M., Garcia-Solsona, E., Lemaitre, N., Trull, T. W., Bouvier, V., Nonnotte, P., van Beek, P., Souhaut, M., Lacan, F., and Jeandel, C., 2018. Differentiating Lithogenic Supplies, Water Mass Transport, and Biological Processes On and Off the Kerguelen Plateau Using Rare Earth Element Concentrations and Neodymium Isotopic Compositions. Frontiers in Marine Science 5.
- Guieu, C., Bonnet, S., Petrenko, A., Menkes, C., Chavagnac, V., Desboeufs, K., Maes, C., and Moutin, T., 2018. Iron from a submarine source impacts the productive layer of the Western Tropical South Pacific (WTSP). Scientific Reports 8, 9075.
- Jeandel, C. and Derek, V., 2018. New Tools, New Discoveries in Marine Geochemistry. Elements 14, 379-384.
- Klar, J. K., Schlosser, C., Milton, J. A., Woodward, E. M. S., Lacan, F., Parkinson, I. J., Achterberg, E. P., and James, R. H., 2018. Sources of dissolved iron to oxygen minimum

zone waters on the Senegalese continental margin in the tropical North Atlantic Ocean: Insights from iron isotopes. Geochimica et Cosmochimica Acta 236, 60-78.

- Le Roy, E., Sanial, V., Charette, M. A., van Beek, P., Lacan, F., Jacquet, S. H. M., Henderson, P. B., Souhaut, M., García-Ibáñez, M. I., Jeandel, C., Pérez, F. F., and Sarthou, G., 2018. The 226Ra–Ba relationship in the North Atlantic during GEOTRACES-GA01. Biogeosciences 15, 3027-3048.
- Lemaitre, N., Planchon, F., Planquette, H., Dehairs, F., Fonseca-Batista, D., Roukaerts, A., Deman, F., Tang, Y., Mariez, C., and Sarthou, G., 2018a. High variability of particulate organic carbon export along the North Atlantic GEOTRACES section GA01 as deduced from 234Th fluxes. Biogeosciences 15, 6417-6437.
- Lemaitre, N., Planquette, H., Planchon, F., Sarthou, G., Jacquet, S., García-Ibáñez, M. I., Gourain, A., Cheize, M., Monin, L., André, L., Laha, P., Terryn, H., and Dehairs, F., 2018b. Particulate barium tracing of significant mesopelagic carbon remineralisation in the North Atlantic. Biogeosciences 15, 2289-2307.
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- Roy-Barman, M., Pons-Branchu, E., Levier, M., Bordier, L., Foliot, L., Gdaniec, S., Ayrault, S., Garcia-Orellana, J., Masque, P., and Castrillejo, M., 2019. Barium during the GEOTRACES GA-04S MedSeA cruise: The Mediterranean Sea Ba budget revisited. Chem. Geol. 511, 431-440.
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GEOVIDE transect (GEOTRACES GA-01) and their decadal evolution. Biogeosciences 15, 4995-5014.

Completed GEOTRACES PhD or Master theses

- M. Tonnard (PhD in cotutelle University of Brest/University of Tasmania), Biogeochemical cycle of iron: distribution and speciation in the North Atlantic Ocean (GA01) and the Southern Ocean (GIpr05) (GEOTRACES) in 2018.
- S. Bejannin (PhD) "Submarine groundwater discharge along the French Mediterranean coastline" in 2018.
- M. Lagarde (Master) in 2018. She started her PhD (2018-2021).

GEOTRACES presentations in international conferences

Intl Goldschmidt Conf. Boston, 2018

- Cheize M., H. Planquette, D. Gonzalez-Santana, H. Whitby, A. Gourain, T. Holmes, V. Guyader, Y. Germain, M. Roudaut, C. Cathalot, G. Sarthou, E. Pelleter, Y. Fouquet, High resolution particulate trace metals dispersion from the TAG hydrothermal vent (Mid-Atlantic Ridge).
- Grenier, M., Francois, F., Soon, M., Baconnais, I., Pham, V., Jeandel, C., Ocean circulation and land-ocean exchanges off the north eastern Canadian coasts as told by dissolved geochemical tracers.
- Gonzalez-Santana D., A. Lough, N. J. Wyatt, L. Artigue, M. C. Lohan, H. Planquette, G. Sarthou, dFe(II) variability across hydrothermal vents in the Mid Atlantic Ridge.
- Lagarde, M., Lamaitre, N., Planquette, H., Grenier, M., Belhaj, M., Jeandel, C., Particulate Rare Earth Elements behavior in the North Atlantic (GEOVIDE cruise).

The 7th Kaplan Symposium, Eilat, Israel, 2019

- Lagarde M., Lemaitre N., Planquette H., Grenier M., Belhadj M., Jeandel C., Particulate Rare Earth Elements behavior in the North Atlantic (GEOVIDE cruise).
- Pham V., Jeandel C., Belhadj M., Nachez Y., Grenier M. Land-ocean processes traced by Rare Earth Elements in the Solomon Seas (Pandora-GEOTRACES).

7th international Ra-Rn workshop, Delmenhorst (Germany), July 2018

- Le Roy E, Sanial V., van Beek, P. Lacan F., Souhaut M., Charette M.A., Paul B. Henderson, Deng F., Henderson G.M., Distribution of dissolved 227Ac along the GA01 section in the North Atlantic.

IAEA Environment Laboratories, Monaco, December 2018.

- Van Beek P., Joint EC-JRC/IAEA workshop on low-level radioactivity measurements and applications (JEILORA)

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

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN GERMANY

May 1st, 2018 to March 30th, 2019

New scientific results

Runoff from the Greenland Ice Sheet (GrIS) is thought to enhance marine productivity by adding bioessential iron and silicic acid to coastal waters. However, experimental data suggest nitrate is the main summertime growth-limiting resource in regions affected by meltwater around Greenland. While meltwater contains low nitrate concentrations, subglacial discharge plumes from marine-terminating glaciers entrain large quantities of nitrate from deep seawater. Here, we characterize the nitrate fluxes that arise from entrainment of seawater within these plumes using a subglacial discharge plume model. The upwelled flux from 12 marine-terminating glaciers is estimated to be >1000% of the total nitrate flux from GrIS discharge. This plume upwelling effect is highly sensitive to the glacier grounding line depth. For a majority of Greenland's marine-terminating glaciers nitrate fluxes will diminish as they retreat. This decline occurs even if discharge volume increases, resulting in a negative impact on nitrate availability and thus summertime marine productivity.

Hopwood, M. J., D. Carroll, T. J. Browning, L. Meire, J. Mortensen, S. Krisch, E. P. Achterberg (2018): Non-linear response of summertime marine productivity to increased meltwater discharge around Greenland. Nature Communications, 9 (1), 3256, https://doi.org/10.1038/s41467-018-05488-8.

Cruises

- GEOTRACES Process Study Meteor M147 (GEOTRACES Process study GApr11 (19/04/2018 - 21/05/2018) to the Amazon mouth Chief-Scientist: Andrea Koschinsky (IUB Bremen). Other PIs Martin Frank, Martha Gledhill, Eric Achterberg, Pablo Lodeiro (GEOMAR), Thorsten Dittmar (ICBM, Oldenburg). Brazilian partner institutes: Universidade Federal de Rio Grande do Sul-UFRGS, Universidade Estadual do Norte Fluminense-UENF, Universidade Federal de Santa Maria-UFSM, Universidade Federale de Rio de Janeiro-UFRJ.

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

  - Cruise report: https://doi.org/10.2312/cr_m147

New projects and/or funding

- GP11 section cruise on FS Sonne in the Equatorial Pacific has been awarded (Achterberg and Frank). We will now wait for the scheduling of the cruise.
- DFG funding of cruise M147 and associated first evaluation project for ICBM, Univ. Oldenburg, and Jacobs University Bremen
- GIO6 section cruise on FS Sonne in the South Indian Ocean has been scheduled for 6 July-August 25 2020 (Achterberg and Frank).

GEOTRACES workshops and meetings

The 7th workshop on radium and radon was held at the Hanse Wissenschafts Kolleg in Delmenhorst, Germany from 2-6 July 2018. 48 Participants discussed the application of these natural radionuclides to environmental topics, the comparability of measurements, and method improvements. GEOTRACES was an important contributor of data and provided context for the science.

Other activities

- M147 blog http://amazongeotraces-m147.com covering the M147 Amazon cruise and also including news on ongoing work and publications.

New publications (published or in press)

- Valk, O., Rutgers van der Loeff, M. M., Geibert, W., Gdaniec, S., Rijkenberg, M.J.A, Moran, S.B., Lepore, K, Edwards, R.L., Lu, Y and Puigcorbé, J. (2018). Importance of Hydrothermal Vents in Scavenging Removal of 230Th in the Nansen Basin. Geophys. Res. Lett. https://doi.org/10.1029/2018GL079829.
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- Biller, S.J., Berube, P.M., Dooley, K., Williams, M., Satinsky, B.M., Hackl, T., Hogle, S.L., Coe, A., Bergauer, K., Bouman, H.A., Browning, T.J., De Corte, D., Hassler, C., Hulston, D., Jacquot, J.E., Maas, E.W., Reinthaler, T., Sintes, E., Yokokawa, T., Chisholm, S.W.. Marine microbial metagenomes sampled across space and time. Scientific Data 5, 180176 (2018).
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- Sutton, J.N., André, L., Cardinal, D., Conley, D.J., de Souza, G.F., Dean, J., Dodd, J., Ehlert, C., Ellwood, M.J., Frings, P.J., Grasse, P., Hendry, K., Leng, M.J., Michalopoulos, P., Panizzo, V.N., Swann, G.E.A., 2018. A Review of the Stable Isotope Bio-geochemistry of the Global Silicon Cycle and Its Associated Trace Elements. Frontiers in Earth Science 5.
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PhD theses

- Insa Rapp (2018): Trace metal sources and cycling in tropical oxygen minimum zones. (GEOMAR, University of Kiel).
- Dagmara Rusiecka (2018) Biogeochemistry of trace metals in European shelf seas. (University of Southampton, GEOMAR).
- Jan Lukas Menzel (2018). Biogeochemistry of dissolved aluminium in the Atlantic Ocean. (GEOMAR, University of Kiel).

Master theses

- Lisa Leist, 2018, Trace metal distribution on M81 in the tropical N Atlantic (supervisor: E. Achterberg).

Presentations in international conferences

- Stephan Krisch, M. Hopwood, J. Schaffer, P. Lodeiro, S.-M. Chen, C. Schlosser, T. Kanzow, E.P. Achterberg at IASC meeting in Oslo, January 2019. Title: Nioghalvfjerdbrae (79NG) Fe Fluxes; Results from PS100 (GN05).
- Browning, T.J. and Achterberg, E.P. Nutrient controls on productivity overlying and offshore of oxygen minimum zones. Ocean Deoxygenation Conference, Kiel 2018.
- Young, J.C., Browning, T.J., Gledhill, M., Shi, Z., Achterberg, E.P. Sources and composition of water-soluble trace elements in aerosols over the Benguela and Peruvian Oxygen Minimum Zones. Ocean Deoxygenation Conference, Kiel 2018.

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

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN INDIA

April 1st, 2018 to March 31st, 2019

India is actively continuing the GEOTRACES activities. This year new sampling has not been done. However, samples collected earlier are being analysed for various trace metals. Suite of trace metals (Fe, Mn, Zn, Cu, Co, Ni) are being analysed using HR-ICPMS and SeaFast. Several profiles in Indian Ocean are completed for these elements.

New scientific results

- Dissolved Al measurement in the Indian Ocean

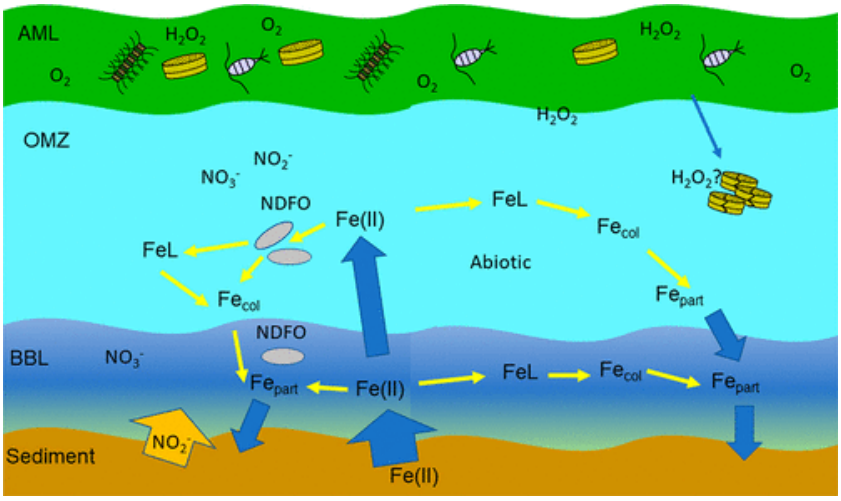
  Dissolved aluminum concentrations have been determined in a total of 34 full vertical water column profiles along the two separate GEOTRACES–India transects (GI–01 and GI–10). The impact of huge supply of suspended lithogenic sediments to the BoB waters from the Ganga–Brahmaputra river system, Indian peninsular rivers and resuspended terrigenous sediments from the continental shelf and slope on dAl distribution is seen. Sediment resuspension induced by hydrothermal activity enrich the dAl in the deep water hydrothermal plume observed near Central Indian Ridge.

Publications

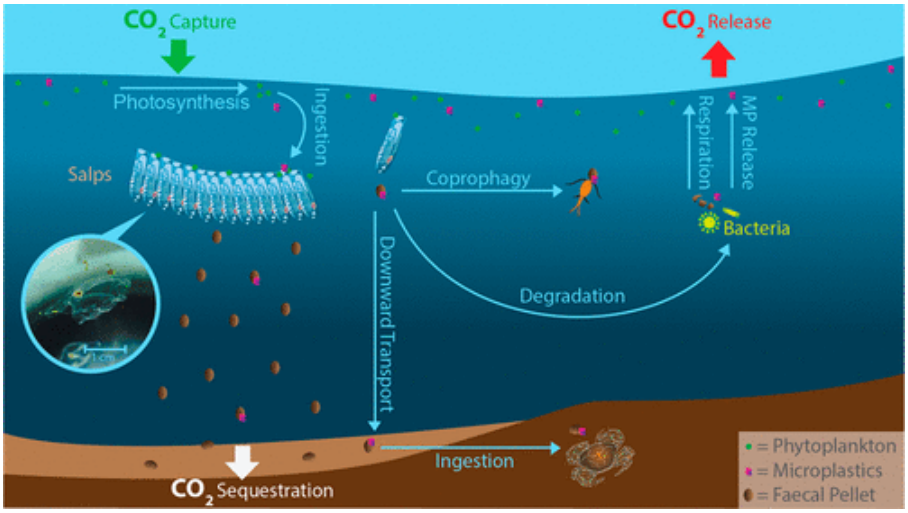
- Chinni V., Singh S. K., Bhushan R., Rengarajan R., Sarma V. V. S.S., Spatial variability in dissolved iron concentrations in the marginal and open waters of the Indian Ocean, Marine Chemistry 208, 11-28, 2019.
- Samanta S., Dalai T. K., Massive production of heavy metals in the Ganga (Hooghly) River estuary, India: Global importance of solute-particle interaction and enhanced metal fluxes to the oceans, Geochimica et Cosmochimica Acta, 228 () 243–258, 2018.
- Shah C., Sudheer A. K., Bhushan R., Distribution of dissolved organic carbon in the Bay of Bengal: Influence of sediment discharge, fresh water flux, and productivity, Marine Chemistry, 203, 91-101, 2018.

Submitted by Vineet Goswami and Sunil Kumar Singh (sunil@nio.org).

New scientific results



- During the reporting period, new works were published by Irish researchers with international GEOTRACES colleagues on the cycling of Fe(II) in the Peruvian Oxygen Minimum Zone (OMZ). Schlosser et al (2018) showed how Fe(II) fluxes were greatly increased from the sediments when sulfide was present. A further study by Croot et al. (2019) combined high resolution measurements of Fe(II) and H_2O_2 in the water column and close to the sediment/water interface with modelling of Fe(II) fluxes from the sediment (based on earlier models using radon) to determine in situ oxidation rates. These rates were then compared to the known oxidizers in the water column and suggests that nitrate-dependent anaerobic Fe(II) oxidizing (NDFO) bacteria are the main oxidizers of Fe(II). H_2O_2 was also found to be at low but detectable levels in the OMZ.



New work on the fate of microplastics in the Ocean is being undertaken at NUI Galway and links to GEOTRACES work through the potential for microplastics to act as vectors for TEIs in the marine environment. Wieczorek et al. (2018) showed that microplastics were present in deep sea fish from the northwest Atlantic, this paper had significant media

attention and over 50,000 views on the Frontiers website over its first 2 weeks online. A follow up paper, Wieczorek et al. (2019) examined the influence of microplastic on salp pellet sinking rates. Studies are continuing on the influence of microplastics on the cycling of TEIs.

Cruises

- Biogeochemical (Nutrients) and optical measurements (CDOM/FDOM) during Western European Shelf Pelagic Acoustic Survey (WESPAS). Expedition on the Celtic Explorer (9 June - 24 July, 2018, CE18009 & CE18010, Galway to Galway). (iCRAG project)
- *Upcoming expedition* - Polarstern PS120 Prof. Peter Croot will again participate as an at sea POGO lecturer on the upcoming South North Atlantic (SoNoAT) training school onboard the RV Polarstern from Port Stanley in the Falklands to Bremerhaven, Germany to take place in June 2019. During this training school Prof Croot will run the physical oceanography program and also introduce the students to the work of GEOTRACES scientists and the GEOTRACES IDP.
- *Upcoming expedition*: Indian Ocean GO-SHIP expedition on the RV Mirai (Dec 2019 – Feb 2020). Prof. Peter Croot will take part in this expedition through a piggyback project hosted by JAMSTEC to look at urea and Ni cycling in this region.

New projects and/or funding

- EPA (Ireland) – A new 4 year project entitled Physico-chemical Cycling of Nutrients and Carbon in Marine Transitional Zones (NUTS&BOLTS) began on February 1st 2019 (PI's Prof. Peter Croot, Dr Rachel Cave, Dr Tiernan Henry and Dr Dagmar Stengel, all at NUI Galway). This project has 4 main research themes: (i) Fluvial derived elemental fluxes along the Irish coast (including many key GEOTRACES TEIs). (ii) Nutrient controls on primary productivity in transitional marine waters. (iii) Bio-optics of transitional marine waters. (iv) Production and consumption of climate relevant gases in transitional marine waters.

GEOTRACES workshops and meetings organised

- There were no GEOTRACES specific workshops run in Ireland during the reporting period. However, at the first annual SCOR Ireland meeting (Dec 4, 2018) held at the National University of Ireland, Galway, Irish marine researchers were presented with an overview of GEOTRACES activities in Ireland and internationally.

Outreach activities conducted

- There were no specific GEOTRACES outreach activities conducted during the reporting period.

Other GEOTRACES activities

- Synchrotron work on marine particles collected across the South Pacific Gyre during Sonne expedition SO245 (2015/2016) at ALS in Berkeley, USA.

New GEOTRACES publications (published or in press)

- Croot, P.L., Heller, M.I., Wuttig, K., 2019. Redox Processes Impacting the Flux of Iron(II) from Shelf Sediments to the OMZ along the Peruvian Shelf. ACS Earth and Space Chemistry.
- Echeveste, P., Croot, P., von Dassow, P., 2018. Differences in the sensitivity to Cu and ligand production of coastal vs offshore strains of Emiliania huxleyi. Science of The Total Environment 625, 1673-1680.
- Petermann, E., Knöller, K., Rocha, C., Scholten, J., Stollberg, R., Weiß, H., Schubert, M., 2018. Coupling End-Member Mixing Analysis and Isotope Mass Balancing (222-Rn) for Differentiation of Fresh and Recirculated Submarine Groundwater Discharge Into Knysna Estuary, South Africa. Journal of Geophysical Research: Oceans 123, 952-970.
- Schlitzer, R., Anderson, R.F., Dodas, E.M., Lohan, M., Geibert, W., Tagliabue, A., Bowie, A., Jeandel, C., Maldonado, M.T., Landing, W.M., Cockwell, D., Abadie, C., Abouchami, W., Achterberg, E.P., Agather, A., Aguliar-Islas, A., van Aken, H.M., Andersen, M., Archer, C., Auro, M., de Baar, H.J., Baars, O., Baker, A.R., Bakker, K., Basak, C., Baskaran, M., Bates, N.R., Bauch, D., van Beek, P., Behrens, M.K., Black, E., Bluhm, K., Bopp, L., Bouman, H., Bowman, K., Bown, J., Boyd, P., Boye, M., Boyle, E.A., Branellec, P., Bridgestock, L., Brissebrat, G., Browning, T., Bruland, K.W., Brumsack, H.-J., Brzezinski, M., Buck, C.S., Buck, K.N., Buesseler, K., Bull, A., Butler, E., Cai, P., Mor, P.C., Cardinal, D., Carlson, C., Carrasco, G., Casacuberta, N., Casciotti, K.L., Castrillejo, M., Chamizo, E., Chance, R., Charette, M.A., Chaves, J.E., Cheng, H., Chever, F., Christl, M., Church, T.M., Closset, I., Colman, A., Conway, T.M., Cossa, D., Croot, P., Cullen, J.T., Cutter, G.A., Daniels, C., Dehairs, F., Deng, F., Dieu, H.T., Duggan, B., Dulaquais, G., Dumousseaud, C., Echegoyen-Sanz, Y., Edwards, R.L., Ellwood, M., Fahrbach, E., Fitzsimmons, J.N., Russell Flegal, A., Fleisher, M.Q., van de Flierdt, T., Frank, M., Friedrich, J., Fripiat, F., Fröllje, H., Galer, S.J.G., Gamo, T., Ganeshram, R.S., Garcia-Orellana, J., Garcia-Solsona, E., Gault-Ringold, M., George, E., Gerringa, L.J.A., Gilbert, M., Godoy, J.M., Goldstein, S.L., Gonzalez, S.R., Grissom, K., Hammerschmidt, C., Hartman, A., Hassler, C.S., Hathorne, E.C., Hatta, M., Hawco, N., Hayes, C.T., Heimbürger, L.-E., Helgoe, J., Heller, M., Henderson, G.M., Henderson, P.B., van Heuven, S., Ho, P., Horner, T.J., Hsieh, Y.-T., Huang, K.-F., Humphreys, M.P., Isshiki, K., Jacquot, J.E., Janssen, D.J., Jenkins, W.J., John, S., Jones, E.M., Jones, J.L., Kadko, D.C., Kayser, R., Kenna, T.C., Khondoker, R., Kim, T., Kipp, L., Klar, J.K., Klunder, M., Kretschmer, S., Kumamoto, Y., Laan, P., Labatut, M., Lacan, F., Lam, P.J., Lambelet, M., Lamborg, C.H., Le Moigne, F.A.C., Le Roy, E., Lechtenfeld, O.J., Lee, J.-M., Lherminier, P., Little, S., López-Lora, M., Lu, Y., Masque, P., Mawji, E., McClain, C.R., Measures, C., Mehic, S., Barraqueta, J.-L.M., van der Merwe, P., Middag, R., Mieruch, S., Milne, A., Minami, T., Moffett, J.W., Moncoiffe, G., Moore, W.S., Morris, P.J., Morton, P.L., Nakaguchi, Y., Nakayama, N., Niedermiller, J., Nishioka, J., Nishiuchi, A., Noble, A., Obata, H., Ober, S., Ohnemus, D.C., van Ooijen, J., O'Sullivan, J., Owens, S., Pahnke, K., Paul, M., Pavia, F., Pena, L.D., Peters, B., Planchon, F., Planquette, H., Pradoux, C., Puigcorbé, V., Quay, P., Queroue, F., Radic, A., Rauschenberg, S., Rehkämper, M., Rember, R., Remenyi, T., Resing, J.A., Rickli, J., Rigaud, S., Rijkenberg, M.J.A., Rintoul, S., Robinson, L.F., Roca-Martí, M., Rodellas, V., Roeske, T., Rolison, J.M., Rosenberg, M., Roshan, S., Rutgers van der Loeff, M.M., Ryabenko, E., Saito, M.A., Salt, L.A., Sanial, V., Sarthou, G., Schallenberg, C., Schauer,

U., Scher, H., Schlosser, C., Schnetger, B., Scott, P., Sedwick, P.N., Semiletov, I., Shelley, R., Sherrell, R.M., Shiller, A.M., Sigman, D.M., Singh, S.K., Slagter, H.A., Slater, E., Smethie, W.M., Snaith, H., Sohrin, Y., Sohst, B., Sonke, J.E., Speich, S., Steinfeldt, R., Stewart, G., Stichel, T., Stirling, C.H., Stutsman, J., Swarr, G.J., Swift, J.H., Thomas, A., Thorne, K., Till, C.P., Till, R., Townsend, A.T., Townsend, E., Tuerena, R., Twining, B.S., Vance, D., Velazquez, S., Venchiarutti, C., Villa-Alfageme, M., Vivancos, S.M., Voelker, A.H.L., Wake, B., Warner, M.J., Watson, R., van Weerlee, E., Alexandra Weigand, M., Weinstein, Y., Weiss, D., Wisotzki, A., Woodward, E.M.S., Wu, J., Wu, Y., Wuttig, K., Wyatt, N., Xiang, Y., Xie, R.C., Xue, Z., Yoshikawa, H., Zhang, J., Zhang, P., Zhao, Y., Zheng, L., Zheng, X.-Y., Zieringer, M., Zimmer, L.A., Ziveri, P., Zunino, P., Zurbrick, C., 2018. The GEOTRACES Intermediate Data Product 2017. Chemical Geology.

- Schlosser, C., Streu, P., Frank, M., Lavik, G., Croot, P.L., Dengler, M., Achterberg, E.P., 2018. H2S events in the Peruvian oxygen minimum zone facilitate enhanced dissolved Fe concentrations. Scientific Reports 8, 12642.
- Wieczorek, A.M., Croot, P.L., Lombard, F., Sheahan, J.N., Doyle, T.K., 2019. Microplastic Ingestion by Gelatinous Zooplankton May Lower Efficiency of the Biological Pump. Environmental Science & Technology. AOP
- Wieczorek, A.M., Morrison, L., Croot, P.L., Allcock, A.L., MacLoughlin, E., Savard, O., Brownlow, H., Doyle, T.K., 2018. Frequency of Microplastics in Mesopelagic Fishes from the Northwest Atlantic. Frontiers in Marine Science 5.

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

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN ISRAEL

April 1st, 2018 to March 31st, 2019

New scientific results

- Adi Torfstein's research group (Institute of Earth Sciences at the Hebrew University and Interuniversity Institute (IUI) for Marine Sciences of Eilat) operates a sediment trap mooring that has been deployed continuously in the centre of the north Gulf of Aqaba/Eilat since January 2014. This mooring combines monthly profiles with daily-timescale sample collection. The particulate samples are measured for organic C and N and their isotope composition, as well as major and trace element concentrations and foraminifera assemblages. Coeval seawater profiles are sampled using a Kevlar cable and Teflon-coated Go-Flo bottles, with emphasis of monitoring the short-term impact of dust storms on seawater trace element cycling. The dissolved samples are analysed trace element concentrations, Pb isotopic compositions and 230Th/232Th ratios. In addition, two dust samplers are deployed at the IUI, and collect dust samples continuously. During the reporting period, the research group included two postdocs (Daniel Palchan, David Weinstein), two PhD students (Natalie Tchernihovsky, Tal Ben-Altabet), 2 MSc students (Gil Lapid, Merav Gilboa), and a lab technician (Barak Yarden).

- Yeala Shaked's research group (Institute of Earth Sciences at the Hebrew University and IUI) with 1 PhD students (Siyuan Wang), 3 post-docs (Sunbhajit Basu, Tzachi Yaccobson and Meri Eichenr), and a research technician (Murielle Dray) continue investigating the bioavailability of dust and mineral iron to cyanobacteria. The study of dust as a source of iron to Trichodesmium is conducted with various international collaborators, including Satish Myneni from Princeton (Synchrotron analysis of bio-induced transformations of dust), Rhona Stuart from Livermore National Laboratories (Fe uptake from dust using Nano-Sims), Martha Gledhill from GeoMar (siderophore identification with Orbitrap mass spectrometer), Dirk De Baar from Max Plank Inst for Microbiology (microelectrode measurements in trichodesmium colonies).

- 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, NO_2, NO_3, $Si(OH)_4$, PO_4, 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.

New projects and/or funding

- "Carbon export at the southeastern Levantine basin" (Weinstein and Berman-Frank). The initial results of this project were submitted for publication (see Alkalay et al. in the publication list below).
- "Bioavailability of particulate Fe to planktonic cyanobacteria", funded by the Israel

Science Foundation (Shaked).
- "Dust iron utilization by natural Trichodesmium colonies", funded by the German-Israeli Foundation (Shaked, Gledhill, Achterberg).
- "Marine particle dynamics across abrupt storm events in the Gulf of Aqaba, north Red Sea: A unified Thorium isotope study" funded by the Israel Science Foundation (Torfstein)
- "The magnitude and distribution of anthropogenic pollution in the Gulf of Eilat", funded by the Ring Foundation (Torfstein, Shaar).

GEOTRACES workshops and meetings organised

- The 7th Kaplan Symposium was convened in Eilat during February 2019, titled: "Tracers in the Sea: Trace Elements and their Isotopes in the Oceans, Future Directions and Instrumental Frontiers". The meeting convened by Torfstein and Shaked hosted 8 international invited speakers with a total of 81 participants. More details on the website: https://sites.google.com/view/7th-kaplan-symposium

Other GEOTRACES activities

- Gil Lapid participated in a Training Course on Marine Radioactivity, 20-22 February 2019, Puerto Rico.
- Adi Torfstein participated in the GEOTRACES-PAGES workshop in France.
- Yeala Shaked participated in the GEOTRACES SSC meeting in Taipei.
- Yeala Shaked attended a workshop in WHOI on a follow-up program, a Bio-Geotraces like initiative involving trace elements, nutrients and omics (Biogeoscapes).

New GEOTRACES publications

- Chernihovsky N., Torfstein A., Almogi-Labin A. (2018) Seasonal flux patterns of planktonic foraminifera in a deep, oligotrophic, marginal sea: sediment trap time series from the Gulf of Aqaba, north Red Sea. Deep Sea Research I 140, p. 78-94.
- Torfstein A., Kienast S.S. (2018) No correlation between atmospheric dust and surface ocean chlorophyll-a in the oligotrophic Gulf of Aqaba, northern Red Sea. Journal of Geophysical Research- biogeosciences 123, doi.org/10.1002/2017JG004063.
- Basu S and Y. Shaked. 2018 Mineral iron utilization by natural and cultured Trichodesmium and associated bacteria, Limnology and Oceanography 63 (6), 2307-2320
- Basu S, M. Gledhill, D. de Beer, SG P Matondkar, Y Shaked. The mutual quest of Trichodesmium colonies and associated bacteria for iron from dust. Communications Biology, Final revisions.
- Alkalay R., Zlatkin O., Katz T., Herut B., Berman-Frank I., Halicz L. (submitted) Carbon export and drivers in the southeastern Levantine Basin. Deep Sea Research II.

GEOTRACES presentations in international conferences

- Chernihovsky N., Almogi-Labin A. and Torfstein A. (2018) Seasonal flux patterns of planktonic foraminifera in a deep, oligotrophic, marginal sea: sediment trap time series from the Gulf of Aqaba, north Red Sea. Foraminifera in a changing world workshop, Edinburgh, Scotland.
- Torfstein A. and Kienast S.S. (2018) Trace element fluxes and export production across daily-, seasonal- and multiannual- timescales in the oligotrophic Gulf of Aqaba, Red Sea,

Goldschmidt meeting.

- Benaltabet T. and Torfstein A. (2018) Dissolved trace metals and Pb isotopes across dust storm events in the oligotrophic waters of the Gulf of Aqaba, Goldschmidt meeting.
- Kienast S.S., Torfstein A., Riehl L. and Fennel K. (2018) Organic carbon fluxes and Nitrogen isotopes in the oligotrophic Gulf of Aqaba, Goldschmidt meeting.
- Alkalay R., Zlatkin O., Katz T., Herut B., Berman-Frank I., Halicz L. (2018) Carbon Export in the Ultra-Oligotrophic Levantine Basin: Results from the Deep-Lev Mooring, Gordon Conference of Marine Biogeochemistry in Hong Kong.
- Lapid G. and Torfstein A. (2019) Dissolved 230Th and 232Th as tracers of the impact of dust storms in the Gulf of Aqaba, Red Sea, ASLO meeting.

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

New scientific results

We reported helium-3 plumes in the central Indian Ocean (GI04). The vertical distribution of δ^3He showed a similar trend with dissolved iron and manganese distributions in the hydrothermal plume. Lateral δ^3He distribution at mid-depth suggests that the helium-3 plume in the central Indian Ocean derived from the Central Indian Ridge around 20°S (Takahata et al., *Terrestrial, Atmospheric and Oceanic Sciences*, 2018).

New GEOTRACES publications (published or in press)

Fifteen papers have been published as shown below:

- Inomata, Y., M. Aoyama, T. Tsubono, D. Tsumune, Y. Kumamoto, H. Nagai, T. Yamagata, M. Kajino, T. Tanaka, T. Sekiyama, E. Oka and M. Yamada (2018): Estimate of Fukushima-derived radiocaesium in the North Pacific Ocean in summer 2012. Journal of Radioanalytical and Nuclear Chemistry, 318, 1587-1596.
- Li, L., F. M. Li, Z. W. Wang, M. X. Zhao, J. Zhang and J. L. Ren (2018): Factors influencing the use of dissolved aluminum as a source tracer in the East China Sea and adjacent waters. Marine Chemistry, 204, 133-143.
- Lutfi Firdaus, M., A. S. Mashio, T. Kim, R. Muhammad, J. A. McAlister, H. Obata, T. Gamo, and R. Khaydarov (2018): Simultaneous determination of picomolar zirconium, hafnium, niobium and tantalum in seawater using commercially available chelating resin and subsequent ICP-MS determination. Geochemical Journal, 52, 427-431.
- Lutfi Firdaus, M., A. S. Mashio, H. Obata, J. A. McAlister and K. J. Orians (2018): Distribution of zirconium, hafnium, niobium and tantalum in the North Atlantic Ocean, northeastern Indian Ocean and its adjacent seas. Deep-Sea Research-I, 140, 128-135.
- Sakata, K., M. Kurisu, H. Tanimoto, A. Sakaguchi, M. Uematsu, C. Miyamoto and Y. Takahashi (2018): Custom-made PTFE filters for ultra-clean size-fractionated aerosol sampling for trace metals. Marine Chemistry, 206, 100-108.
- Takahata, N, K. Shirai, K. Ohmori, H. Obata, T. Gamo, and Y. Sano (2018): Distribution of helium-3 plumes and deep-sea circulation in the central Indian Ocean. Terrestrial, Atmospheric and Oceanic Sciences, 29, 331-340.
- Yang, S.-C., J. Zhang, Y. Sohrin, T.-Y. Ho (2018): Cadmium cycling in the water column of the Kuroshio-Oyashio Extension region: Insights from dissolved and particulate isotopic composition. Geochimica et Cosmochimica Acta, 233, 66-80.
- Evans, L. K. and J. Nishioka (2018): Accumulation processes of trace metals into Arctic sea ice: distribution of Fe, Mn and Cd associated with ice structure, Marine Chemistry, 209, 36-47.
- Kanna, N., Y. Sibano, T. Toyota, J. Nishioka (2018): Winter iron supply processes fueling spring phytoplankton growth in a sub-polar marginal sea, the Sea of Okhotsk: Importance of sea ice and the East Sakhalin Current. Marine Chemistry, 206, 109-120.

- Kawagucci, S., A. Makabe, T. Kodama, Y. Matsui, C. Yoshikawa, E. Ono, M. Wakita, T. Nunoura, H. Uchida and T. Yokokawa (2018): Hadal water biogeochemistry over the Izu-Ogasawara Trench observed with a full-depth CTD-CMS. Ocean Science, 14, 575–588.
- Kozaka, Y., K. Horikawa, Y. Asahara, H. Amakawa, and Y. Okazaki (2018): Late Miocene–mid-Pliocene tectonically induced formation of the semiclosed Japan Sea, inferred from seawater Nd isotopes. Geology, 46, 903-906.
- Kumamoto, Y., M. Yamada, M. Aoyama, Y. Hamajima, H. Kaeriyama, H. Nagai, T. Yamagata, A. Murata and Y. Masumoto (2018): Radiocesium in North Pacific coastal and offshore areas of Japan within several months. Journal of Environmental Radioactivity, 198, 79-88.
- Otosaka, S., Y. Satoh, T. Suzuki, J. Kuwabara and T. Nakanishi (2018): Distribution and fate of I-129 in the seabed sediment off Fukushima. Journal of Environmental Radioactivity, 192, 208-218.
- Wong, K. H., H. Obata, T. Kim, A. S. Mashio, H. Fukuda, and H. Ogawa (2018): Organic complexation of copper in estuarine waters: An assessment of the multi-detection window approach. Marine Chemistry, 204, 144 - 151.
- Zhang, J., Q. Liu, L. L. Bai and T. Matsuno (2018): Water mass analysis and contribution estimation using heavy rare earth elements: Significance of Kuroshio intermediate water to Central East China Sea shelf water. Marine Chemistry, 204, 93-102.

GEOTRACES workshops and meetings organised

- We had a workshop, entitled ”BioGEOTRACES-Japan begins” on September 19-21, 2018 at Nagasaki University, Nagasaki to evaluate the potentials of biological studies related to trace elements and their isotopes (TEI) in the ocean, and to find the future directions of these studies in Japan. For three days, 15 registered Japanese scientists took part in the workshop. We invited Drs. Maria Maldonado and Tung-Yuan Ho as guest speakers. The workshop consisted of 3 invited talks, 3 keynote talks and 11 research topics related to GEOTRACES & BioGEOTRACES. During the workshop, we discussed recent scientific findings, and possible future collaborations among TEI chemists, biologists and modelers.
- Domestic GEOTRACES session was held during annual meeting of Geochemical Society of Japan 2018 in September 11-13, 2018, for pursuing scientific discussion on recent Japanese GEOTRACES studies (30 papers were presented). This annual meeting was held at Ryukyu University, Okinawa.
- We had a national GEOTRACES symposium in February 21-22, 2019, for promoting scientific discussion on recent Japanese GEOTRACES studies (29 papers were presented). We also had a business meeting as a GEOTRACES sub-committee meeting under the national SCOR committee (Science Council of Japan) on February 22, 2019. These symposium and meeting were held at the Atmosphere and Ocean Research Institute, the University of Tokyo.

GEOTRACES presentations in international conferences

- During Goldschmidt Conference 2018, several GEOTRACES-related sessions were held. More than 8 papers were presented by Japanese scientists during the Goldschmidt Conference 2018 as listed below.

- Escobar, M. T., N. Takahata, H. Obata and Y. Sano. Distribution of Helium Isotopes along 47°N of the Subarctic North Pacific. Goldschmidt Conference 2018, Boston (USA), 13-17, 2018.
- Kim, T., H. Obata, A. S. Mashio, T. Gamo and S. Takeda. Trace metals and zinc complexing ligands in seawaters at a shallow hydrothermally active area in Japan. Goldschmidt Conference 2018, Boston (USA), 13-17, 2018.
- Kurisu, M., K. Sakata, M. Uematsu and Y. Takahashi. Investigation of Isotope Fractionation of Fe in Anthropogenic Aerosols to Determine its Contribution to the Surface Ocean. Goldschmidt Conference 2018, Boston (USA), 13-17, 2018.
- Norisuye, K., H. Obata, T. Gamo, J.-M. Lee and E. A. Boyle. Dissolved Pb stable isotopes in the Bay of Bengal. Goldschmidt Conference 2018, Boston (USA), 13-17, 2018.
- Maruyama, K., K. Norisuye, H. Obata, H. Minami, Y. Nakaguchi, H. Tazoe and T. Gamo. Distributions of total particulate trace elements in the subarctic North Pacific. Goldschmidt Conference 2018, Boston (USA), 13-17, 2018.
- Tanaka, Y., M. Tsujisaka, L. Zheng, S. Takano and Y. Sohrin. An Advanced Method for Preconcentration and Determination of Zr, Hf, Nb, and Ta in Seawater. Goldschmidt Conference 2018, Boston (USA), 13-17, 2018.
- Wong, K. H., H. Obata, T. Kim and R. Muhammad. Distribution of copper and its speciation in the subarctic North Pacific. Goldschmidt Conference 2018, Boston (USA), 13-17, 2018.
- Zheng, L., T. Minami, S. Takano and Y. Sohrin. Distribution of Recycled-Type Trace Metals (Ni, Cu, Zn, and Cd) in Dissolved and Labile Particulate Fractions in the North Pacific Ocean. Goldschmidt Conference 2018, Boston (USA), 13-17, 2018.

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

Other GEOTRACES activities

The 2nd workshop of WESTPAC WG06 “A framework for cooperative studies in the Western Pacific Marginal Seas: Energy and materials exchange between land and open ocean” (PI, Jing Zhang; 2017-2020), was held in Qingdao, China, on 17 and 18 December 2018, where 28 experts from 6 countries in the East and Southeast Asia gathered along with one participant from US. During a half day sub-session, TEI including GEOTRACES parameters, such as 1) Fe, Al, Mn; 2) REEs, Nd isotope; 3) Ra, Rn; 4) Hg; 5) paleo proxies etc. especially in the East China Sea and West Pacific Ocean, were discussed.

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

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN THE NETHERLANDS

April 1st, 2018 to March 31st, 2019

New scientific results

- Progress is being made with the interpretation and publication of results from cruises GA02 and GA04N.
- A process study was done aboard FS Polarstern in collaboration with AWI. In total 26 vertical profiles were collected in the Weddell Sea and Lazarev Sea. Additionally, 4 bio-assay experiments were performed to test the effects of temperature and iron and manganese additions. Samples are currently being transported and will be analysed in the coming years
- Samples are being analysed from cruise ANA08B, a GEOTRACES Process study.
- Samples are being analysed from the RV Pelagia cruise from March 12 – April 4, 2018. St Maarten – Nassau. Benthic flux measurements with landers and pore water sampling was carried out at two stations. Analyses of Fe (flow injection) have been completed, SeaFAST-ICP-MS analyses for other elements are in progress.

Cruises

- PS117 aboard the FS Polarstern to the Weddell and Lazarev Sea (Antarctica) from December 15th till February 7 (Cape Town, South Africa to Punta Arenas, Chile).

New projects and/or funding

- 'Metalgate, Trace metals and the Arctic-Atlantic gateway in a changing world, local processes and global connections'. Vidi grant to Rob Middag.

Outreach activities conducted

- Blog on cruise activities: https://www.nioz.nl/en/blog/antarctic-expedition-fephyrus-2

New GEOTRACES publications (published or in press)

- Dulaquais, G., Waeles, M., Gerringa, L. J. A., Middag, R., Rijkenberg, M. J. A., & Riso, R. (2018). The biogeochemistry of electroactive humic substances and its connection to iron chemistry in the North East Atlantic and the Western Mediterranean Sea. Journal of Geophysical Research: Oceans, 123. https://doi.org/10.1029/2018JC014211
- Sukekava, C. Downes, J., Slagter, H.A., Gerringa, L.J.A., Laglera, L.M., 2018. Determination of the contribution of humic substances to iron complexation in seawater by catalytic cathodic stripping voltammetry. Talanta 189, 359-364. https://doi.org/10.1016/j.talanta.2018.07.021
- López-Sánchez, D.E., Cobelo-García, A., Rijkenberg, M.J.A., Gerringa, L.J.A., de Baar, H.J.W., 2018. New insights on the dissolved platinum behavior in the western Atlantic Ocean. Chemical Geology, special issue GEOTRACES. https://doi.org/10.1016/j.chemgeo.2019.01.003

- George, E., Stirling, C.H., Gault-Ringold, M., Ellwood., M.J., Middag, R., (2019). Marine biogeochemical cycling of cadmium and cadmium isotopes in the extreme nutrient-depleted subtropical gyre of the South West Pacific Ocean. Earth and Planetary Science Letters, 514, 84-95. https://doi.org/10.1016/j.epsl.2019.02.031
- Grand M.M., Laes-Huon A., Fietz S., Resing J.A., Obata H., Luther G.W., Tagliabue A., Achterberg E.P., Middag R., Tovar-Sánchez A., Bowie A.R., (2019) Developing Autonomous Observing Systems for Micronutrient Trace Metals. Frontiers in Marine Science, 6.
- Middag R., de Baar H.J.W., Bruland K.W., (2019) The Relationships Between Dissolved Zinc and Major Nutrients Phosphate and Silicate Along the GEOTRACES GA02 Transect in the West Atlantic Ocean. Global Biogeochemical Cycles, 33, 63-84.
- Slagter, H.A., Laglera, L.M., Sukekava, C., Gerringa, L.J.A., 2019. Fe-binding organic ligands in the humic-rich TransPolar Drift in the surface Arctic Ocean using multiple voltammetric methods. Journal of Geophysical Research: Oceans. DOI: 10.1029/2018JC014576.
- Lenstra, W.K., Hermans, M., Séguret, M.J.M., Witbaard, R., Behrends, T., Dijkstra, N., Van Helmond, N.A.G.M., Kraal, P., Laan, P., Rijkenberg, M.J.A., Severmann, S., Teacă, A. & Slomp, C.P 2018. The shelf-to-basin iron shuttle in the Black Sea revisited. Chemical Geology. https://doi.org/10.1016/j.chemgeo.2018.10.024.

Completed GEOTRACES PhD or Master theses

- H.A. Slagter, PhD University Groningen 10 December, 2018, Promotores (Advisors): Prof. Dr. Ir. H.J.W. de Baar and Prof Dr. C.P.D. Brussaard, co-promotor: Dr. L.J.A. Gerringa. The Organic Ties of Iron, or the origin and fate of Fe-binding organic ligands. 220 pages, ISBN 978-94-6375-228-2
- O. Żygadłowska. Msc thesis. 2019. Iron and Manganese dynamics along a water depth transect on the Louisiana Shelf, USA. Advisors: C.P. Slomp, W. Lenstra, M. Seguret. Utrecht University.

GEOTRACES presentations in international conferences

- Middag, R., Bertrand, E.M., Brussaard, C.P.D., Eich, C.U.M, Gerringa, L.J.A., Jung, J., Lee, S., Lee, Y., van Manen, M.H., McCain, J.S.P., Pont, S.B.E.H., Reichart, G.J., Tian, H.A. Dissolved Iron in the Amundsen Sea. Poster presentation at the 2018 Goldschmidt conference - Boston 15-08-2018, USA.
- Lenstra, W., Seguret, M.J.M, Hermans, M., Groeneveld, R.K., van Helmond, N.A.G.M., Witbaard, R. Severmann, S., Behrends, T., Slomp, C.P. Transfer of iron from continental shelves to anoxic basins: a comparison of the Black Sea and Baltic Sea. Goldschmidt conference. Oral Presentation, August, 2018. Boston, USA.

Submitted on behalf of all Dutch GEOTRACES participants by Rob Middag (rob.middag@nioz.nl).

New scientific results

- GEOTRACES GA04N Black Sea and Mediterranean Sea Expedition

  The GEOTRACES (GA04N) expedition to the Black Sea in 2013 provided an opportunity to examine the biogeochemical cycling of a suite of trace elements and their isotopes under low- and zero-oxygen conditions. Using multiple-collector inductively coupled plasma mass spectrometry (MC-ICPMS) combined with double spiking techniques, we have measured the isotopic composition of U, Fe and Cd for the entire water column and underlying sediments of the Black Sea across oxic-suboxic-anoxic-euxinic transitions. These new data help elucidate the mechanisms driving the uptake and removal of redox-sensitive metals from the dissolved phase and their export to the solid phase across a gradation of changing redox settings from oxic to anoxic and ultimately euxinic. These results formed the basis of the PhD research programmes of completed graduate students John Rolison and Ejin George. The U and Fe isotope datasets have been published in GCA and EPSL, respectively, and a manuscript detailing the Cd isotope systematics of this region is currently being prepared.

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

- GEOTRACES GP13 South Pacific Ocean Expedition

  Using techniques in double-spiking and MC-ICPMS, we have obtained measurements of Cd isotopic composition and Cd concentration for water column samples collected from a suite of 8 depth profiles and additional surface locations along the GEOTRACES GP13 zonal section. This cruise transect extends for 5,500 km from offshore Australia to the remote interior of the subtropical Pacific Ocean, an understudied region of the world's oceans, where Cd concentrations in the upper water column are at ultra-trace levels, and some of the lowest detected globally. These results formed the basis of the PhD research of graduate student Ejin George. The Cd isotope and Cd concentration datasets for the GP13 expedition were recently published in EPSL.

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

- GEOTRACES GPpr08 (Leg 2, Phantastic II) Ross Sea, Antarctica Expedition

  Water samples collected in 2013/2014 during Leg 2 of the GEOTRACES GPpr08 (Phantastic II) Expedition have provided an opportunity to investigate the biogeochemical cycling of a suite of bioactive trace elements, with emphasis on Fe and Fe stable isotopes, in the High Nutrient Low Chlorophyll (HNLC) region adjacent to the West Antarctic Peninsula, with a primary objective of elucidating the sources of Fe to this oceanic region. The concentrations of a suite of ca. 20 elements was obtained for water samples collected during the Phantastic II cruise by University of Otago PhD student Kyyas Seyitmuhammedov (primary supervisor: Claudine Stirling), while visiting offshore-supervisor Rob Middag at NIOZ, The Netherlands. The remaining samples are scheduled to be analysed for their elemental concentrations at the University of Otago in mid-2018. These analyses were completed in 2018. The distribution of dissolved metals offshore from the West Antarctic Peninsula, with emphasis on Fe and Mn, is currently being prepared for publication.

New GEOTRACES publications (published or in press)

- E. George, C.H. Stirling, M. Gault-Ringold, R. Middag (2019). Anomalous biogeochemical cycling of cadmium in the subtropical gyre of the South West Pacific Ocean. Earth Planet. Sci. Lett. 514, 84-95.
- J.M. Rolison, C.H. Stirling, R. Middag, M. Gault-Ringold, E. George, M.J.A. Rijkenberg (2018). Iron isotope fractionation during pyrite formation in a sulfidic Precambrian ocean. Earth Planet. Sci. Lett. 488, 1-13.
- Schlitzer, R., Anderson, R.F., Dodas, E.M., Lohan, M., Geibert, W., Tagliabue, A., Bowie, A., Jeandel, C., Maldonado, M.T., Landing, W.M., Cockwell, D., Abadie, C., Abouchami, W., Achterberg, E.P., Agather, A., Aguliar-Islas, A., van Aken, H.M., Andersen, M., Archer, C., Auro, M., de Baar, H.J., Baars, O., Baker, A.R., Bakker, K., Basak, C., Baskaran, M., Bates, N.R., Bauch, D., van Beek, P., Behrens, M.K., Black, E., Bluhm, K., Bopp, L., Bouman, H., Bowman, K., Bown, J., Boyd, P., Boye, M., Boyle, E.A., Branellec, P., Bridgestock, L., Brissebrat, G., Browning, T., Bruland, K.W., Brumsack, H.-J., Brzezinski, M., Buck, C.S., Buck, K.N., Buesseler, K., Bull, A., Butler, E., Cai, P., Mor, P.C., Cardinal, D., Carlson, C., Carrasco, G., Casacuberta, N., Casciotti, K.L., Castrillejo, M., Chamizo, E., Chance, R., Charette, M.A., Chaves, J.E., Cheng, H., Chever, F., Christl, M., Church, T.M., Closset, I., Colman, A., Conway, T.M., Cossa, D., Croot, P., Cullen, J.T., Cutter, G.A., Daniels, C., Dehairs, F., Deng, F., Dieu, H.T., Duggan, B., Dulaquais, G., Dumousseaud, C., Echegoyen-Sanz, Y., Edwards, R.L., Ellwood, M., Fahrbach, E., Fitzsimmons, J.N., Russell Flegal, A., Fleisher, M.Q., van de Flierdt, T., Frank, M., Friedrich, J., Fripiat, F., Fröllje, H., Galer, S.J.G., Gamo, T., Ganeshram, R.S., Garcia-Orellana, J., Garcia-Solsona, E., Gault-Ringold, M., George, E., Gerringa, L.J.A., Gilbert, M., Godoy, J.M., Goldstein, S.L., Gonzalez, S.R., Grissom, K., Hammerschmidt, C., Hartman, A., Hassler, C.S., Hathorne, E.C., Hatta, M., Hawco, N., Hayes, C.T., Heimbürger, L.-E., Helgoe, J., Heller, M., Henderson, G.M., Henderson, P.B., van Heuven, S., Ho, P., Horner, T.J., Hsieh, Y.-T., Huang, K.-F., Humphreys, M.P., Isshiki, K., Jacquot, J.E., Janssen, D.J., Jenkins, W.J., John, S., Jones, E.M., Jones, J.L., Kadko, D.C., Kayser, R., Kenna, T.C., Khondoker, R., Kim, T., Kipp, L., Klar, J.K., Klunder, M., Kretschmer, S., Kumamoto, Y., Laan, P., Labatut, M., Lacan, F., Lam, P.J.,

Lambelet, M., Lamborg, C.H., Le Moigne, F.A.C., Le Roy, E., Lechtenfeld, O.J., Lee, J.-M., Lherminier, P., Little, S., López-Lora, M., Lu, Y., Masque, P., Mawji, E., McClain, C.R., Measures, C., Mehic, S., Barraqueta, J.-L.M., van der Merwe, P., Middag, R., Mieruch, S., Milne, A., Minami, T., Moffett, J.W., Moncoiffe, G., Moore, W.S., Morris, P.J., Morton, P.L., Nakaguchi, Y., Nakayama, N., Niedermiller, J., Nishioka, J., Nishiuchi, A., Noble, A., Obata, H., Ober, S., Ohnemus, D.C., van Ooijen, J., O'Sullivan, J., Owens, S., Pahnke, K., Paul, M., Pavia, F., Pena, L.D., Peters, B., Planchon, F., Planquette, H., Pradoux, C., Puigcorbé, V., Quay, P., Queroue, F., Radic, A., Rauschenberg, S., Rehkämper, M., Rember, R., Remenyi, T., Resing, J.A., Rickli, J., Rigaud, S., Rijkenberg, M.J.A., Rintoul, S., Robinson, L.F., Roca-Martí, M., Rodellas, V., Roeske, T., Rolison, J.M., Rosenberg, M., Roshan, S., Rutgers van der Loeff, M.M., Ryabenko, E., Saito, M.A., Salt, L.A., Sanial, V., Sarthou, G., Schallenberg, C., Schauer, U., Scher, H., Schlosser, C., Schnetger, B., Scott, P., Sedwick, P.N., Semiletov, I., Shelley, R., Sherrell, R.M., Shiller, A.M., Sigman, D.M., Singh, S.K., Slagter, H.A., Slater, E., Smethie, W.M., Snaith, H., Sohrin, Y., Sohst, B., Sonke, J.E., Speich, S., Steinfeldt, R., Stewart, G., Stichel, T., Stirling, C.H., Stutsman, J., Swarr, G.J., Swift, J.H., Thomas, A., Thorne, K., Till, C.P., Till, R., Townsend, A.T., Townsend, E., Tuerena, R., Twining, B.S., Vance, D., Velazquez, S., Venchiarutti, C., Villa-Alfageme, M., Vivancos, S.M., Voelker, A.H.L., Wake, B., Warner, M.J., Watson, R., van Weerlee, E., Alexandra Weigand, M., Weinstein, Y., Weiss, D., Wisotzki, A., Woodward, E.M.S., Wu, J., Wu, Y., Wuttig, K., Wyatt, N., Xiang, Y., Xie, R.C., Xue, Z., Yoshikawa, H., Zhang, J., Zhang, P., Zhao, Y., Zheng, L., Zheng, X.-Y., Zieringer, M., Zimmer, L.A., Ziveri, P., Zunino, P., Zurbrick, C. (2018). The GEOTRACES Intermediate Data Product 2017. Chem. Geol. 493, 210-223.

GEOTRACES presentations in international conferences

- K. Seyitmuhammedov, C.H. Stirling, M.R. Reid, R. Van Hale, K. Arrigo, R. Middag (in review). Sources and sinks of Fe during the early austral spring offshore from the western Antarctic Peninsula, 2019 Goldschmidt Conference, Barcelona, Spain, to be held in August 2019.
- C.H. Stirling (2018). The uranium isotope redox tracer of oxygen levels on Earth: Refining modern calibrations. Invited Speaker, 2018 Uranium Biogeochemistry Conference. Ascona, Switzerland, August 2018.

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

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN NORWAY

April 1st, 2018 to March 31st, 2019

Cruises

August 2018; first cruise in The Nansen Legacy program to Arctic (the Barents sea); Trace metal (including Fe, Hg and others) sampling. Preliminary data collected from an August 2018 cruise indicate an average total mercury concentration of 0.86±0.21pM in the upper 500m of the water column in the Northern Barents Sea.

New GEOTRACES-related projects and/or funding

Funded projects

- The nature of particulate iron inputs in high Arctic fjord during the spring season (Svalbard)
- SophyCO2: Southern Ocean phytoplankton community characteristics, primary production, CO2 flux and the effects of climate change (Funded by Research Council Norway and South African National Research Foundation as part of the SANOCEAN bilateral research cooperation between Norway and South Africa on ocean research)
- Coast-LaB : Impact of land-based activities to the coastal environment: Seawater desalination and wastewater discharge.(part of SANOCEAN)
- H2O2 dynamic in the coastal system.

Submitted applications

- AtoMS: An Autonomous trace-Metal-clean seawater Sampler to study iron and mercury dynamics in the Arctic (submitted to Research Council Norway, 10 April 2019).

Outreach activities conducted

Sailing for Science cruise (10 students and M. Ardelan) to the Dodecanese islands in the southeastern Aegean Sea: Sailing for Science is a citizen science initiative brainchild of Dr Murat Ardelan at the Norwegian University of Science and Technology in Trondheim. The goal of the project is to facilitate interdisciplinary marine research and offer students the opportunity to take part in hands on science cruises on citizen sail boats. Topics of interest include organic contamination, trace metal analysis, impacts of tourism on marine chemistry, phytoplankton studies and the impacts of microplastics.

New GEOTRACES publications (published or in press)

- Christoph Heinze, Tatiana Ilyina, and Marion Gehlen (2018. The potential of 230Th for detection of ocean acidification impacts on pelagic carbonate production Biogeosciences, 15, 3521-3539. https://doi.org/10.5194/bg-15-3521-2018
- Sanchez N, Ardelan MV, Reiss CS, Bizsel C, Holm-Hansen O. 2019. Fe distribution around the South Orkneys Islands Scotia Sea in the Southern Ocean along the 2008 International polar year (IPY) AMLR survey, ready for submision.
- Hopwood M, Santana-González, C, Gallego-Urrea J, Sanchez N, Achterberg E, Ardelan MV, Gledhill M, González-Dávila M, Hoffmann L, Leiknes Ø, Santana-Casiano JM,

Tsagaraki T, and Turner D. 2019. Trace chemical species in marine incubation experiments, part B. Fe(II) stability in seawater. Submitted to Biogeoscience.

- Szymczak-Żyła M, Krajewska M, Witak M, Ciesielski T,, Ardelan MV, Jenssen BM, Goslar T, Winogradow A, Filipkowska A. Lubecki L, Kowalewska G. 2019. Present and Past-Millennial Eutrophication in the Gulf of Gdańsk (Southern Baltic Sea), in print, Paleoceanography and Paleoclimatology.
- Sanchez N, Peterson C, Gonzalez SV, Vadstein O, Olsen Y, Ardelan MV. 2019 Effect of hydroxamate and catecholate siderophores on iron availability in the diatom Skeletonema costatum: Implications of siderophore degradation by associated bacteria. in print Marine Chemistry.
- Kleiven W, Johnsen, G, and Ardelan MV, 2019, Elemental composition in phaeo-, chloro- and rhodophytes in winter and spring. In print Journal of Phycology.
- Sanchez N, Ardelan MV, Bizsel N, Iriarte JL, Olsen LM. 2019. Iron cycling in a mesocosm experiment in a north Patagonian fjord: Potential effect of ammonium addition by salmon aquaculture. In print, Estuarine, Coastal and Shelf Science.
- Hopwood M, Sanchez N, Polyviou D, Leiknes Ø, Gallego-Urrea J, Achterberg E, Ardelan MV, Aristegui J, Bach L, Besiktepe S, Heriot Y, Kalantzi I, Kurt T, Santi I, Tsagaraki T, and Turner D. 2018. Trace chemical species in marine incubation experiments, part A. Experiment design and bacterial abundance control extracellular H2O2 concentrations. Accepted for publication in Biogeoscience.
- Filipkowska A, Lubecki L, Szymczak-Żyła M, Ciesielski T, Jenssen BM, Ardelan MV, Mazur-Marzec H, Breedveld GD, Oen AMP, Zamojska A, Kowalewska G. 2018. Multi-proxy investigation of recent sediments in two different European coastal areas (Poland, Norway) – anthropogenic impact on ecosystem health. In print, Marine Pollution Bulletin.
- Sanchez N, Brown EA, Olsen Y, Vadstein O, Iriarte JL, Gonzalez HE and Ardelan MV 2018. Effect of Siderophore on Iron Availability in a Diatom and a Dinoflagellate Species: Contrasting Response in Associated Bacteria. Front. Mar. Sci. 5:118. doi: 10.3389/fmars.2018.00118.
- Bizsel N, Ardelan, M. V, Bizsel K. C, Suzal A, Demirdağ A, Sarıca D. Y, and Steinnes E. 2018. Distribution and removal of selenium in the plume of the Gediz River, Izmir Bay, Aegean Sea, Journal for Marine Research. 75: 81-98(18).

Completed GEOTRACES Master theses *(at NTNU)*

- Andrea Faltynkova, 2018. Mobility of Elements at the Sediment Water Interface in a Simulated Sub-Seabed CO2 Seepage Site.
- Ayten Pehlivan, 2018. Iron Acquisition in Cynobacteria Synechococcussp. PCC 7002 Culture.
- Maria Villegas, 2018. Determination of Fe(II) and Fe(III) in Synechococcus sp. PCC 7002 culture.
- Dunia Rios Yunes, 2018. The impact of high CO2 and low pH on the organic carbon characterization.

Submitted by Kuria Ngundu (kuria.ndungu@niva.no).

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN POLAND

April 1st, 2018 to March 31st, 2019

New scientific results

- Environmental impact of wind farm on Baltic Sea Ecosystem 2017-2018
  The research cruise performed in January 2018 was part of the study committed to the environmental impact of the planned wind farm on the southern Baltic Sea ecosystem. The farm will be built approximately 50 km from land. The study included water and suspended trace metals. The report is under preparation.

- Spring *r/v Oceania* cruise
  The results obtained in March 2018 are still under interpretation. The results obtained within this cruise will be used in a study dedicated to mineralization of organic matter under oxic and hypoxic conditions. The publication is under preparation.

- Submarine Groundwater Discharge (SGD) in the Baltic Sea
  Measurements of trace metals in submarine groundwater discharge (SGD) samples were made within 2016-2018. The study was devoted to verification of several hypotheses two of them were related to trace metals: 1) SGD is a significant source of trace metals to the marine environment in several sites located within the Bay of Puck 2) trace metals flux via SGD changes due to spatial and temporal variability. The publication is under preparation.

Cruises

- January 2018 southern Baltic Sea; analyses of Hg, Ni, Pb, Cd, Cr, As in bottom waters of several sites and in suspended matter:

55 07 .051N	16 43 .159E
55 05 .453N	16 36 .495E
55 05 .479N	16 40 .425E
55 03 .896N	16 33 .887E
55 03 .086N	16 36 .475E
55 01 .082N	16 51 .017E
54 56 .274N	16 54 .452E
54 50 .873N	16 54 .077E
54 45 .608N	16 52 .414E
54 40 .208N	16 50 .681E
54 35 .479N	16 47 .317E

- March 2018 Baltic Proper; analyses of Al, Fe, Mn in water column in several sites:

54 38.702 N	18 42.179 E
54 37.495 N	18 39.604 E
54 36.216 N	18 40.757 E
54 36.152 N	18 44.493 E

54 36.782 N	18 45.439 E
54 34.952 N	18 42.069 E
54 48.849 N	19 13.143 E
54 49.945 N	19 19.773 E
54 51.200 N	19 15.576 E
54 53.695 N	19 17.641 E
54 52.689 N	19 10.790 E
55 14.991 N	18 29.893 E
55 17.297 N	17 42.342 E
55 21.628 N	15 38.389 E
55 17.537 N	15 38.244 E
55 19.532 N	15 42.059 E
55 21.570 N	15 45.386 E
55 17.606 N	15 45.373 E
55 13.076 N	17 00.210 E

- March and May 2018 Bay of Puck; analyses of Pb, Mn, Ni, Zn, Co, Cr, Cd, Cu seawater, river water, shallow groundwater, deep groundwater and pore water in submarine groundwater discharge areas Figure 7.

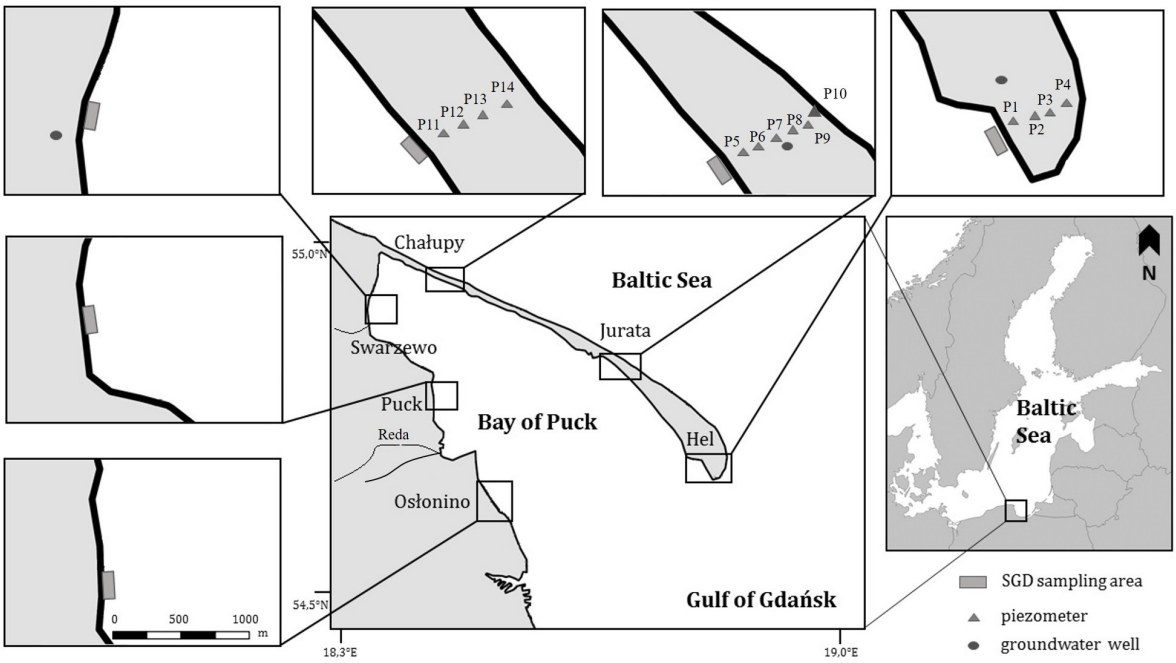


Figure 7. *Map of the study sites located in the Bay of Puck, southern Baltic Sea. The submarine groundwater discharge (SGD) sites situated off Hel Peninsula (Hel, Jurata, Chałupy) and off mainland (Puck, Swarzewo and Osłonino) are marked as grey rectangles while piezometers and groundwater wells are marked as triangles and cirles, respectively.*

Submitted by Beata Szymczycha (beat.sz@iopan.gda.pl).

New scientific results

Arctic Ocean Basin

- "The White Sea Environment" monograph was published in book series of "The Handbook of Environmental Chemistry", Springer, 2018: part 1 "Biogeochemistry of the Atmosphere, Ice and Water of the White Sea", A.P. Lisitsyn and V.V. Gordeev (eds.); part 2 "Sedimentation Processes in the White Sea", A.P. Lisitsyn and L.L. Demina (eds.). The results of multidisciplinary researches in the White Sea basin (subarctic) from 2000 to 2016 were summarized in the monograph. We should note that most of the data presented in the volumes is directly related to the goals and objectives of the GEOTRACES.

- The large (size up to 51×40×10 cm) randomly distributed single blocks (massive crusts) and small crusts micrite-cemented by Mg-calcite were found for the first time on the surface of the modern shelf sediments of the Siberian Arctic seas. The researches were carried out at a cold methane seep site in the Laptev Sea (depth of 63 m) (Figure 8). Microbial mats, methane gas bubbles and carbonate blocks were also visually observed. The composition, morphology, macro- and microstructure of carbonate blocks and crusts have been studied. We guess the carbonate blocks and crusts were developed earlier (not in recent conditions), and evidently not at the site they were sampled. The involvement of methane in the carbonate formation has been proven. We suggested that the methane is predominantly thermogenic. It participated in the formation of carbonate blocks and crusts during the dissociation of gas hydrates during the warming period in the Arctic, which occurred in the Holocene, about 10.5–8.5 ka. Further task of studying authigenic carbonates on the East Siberian shelf should be a detailed study of their U-Th carbonate age to determine carbonate precipitation rates and to provide new insights on the intensity of methane-containing fluids in the Arctic (Kravchishina et al., in preparation).

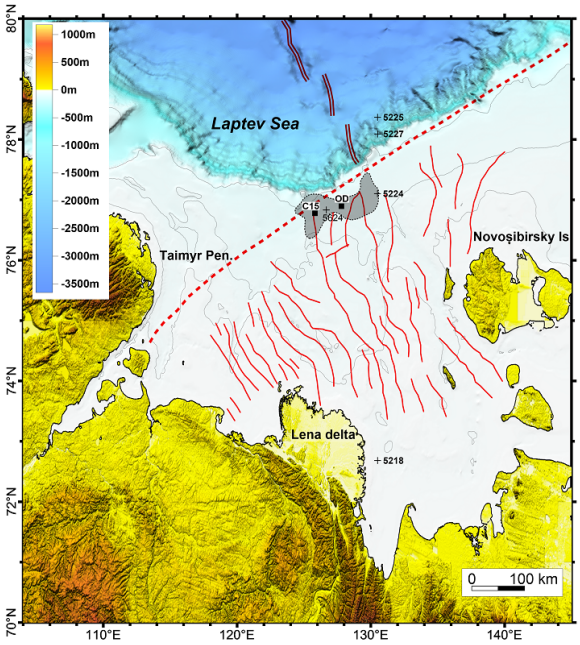


Figure 8. Map of the study area in the Laptev Sea, grid is from IBCAO V.3 (Jakobsson et al. 2012). Filled squares mark two studied sites, crosses indicate sampling sites. Gray color shows the domain of cold methane seep fields according to data from (Shakhova et al., 2015). The double red line is the axis of the Gakkel Ridge, the dashed red line is the Khatanga-Lomonosov Fault Zone, and the red lines are the faults of the Laptev Sea Rift System (Drachev, 2000).

• The isotopic characteristics (εNd, $^{207}Pb/^{206}Pb$, and $^{87}Sr/^{86}Sr$) of the modern bottom sediments sampled in the Barents Sea during the 67th cruise of the R/V *Akademik Mstislav Keldysh* were studied. The major contribution to the formation of the isotopic Nd and Sr composition of bottom sediments in the Barents Sea is made of rocks from the northern European continental margin. The material from the island uplifts (Franz Josef Land, Novaya Zemlya Archipelago), which are composed mainly of basic magmatic rocks, is delivered to the northern Barents Sea along with the Arctic currents, being accumulated within the first few tens of kilometers from their shores. However, this material does not significantly influence the isotopic characteristics of bottom sediments in the central areas of the sea. It is interesting to note that the values of εNd and $^{87}Sr/^{86}Sr$ in the bottom sediments of the central Barents Sea are markedly lower than the corresponding characteristics of sedimentary material incorporated in the ice and carried by the Transpolar Drift Stream (Figure 9). This suggests that ice rafting did not contribute much to the formation of the bottom sediments in the Barents Sea (*Maslov et al., 2019*).

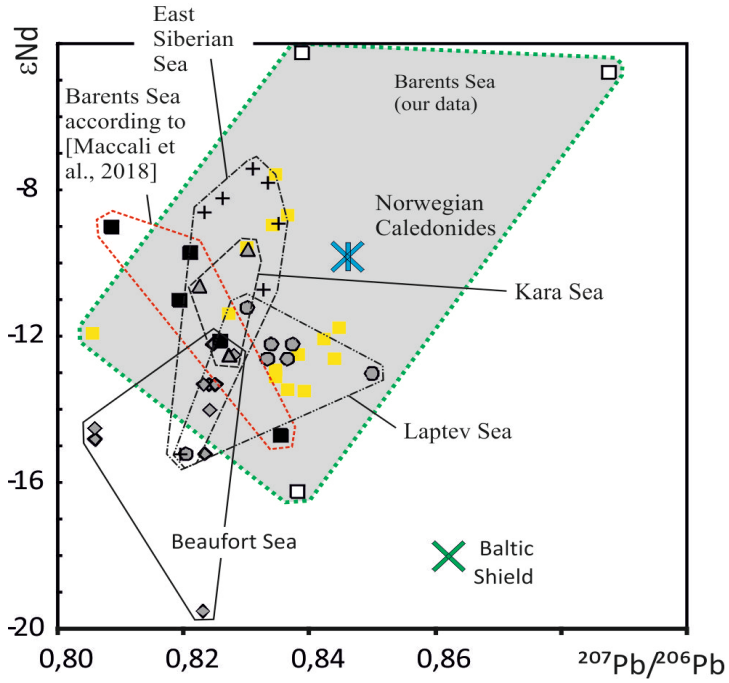


***Figure 9**. Distribution of points of bottom sediments from the Eurasian region of the Arctic Sea and the Beaufort Sea (according to (Maccali et al., 2018) and our data) in the $^{207}Pb/^{206}Pb$–εNd diagram (Maslov et al., 2019).*

• In the central part of the Arctic Ocean, sea ice actively accumulates sedimentary material from the atmosphere (in snow) in its top layer and from the hydrosphere (under new ice formation). The snow – ice – water system in the region of the North Pole is characterized by high values of the biogenic matter (from 65 to 85%) even in winter. The participation of the lithogenic component is small (from 15 to 35%) and is mainly related to aeolian transportation. Sea ice fluxes of sedimentary material at the North Pole in April are characterized by a total flux of 37 mg/(m^2 day) and a flux of organic carbon of 7.4 mg C/(m^2 day) (*Novigatsky, Lisitzin, 2018*).

• The fluorescence quantum yield (FQY) as a function of excitation wavelength within 240–500 nm range for a variety of the Arctic shelf waters was determined for the first time in order to identify the characteristic chromophoric dissolved organic matter (CDOM) peculiar to different regions of the Arctic basin affected by freshwater runoff. The surface water samples were collected during several cruises in 2015–2017 in the Laptev Sea, White Sea, Kara Sea and East Siberian Sea influenced by freshwaters river runoff, as well the shelf areas of those seas not affected by terrigenous runoff. To characterize DOM, conventional optical indices SR, HIX, and BIX were calculated. In most cases, important humic character of DOM

was established, while the contribution of autochthonous organic matter varied from low to intermediate level. For the samples with terrestrial impact, the FQY decreased from excitation at 240 nm to 270–280 nm and then increased, demonstrating two peaks at 340 and 380 nm, with constant decrease towards longer excitation wavelengths; at λ_{ex} = 380 nm FQY varied from 1.4% to 3.1%. In some cases, additional maximum at 270 nm of FQY-excitation dependency was observed as an indicator of autochthonous nature of biological material. Minimal FQY was measured for the White Sea surface waters, the maximal for the Laptev and East Siberian seas (*Drozdova et al., 2018*).

• The fluxes of anthropogenic heavy metals (Pb, Cd, As, Zn, Ni, Cr, Cu) to the surface of four Russian Arctic seas (the White, Pechora, Kara, and Laptev seas) were estimated using previously calculated concentrations of these elements in the surface atmosphere at some island and continental points. Comparison of the obtained values with the flows of the same components carried by the big rivers into the sea has been carried out. We included the amendments for Pb and Cd atmospheric fluxes to the waters of the White Sea and Pechora Sea, taking into account the contribution of Europe, as well as the contribution of wind raising dust and soil particles in these fluxes, according to EMER reports. The contribution of the atmosphere is comparable with rivers ones for Pb, Ni, Cu and Cr in the White Sea. The contribution of atmospheric transport of heavy metals to the waters of the Kara Sea and Laptev Sea are small, but may be important for those parts of the seas where the roles of large Siberian rivers (Ob', Yenisei, and Lena) are negligible (*Vinogradova, Kotova, 2019*).

Atlantic Ocean Basin

• Distribution of platinum group elements (Ru, Pd, Pt, and Ir) and gold in hydrogenous ferromanganese deposits from the southern part of the Atlantic Ocean (Brazil Basin and Cape Basin) has been studied. The presented samples were the surface and buried Fe–Mn hydrogenous nodules, biomorphous nodules containing predatory fish teeth in their nuclei, and crusts. Platinum content varied from 47 to 247 ng/g, Ru from 5 to 26 ng/g, Pd from 1.1 to 2.8 ng/g, Ir from 1.2 to 4.6 ng/g, and Au from less than 0.2 to 1.2 ng/g. In the studied Fe–Mn crusts and nodules, Pt, Ir, and Ru are significantly correlated with some redox-sensitive trace metals (Co, Ce, and Tl). Similar to cobalt and cerium behaviour, ruthenium, platinum, and iridium are scavenged from seawater by suspended ferromanganese oxyhydroxides (Figure 10). The most likely mechanism of PGE accumulation can be sorption and oxidation on δ-MnO_2 surfaces. The obtained platinum fluxes to ferromanganese crusts and to nodules are close and vary from 35 to 65 ng×cm^{-2}×Ma^{-1} (*Berezhnaya et al., 2018*).

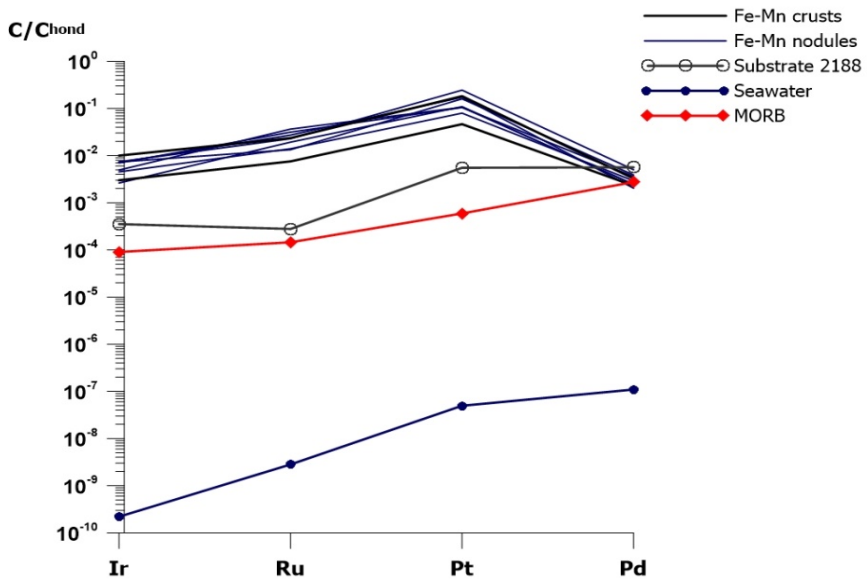


Figure 10. *CI Chondrite-normalized platinum group elements patterns in studied nodules, crust and substrate. For comparison MORB and seawater PGE pattern is shown (Berezhnaya et al., 2018).*

• Investigation of the sinking particles' fluxes using sediment traps at five depths on a latitudinal transect along 59°30'N in the North Atlantic during 2015–2017 was carried out. A seasonal, inter-annual, and vertical change of the total particle flux was revealed, whose values varied between 10 and 145 mg/m^2/day, the latter was measured in July, 2016.The Fe speciation in the deep-sea particle flux at 3 stations were examined by use of sequential leaching procedure. Our data exhibit that at station 3580 (2192 m depth), located above the Snorry Drift, the total Fe content increased strongly with the water depth, while proportion of the Fe main geochemical phases did not remain significantly: the lithogenic form varied within the limits of 55–70%, and Fe in form of authigenic oxy-hydroxides from 20 to 30% of total Fe content (Figure 11). Portion of Fe bound to organic matter did not exceed 20% of total Fe content throughout the water column investigated (*Demina, Klyuvitkin, in press*).

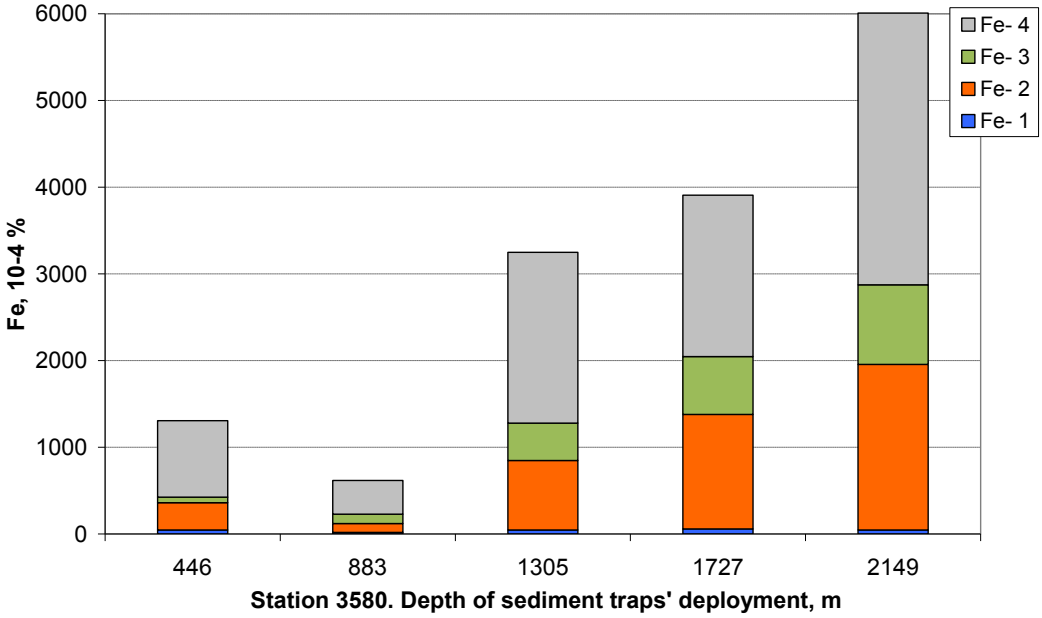


Figure 11. *Concentration of Fe in the 4 different occurrence forms in particle fluxes at station 3580 (59°29.977 N; 32°50.533 W) in the North Atlantic. Speciation of Fe: Fe-1 – adsorbed/bound to carbonates [Luoma, Bryan, 1981], Fe-2 – oxy-hydroxides [Chester, Hoges, 1967], Fe-3 – bound to organic matter [Kitano, Fujiyoshi, 1980], Fe-4 – lithogenic form (total digestion with concentrated HNO_3, HCl and HF) (Demina, Klyuvitkin, in press).*

Cruises GEOTRACES-related

- The researches of aerosols, suspended particulate matter (including vertical fluxes of trapped sedimentary material) and bottom sediments in the North Atlantic and the Barents Sea were carried out during the 71th cruise of RV Akademik Mstislav Keldysh, July–August 2018 (Figure 12). Principal Scientist – Sergey V. Gladyshev, Shirshov Institute of Oceanology, Russian Academy of Sciences.
- The researches of suspended particulate matter and vertical fluxes of trapped sedimentary material in the Siberian Arctic seas were carried out during 72th cruise of RV Akademik Mstislav Keldysh, August–September 2018 (Figure 13). Principal Scientist – Mikhail V. Flint, Shirshov Institute of Oceanology, Russian Academy of Sciences.

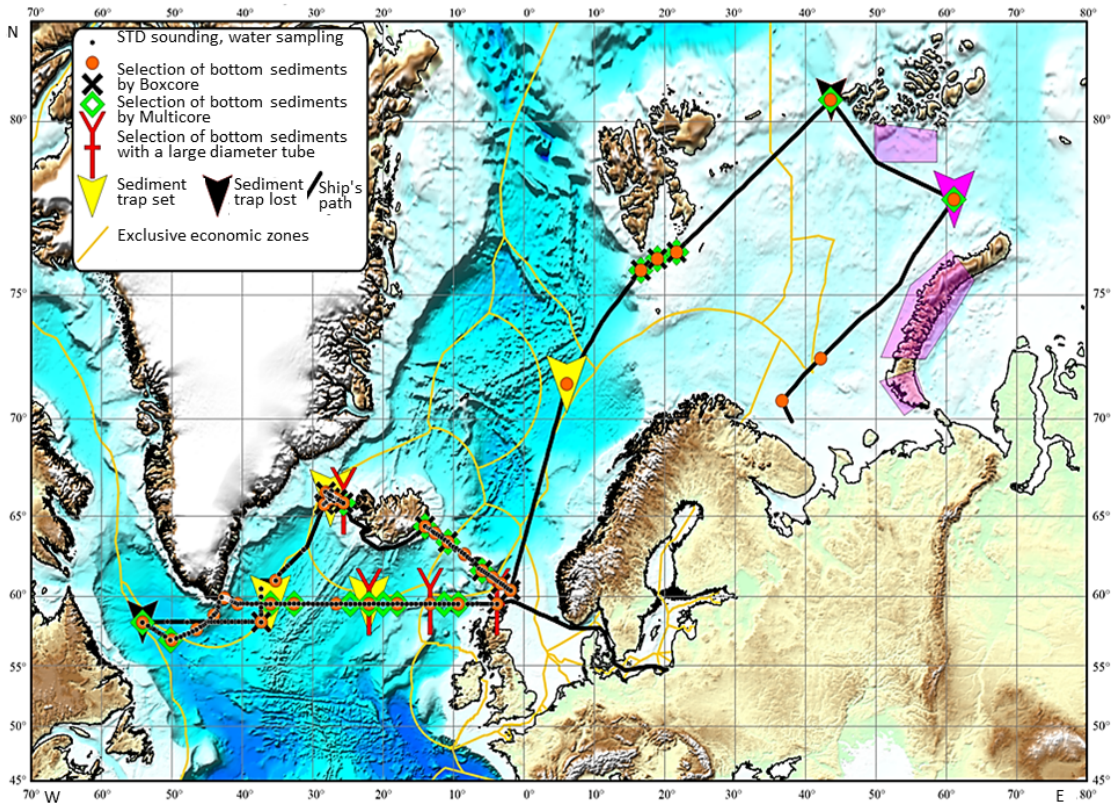


Figure 12. *The rout and sampling sites in the 71th cruise of RV Akademik Mstislav Keldysh.*

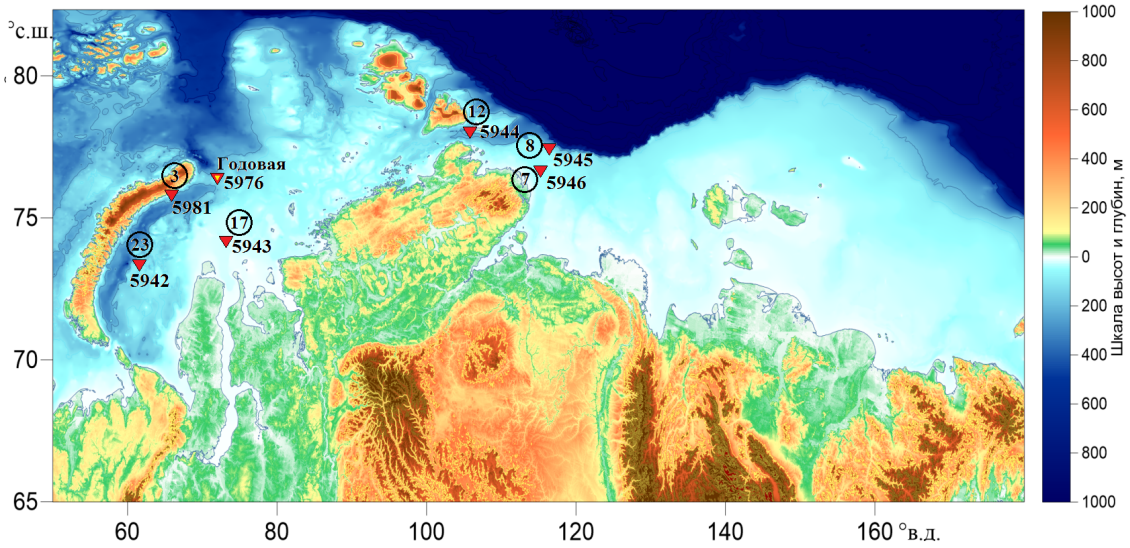


Figure 13. *The location of moorings (with sediment traps) deployed in the Kara and Laptev seas, 72th cruise of RV Akademik Mstislav Keldysh. The circles indicate the number of days of exposure.*

New projects and/or funding

- Project of the Russian Science Foundation, No. 19-17-00234 "Biogeochemistry of organic compounds, heavy metals, and radionuclides in the ecosystems of the Arctic Seas (by example of the White, Barents, Laptev and East Siberian Seas)", 2019–2021.
- Project of the Russian Foundation for Basic Research, No. 19-05-007-87 "Formation, transformation and transport of dispersed sedimentary matter under the influence of the

constant movement of water masses in the dynamic hydrological structure of the Atlantic branch of the Great Ocean Conveyor Belt", 2019–2021.

New GEOTRACES-related publications (published or in press)

- Berezhnaya E., Dubinin A., Rimskaya-Korsakova M., Safin T., 2018. Accumulation of Platinum Group Elements in Hydrogenous Fe–Mn Crust and Nodules from the Southern Atlantic Ocean. Minerals. 2018. 8(7). 275.
- Chernov I., Lazzari P., Tolstikov A., Kravchishina M., Iakovlev N., 2018. Hydrodynamical and biogeochemical spatiotemporal variability in the White Sea: A modeling study. Journal of Marine Systems. V. 187. P. 23–35. doi: 10.1016/j.jmarsys.2018.06.006.
- Demina L.L., Budko D.F., Novigatsky A.N., Alexeeva T.N., Kochenkova A.I., 2018. Occurrence forms of heavy metals in the bottom sediments of the White Sea. Sedimentation Processes in the White Sea: The White Sea Environment Part II / A.P. Lisitsyn, L.L. Demina (eds.). The Handbook of Environmental Chemistry. Springer, Berlin, Heidelberg. P. 241–270.
- Drozdova A.N., Kravchishina M.D., Khundzhua D.A., Freidkin M.P., Patsaeva S.V., 2018. Fluorescence quantum yield of CDOM in coastal zones of the Arctic seas. International Journal of Remote Sensing. P. 1–24. https://doi.org/10.1080/01431161.2018.1506187.
- Klyuvitkin A.A., Kravchishina M.D., Dara O.M., Rusanov I.I., Lisitzin A.P., 2018. Seasonal variability of vertical fluxes of dispersed sedimentary matter in the Black Sea. Doklady Earth Sciences. V. 483. Part 2. P. 1558–1563. doi: 10.1134/S1028334X18120139
- Kravchishina M.D., Klyuvitkin A.A., Lukashin V.N., Politova N.V., Novigatsky A.N., Lisitsyn A.P., 2018. Distribution of suspended particulate matter in the Caspian Sea. Russian Meteorology and Hydrology. V. 43. No. 10. P. 697–705.
- Kravchishina M.D., Lein A.Yu., Flint M.V., Baranov B.V., Miroshnikov A.Yu., Dara O.M., Dubinina E.O., Boev A.G., Savvichev A.S., in preparation. Newly discovered methane-derived antigenic carbonates on the Laptev Sea shelf.
- Kravchishina M.D., Lisitsyn A.P., Klyuvitkin A.A., Novigatsky A.N., Politova N.V., Shevchenko V.P., 2018. Suspended particulate matter as a main source and proxy of the sedimentation processes. The White Sea Environment Part II / A.P. Lisitsyn, L.L. Demina (eds.). The Handbook of Environmental Chemistry. Springer, Berlin, Heidelberg. P. 13–48.
- Kravchishina M.D., Novigatskii A.N., Savvichev A.S., Pautova L.A., Lisitsyn A.P., 2019. Studies on sedimentary system in the Barents Sea and Norwegian-Greenland Basin during cruise 68th of the R/V Akademik Mstislav Keldysh. Oceanology. V. 59(1). P. 158–160.
- Lein A.Y., Dara O.M., Bogdanova O.Y., Novikov G.V., Ulyanova N.V., Lisitsyn A.P., 2018. Sources of minor and rare-earth elements in hydrothermal edifices of near-continental rifts with sedimentary cover: evidence from the Guaymas Basin, Southern Trough. Oceanology. V. 58. No. 2. P. 250–265.
- Lisitzin A.P., Gordeev V.V. (eds.), 2018. Biogeochemistry of the Atmosphere, Ice and Water of the White Sea. The White Sea Environment. Part I. In: The Handbook of Environmental Chemistry. Springer, Berlin, Heidelberg, 327 pp.

- Maslov A.V., Kuznetsov A.B., Politova N.V., Kozina N.V., Novigatsky A.N., Shevchenko V.P., 2019. Isotopic composition of Nd, Pb, and Sr in modern bottom sediments of the Barents Sea. Doklady Earth Sciences. V. 485. Part 1. P. 268–272.
- Maslov A.V., Shevchenko V.P., Kuznetsov A.B., Stein R., 2018. Geochemical and Sr–Nd–Pb-isotope characteristics of ice-rafted sediments of the Arctic Ocean. Geochemical International. V. 56. No. 8. P. 751–765.
- Novigatsky A.N., Klyuvitkin A.A., Lisitsyn A.P., 2018. Vertical fluxes of dispersed sedimentary matter, absolute masses of the bottom sediments, and rates of modern sedimentation. The White Sea Environment. Part II / A.P. Lisitsyn, L.L. Demina (eds.). The Handbook of Environmental Chemistry. Springer, Berlin, Heidelberg. P. 49–66.
- Novigatsky A.N., Lisitzin A.P., 2018. The North Pole Region: First Data on the Snow–Sea Ice–Ice Water Sedimentation System. Doklady Earth Sciences. V. 483(2), P. 1534–1538. DOI: 10.1134/S1028334X18120085.
- Politova N.V., Novigatsky A.N., Kozina N.V., Terpugova S.A., 2018. Multidisciplinary research in the Barents Sea on cruise 67 of the R/V Akademik Mstislav Keldysh. Oceanology. V. 58(3). P. 499–501.
- Shevchenko V.P., Lisitsyn A.P., Vinogradova A.A., Starodymova D.P., Korobov V.B., Novigatsky A.N., Kokryatskaya N.M., Pokrovsky O.S., 2018. Dispersed sedimentary matter of the atmosphere. The White Sea Environment. Part I / A.P. Lisitsyn, V.V. Gordeev (eds.). The Handbook of Environmental Chemistry. Springer, Berlin, Heidelberg.
- Vinogradova A.A., Kotova E.I., 2019. Pollution of Russian northern seas by heavy metals: comparison of atmospheric flux and rivers inflow. Izvestiya, Atmospheric and Oceanic Physics. V. 55. Iss. 7. https://link.springer.com/journal/volumesAndIssues/11485

Completed GEOTRACES-related PhD theses

- Dina P. Starodymova defended PhD thesis in December 2018 (Shirshov Institute of Oceanology, Russian Academy of Sciences). Based on mean airborne metal concentration their fluxes on the surface water of the White Sea were estimated. Since different heavy metals are related to different size fraction of aerosols they are defined by different dry deposition rates (Milford, Davidson, 1985). Pb, Cd, Sb and Bi fluxes were considered to be on the same level over the area of the White Sea. Ni and Cu fluxes were calculated separately for different areas of the sea. Annual input of particulate Ni, Cu Cd and Bi with aerosols were 22–58% of annual input of these metals by the Severnaya Dvina River runoff (Pokrovsky et al., 2010), while estimates of annual atmospheric input of Pb and Sb exceed their inflow from the Severnaya Dvina River beyond the marginal filter (Figure 14).

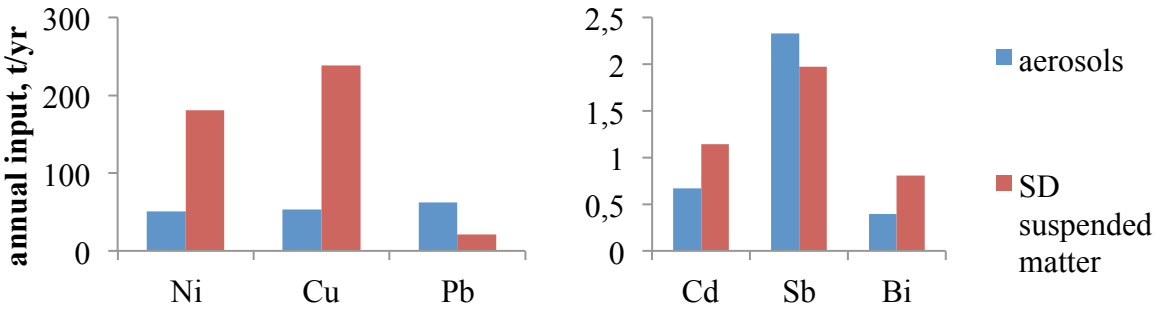


Figure 14. *Annual particulate heavy metals input to the White Sea from atmosphere and with Severnaya Dvina (SD) River runoff (Starodymova, 2018).*

- Dmitry F. Budko defended PhD thesis in December 2018 (Shirshov Institute of Oceanology, Russian Academy of Sciences). The geochemical speciation of Al, Fe, Mn and trace metals in the vertical fluxes of trapped sedimentary matter and in bottom sediments of the White Sea were studied. He evaluated the contribution of some geochemical processes at various stages of sedimentation in the White Sea.

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

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN SLOVENIA

April 1st, 2018 to March 31st, 2019

New scientific results

This year most of the research was oriented into the study of Hg cycle. The research was performed in deep-sea waters of Mediterranean Sea in the lower food web and lagoon environment.

- Zooplankton and small fish were sampled the neuston layer at both coastal and open sea stations in the Mediterranean Sea in fall 2011 and summer 2012 and 2013. Zooplankton and small fish were sorted by morphospecies, and the most abundant taxa (e.g. euphausiids, isopods, hyperiid amphipods) analyzed for methylmercury (MeHg) concentration. Multiple taxa suggested elevated MeHg concentrations in the Tyrrhenian and Balearic Seas in comparison with more eastern and western stations in the Mediterranean Sea. Spatial variation in zooplankton MeHg concentration is positively correlated with single time point whole water MeHg concentration for euphausiids and mysids and negatively correlated with maximum chlorophyll a concentration for euphausiids, mysids, and "smelt" fish. Taxonomic variation in MeHg concentration appears driven by taxonomic grouping and feeding mode. Euphausiids, due to their abundance, relative larger size, importance as a food source for other fauna, and observed relationship with surface water MeHg are a good candidate biotic group to evaluate for use in monitoring the bioavailability of MeHg for trophic transfer in the Mediterranean and potential globally.
- The aim in research performed in lagoon system was to understand if and where recycling at the sediment-water interface (SWI) may affect metal(loid)s. Short sediment cores were also collected near the chamber to investigate the solid (sediments) and dissolved phases (porewaters). Both diffusive and benthic fluxes were estimated to elucidate the release of metal(loid)s at the SWI. Total element concentrations and their labile fractions were determined in sediments to quantify their potential mobility. The total element contents were found to be two orders of magnitude higher in the Italian marina than in the Slovenian one, especially for Hg (up to 1000 mg kg-1), whereas the labile fraction was scarce or null. The opposite occurred in the Slovenian marina. Metal(loid)s in porewaters showed a clear diagenetic sequence and a close dependence upon the suboxic/anoxic conditions of sediments. The results suggest that although the sediments of the Italian marina exhibit the highest total metal(loid) concentration, these elements are scarcely remobilisable. Conversely, in the Slovenian marina, sediments seem to be comparatively more prone to release metal(loid)s at the SWI.

Other studies were biologically oriented and include:

- The review describes the biotechnological potential of host–microorganism systems and focus on gelatinous zooplankton as a host for the microbiome with biotechnological potential. The basic characteristics of jellyfish-associated microbial communities, the mechanisms underlying the jellyfish-microbe relationship, and the role/function of the jellyfish-associated microbiome and its biotechnological potential are reviewed. It appears that the jellyfish-associated microbiome is discrete from the microbial community in the

ambient seawater, exhibiting a certain degree of specialization with some preferences for specific jellyfish taxa and for specific jellyfish populations, life stages, and body parts.

- The data processing that led to the definition of ecological classification criteria for the Biological Quality Element (BQE) phytoplankton in the coastal waters (CW) of the Adriatic and Tyrrhenian seas, according to the Water Framework Directive (2000/60/EC) was performed. The chosen metric was the annual geometric mean of chlorophyll a concentrations owing to the log-normal nature of chlorophyll a distribution. The sensitivity of this metric to the gradient of pressures was tested by adopting an empirical statistical approach. The dilution factor (F_dil), which is the share of freshwater in a sample of seawater, was introduced as a rough, but realistic proxy of nutrient loads from the continent. Correlations between F_dil and trophic indicators (i.e. nitrogen and phosphorus concentrations in seawater and the respective N:P ratio) were then evaluated. The F_dil approach was also used to derive reference conditions for each typology of coastal waters. Functional relationships between chlorophyll a, as phytoplankton biomass indicator, and nutrient concentrations, as pressure indicators, were computed by means of regression techniques. The classification scale for the BQE phytoplankton was based on the TRIX scale of water quality conditions. Reference conditions, pressure/impact relationships, boundary setting and classification criterion definition were treated separately and discussed for each of the CW Types: Type I, Type II A Adriatic, Type II A Tyrrhenian and Type III W for both the Adriatic and Tyrrhenian seas. Due to the lack of a functional relationship between the gradient of pressures and chlorophyll a, and a narrow range of annual chlorophyll a concentrations, only one threshold value was set for Type III W instead of the whole classification scale.

New publications (published or in press)

- PALATINUS, Andreja, KOVAČ VIRŠEK, Manca, ROBIČ, Uroš, GREGO, Mateja, BAJT, Oliver, ŠILJIĆ, Jasna, SUARIA, Giuseppe, LIUBARTSEVA, Svitlana, COPPINI, Giovanni, PETERLIN, Monika. Marine litter in the Croatian part of the middle Adriatic Sea: simultaneous assessment of floating and seabed macro and micro litter abundance and composition. Marine pollution bulletin, ISSN 0025-326X, 2019, vol. 139, 427-439, doi: 10.1016/j.marpolbul.2018.12.038.
- BAJT, Oliver, RAMŠAK, Andreja, MILUN, Vesna, ANDRAL, Bruno, ROMANELLI, Giulia, ALFONSO, Scarpato, MITRIĆ, Milena, KUPUSOVIĆ, Tarik, KLJAJIĆ, Zoran, ANGELIDIS, Michael, ÇULLAJ, Algi, GALGANI, François. Assessing chemical contamination in the coastal waters of the Adriatic Sea using active mussel biomonitoring with Mytilus galloprovincialis. Marine pollution bulletin, ISSN 0025-326X, 2019, vol. 141, 283-298, doi: 10.1016/j.marpolbul.2019.02.007.
- TINTA, Tinkara, KOGOVŠEK, Tjaša, KLUN, Katja, MALEJ, Alenka, HERNDL, Gerhard J., TURK, Valentina. Jellyfish-associated microbiome in the marine environment: exploring its biotechnological potential. Marine drugs, ISSN 1660-3397, 2019, vol. 17, no. 2, 1-34 doi: 10.3390/md17020094.
- BUCKMAN, Kate L., LANE, Oksana, KOTNIK, Jože, BRATKIČ, Arne, SPROVIERI, Francesca, HORVAT, Milena, PIRRONE, Nicola, EVERS, David C., CHEN, Celia Y. Spatial and taxonomic variation of mercury concentration in low trophic level fauna from the Mediterranean Sea. Ecotoxicology, ISSN 0963-9292, [in press] 2018, doi: 10.1007/s10646-018-1986-5.

- RUELAS-INZUNZA, Jorge R., ŠLEJKOVEC, Zdenka, MAZEJ, Darja, FAJON, Vesna, HORVAT, Milena, RAMOS-OSUNA, M. Bioaccumulation of As, Hg, and Se in tunas Thunnus albacares and Katsuwonus pelamis from the Eastern Pacific: tissue distribution and As speciation. Environmental science and pollution research international, ISSN 0944-1344, 2018, vol. 25, 19499-19509, doi: 10.1007/s11356-018-2166-0.
- PETRANICH, Elisa, CROCE, Sara, CROSERA, Matteo, PAVONI, Elena, FAGANELI, Jadran, ADAMI, Gianpiero, COVELLI, Stefano. Mobility of metal(loid)s at the sediment-water interface in two tourist port areas of the Gulf of Trieste (northern Adriatic Sea). Environmental science and pollution research international, ISSN 0944-1344, 2018, vol. 25, no. 27, 26887-26902, doi: 10.1007/s11356-018-2717-4.
- PETRANICH, Elisa, COVELLI, Stefano, ACQUAVITA, Alessandro, FAGANELI, Jadran, HORVAT, Milena, CONTIN, Marco. Evaluation of mercury biogeochemical cycling at the sediment-water interface in anthropogenically modified lagoon environments. Journal of Environmental Sciences(China), ISSN 1001-0742, 2018, vol. 68, 5-23, doi: 10.1016/j.jes.2017.11.014.
- PETRANICH, Elisa, COVELLI, Stefano, ACQUAVITA, Alessandro, DE VITTOR, Cinzia, FAGANELI, Jadran, CONTIN, Marco. Benthic nutrient cycling at the sediment-water interface in a lagoon fish farming system (northern Adriatic Sea, Italy). Science of the total environment, ISSN 0048-9697, 2018, vol. 644, 137-149.
- GIOVANARDI, Franco, FRANCÉ, Janja, MOZETIČ, Patricija, PRECALI, Robert. Development of ecological classification criteria for the Biological Quality Element phytoplankton for Adriatic and Tyrrhenian coastal waters by means of chlorophyll a (2000/60/EC WFD). Ecological indicators: integrating monitoring, assessment and management, ISSN 1470-160X, 2018, vol. 93, 316-332, ilustr., doi: 10.1016/j.ecolind.2018.05.015.
- ARKITZI, Ioanna, FRANCÉ, Janja, BASSET, A., COZZOLI, Francesco, STANCA, Elena, ZERVOUDAKI, Soultana, GIANNAKOUROU, Antonia, ASSIMAKOPOULOU, G., VENETSANOPOULOU, Amalia, MOZETIČ, Patricija, TINTA, Tinkara, SKEJIĆ, Sanda, VIDJAK, Olja, CADIOU, Jean-François, PAGOU, Kalliopi. Pelagic habitats in the Mediterranean Sea: a review of Good Environmental Status (GES) determination for plankton components and identification of gaps and priority needs to improve coherence for the MSFD implementation. Ecological indicators: integrating monitoring, assessment and management, ISSN 1470-160X, 2018, vol. 95, pt. 1, 203-218, doi: 10.1016/j.ecolind.2018.07.036.
- KOS KRAMAR, Maja, TINTA, Tinkara, LUCIĆ, Davor, MALEJ, Alenka, TURK, Valentina. Bacteria associated with moon jellyfish during bloom and post-bloom periods in the Gulf of Trieste (northern Adriatic). PloS one, ISSN 1932-6203, 2019, vol. 14, iss. 1, 1-21, doi: 10.1371/journal. pone.0198056.

Invited lectures

- Ogrinc, Nives. Compound specific isotope analysis: new challenges in environmental and food studies. V: TREBŠE, Polonca (ur.), LEBEDEV, Albert T. (ur.), DAHMANE, Raja (ur.). Petromass 2018: book of abstracts, XI International Mass Spectrometry Conference on Petrochemistry, Environmental and Food Chemistry, Bled, Slovenia, 15-18 April 2018. Ljubljana: Masseco. 2018, 4.

- Horvat, Milena. Analytical challenges in the implementation of the Minamata convention. V: Mercury Monitoring Workshop: 1-2 November 2018, Jeju, Korea: The Korean Society for Environmental Analysis. 2018, 8.
- Ogrinc, Nives. CSIA in the environment and food: presented at Training Workshop on Isotope Techniques in Ecological, Food and Environmental Research, 29-30 January 2019, Ljubljana, Slovenia.

Presentations at conferences

- MOZETIČ, Patricija, PETELIN, Boris, FRANCÉ, Janja, FLANDER-PUTRLE, Vesna, KLUN, Katja, LIČER, Matjaž, TINTA, Tinkara, TURK, Valentina, MALAČIČ, Vlado. Linking long-term changes of pelagic microbial communities to fluctuations in climate and hydrological regime in a coastal ecosystem (Adriatic Sea). V: The Effects of Climate Change on the World's Oceans: book of abstracts, 4th International Symposium The Effects of Climate Change on the World's Oceans, June 4-8, 2018, Washington, D.C., USA. 109. https://meetings.pices.int/publications/book-of-abstracts/2018-ECCWO-Book-of-Abstracts.pdf.
- FRANCÉ, Janja, PETELIN, Boris, MOZETIČ, Patricija. Can we track climate related changes in the HAB species assemblage in a highly variable coastal sea (Gulf of Trieste, Adriatic Sea)?. V: The Effects of Climate Change on the World's Oceans: book of abstracts, 4th International Symposium The Effects of Climate Change on the World's Oceans, June 4-8, 2018, Washington, D.C., USA. [S. l.: s. n. 2018], str. 179. https://meetings.pices.int/publications/book-of-abstracts/2018-ECCWO-Book-of-Abstracts.pdf.
- OGRINC, Nives. Isotopic techniques for studying the sources and processes of pollutants in the environment. V: Book of abstracts, XXII. International Mass Spectrometry Conference, IMSC 2018, August 26-31, 2018, Florence, (Italy). [S. l.]: International Mass Spectrometry Foundation. 2018, str. 234-235.
- KRAJNC, Bor, TAMŠE, Samo, OGRINC, Nives. CO2 fluxes and vulnerability to acidification of coastal waters in the Gulf of Trieste (N Adriatic). V: Goldschmidt Conference, August 12-17, 2018, Boston, USA. [S. l.]: Geochemical Society. 2018. https://goldschmidt.info/2018/abstracts/abstractView?id=2018001872.
- KRAJNC, Bor, TAMŠE, Samo, OGRINC, Nives. Carbonate system in the Gulf of Trieste: presented at International Conference THEMES 201 8 - Oceanic and atmospheric variability, from long-term trends to abrupt shifts, 28th-30th November 2018, Venice, Italy.
- FAGANELI, Jadran, KLUN, Katja, FALNOGA, Ingrid, MAZEJ, Darja, KOVAČ, Nives. Colloidal metal(loid)s and their bioaccumulation in plankton in a coastal ecosystem. V: AGU 100, Fall Meeting, Washington, D.C., 10-14 Dec. 2018. [S. l.]: American Geophysical Union. 2018.

New projects and/or funding

- Department of Environmental Sciences at Jožef Stefan Institute (JSI-O2) is involved in the National Key Research & Development Program of China “Mechanisms of red tides and hypoxia as ecological marine disasters and technologies for its early warning and emergency security along the sea of ‘Belt and Road’ countries” (2016YFE0202100). The project coordinated by IHB-CAS has started in September, 2017 and will end in July,

2020. According to the implementation plan, part of the work is conducted in Adriatic Sea in the Gulf of Trieste. There is a need to extend the joint research temporally and spatially. JSI-O2 is responsible for collecting and analyzing the phytoplankton and chemical analysis at two sites in the Gulf of Trieste four times a year from 2018 to 2020. The first sampling campaign was performed in September 2018. The analysis are still in progress.

- Scientific visits (10-14.12.2018) - training programme of Roberto Meigikos dos Anjos (Brazil), Carlos Manuel Alonso Hernandez (Cuba) and Saif Uddin (Kuwait) under the IAEA's INT7019 project: Supporting a Global Ocean Acidification Observing Network towards Increased Involvement of Developing States was performed. The training was held at Jožef Stefan Institute and Marine Biological Station (National Institute of Biology). We presented several techniques that can be used in research concerning the ocean acidification: The use of radioactive isotopes in marine studies, the principles and use of k0-INAA in the marine environment, and methods to investigate dissolved inorganic carbon (DIC) in the marine ecosystem where we demonstrated methods for measuring the isotopic composition of decomposed inorganic carbon in seawater. The main objective of the training was to establish the infrastructure and measurement operational procedure for the determination of isotopic composition of DIC in sea water.
- From 7th till 8th March 2019 Ocean Acidification and Climate Change (OACC) Working Group Meeting was held at Marine Biology Station in Piran. Nives Ogrinc (JSI), Jadran Faganely (NIB), and Nives Kovač (NIB) were introduced as new members of the Working Group. Beside the discussions about accomplished work and planning of future activities three invited lectures were performed:
  - ⇒ Nives Ogrinc (Jožef Stefan Institute, Ljubljana, Slovenia): Stable isotopes in the study of the impact of increasing CO_2 levels on C and Hg cycling in coastal waters in the northern Adriatic Sea.
  - ⇒ Serena Zunino (Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, OGS, Trieste, Italy): Effects of ocean acidification on Posidonia and coralligenous in the Mediterranean Sea.
  - ⇒ Nina Bednaršek (SCCWRP - Southern California Coastal Water Research Project, USA): The effects of OA on marine calcifiers.

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

New scientific results

- MSc students Johan Viljoen and Ian Weir from the Stellenbosch TracEx team probed the interplay of nutrients (macro- and trace) and phytoplankton community compositions in surface waters of the Bonus Good Hope Line (Atlantic sector of the Southern Ocean). They found that there is no single, definite driving factor, including silicic acid or iron that defines communities across the water masses. Instead they concluded on a highly complex nature of interactions.

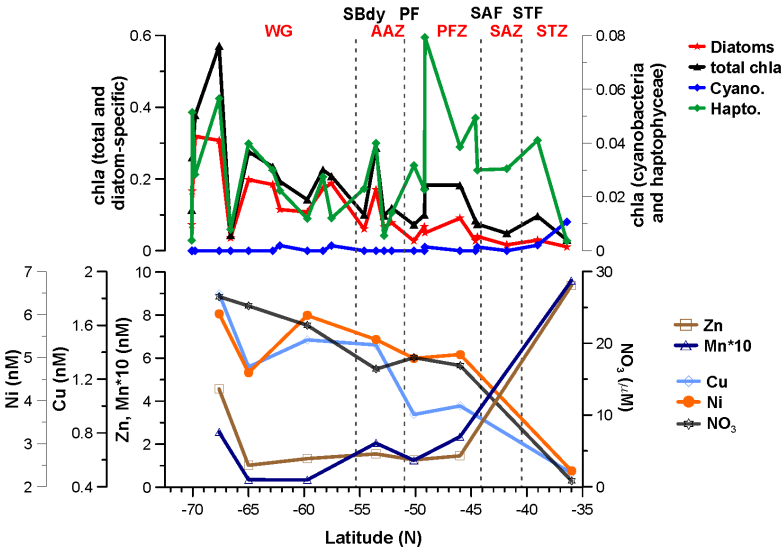


Figure 15. *Total chla and selected phytoplankton group-specific chla (upper panel) versus selected trace and macronutrients (lower panel) illustrating the complex interplay of driving factors for phytoplankton community structure (Viljoen et al., in review)*

- PhD students Ryan Cloete and Jean Loock completed the trace metal measurements from the first Winter Cruise into the Indian sector of the Southern Ocean and linked those to water mass distribution as well as biological processes. For example, first measurements of cadmium (Cd) and zinc (Zn) from the 30°E line allowed them to investigate the biological, geographical and chemical factors controlling the distribution of these important micronutrients. Cd and Zn are geochemically alike yet display different behaviours in the ocean and therefore we aimed to identify the drivers of this phenomenon. We found biological processes to dominate Zn cycling while Cd cycling was driven by water mass characteristics, factors which likely underpin their divergent behaviour in marine environments. Understanding these complexities are particularly important in the Southern Ocean given that waters of Antarctic origin set the biogeochemical signature of the low latitude oceans.

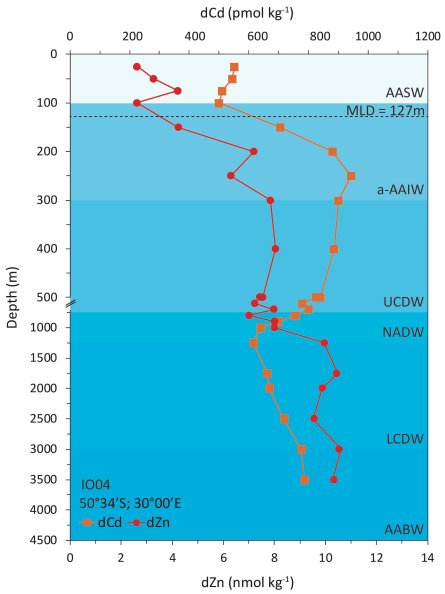


Figure 16*. First measurements of trace nutrients dZn and dCd in the Indian sector of the Southern Ocean at 50°S, 30°E (Cloete et al, in prep.)*

- PhD student Jean Loock and the TracEx team further initiated internal development and testing for the protocols required for the collection of uncontaminated trace metals in ice cores from seasonal sea-ice (pancake ice). It is probable that trace metal fluxes from melting sea ice may be enhancing or sustaining photosynthetic micro-organism (phytoplankton) productivity in remote seasonally ice-covered regions. Hence melting sea-ice may play a significant role in CO_2 uptake within the

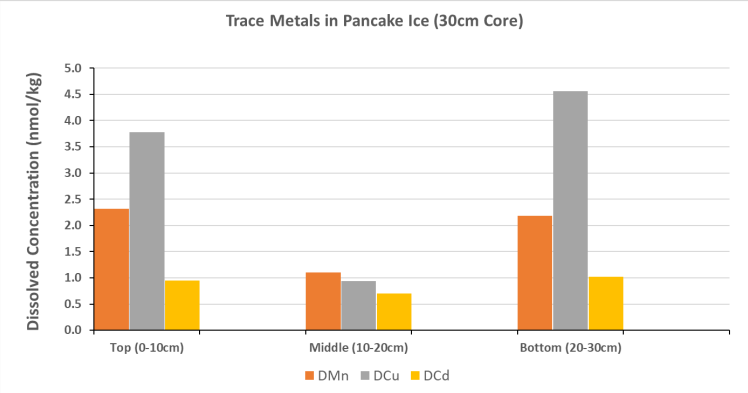


Figure 17*. Trace metal concentrations in different sections (downcore) of a pancake retrieved from the Indian sector of the Southern Ocean in winter 2017.*

Southern Ocean and quantifying the metal flux is imperative to constraining sea-ice as source of trace metals. The team collected ice cores using the Kovacs Mark II corer during the Winter Cruise in 2017. The cores were segmented into three parts (± 10cm) and melted within the on-board clean lab using two techniques 1) Direct Melting 2) Seawater addition melting. Sub sample fractions were collected for the total, 0.45µm and 0.2µm. In 2018, we compared the results and found that concentration ranges are within the range of a previously analyzed sea ice core by Grotti *et al*., 2005. These preliminary results suggest that sea-ice contains a potentially significant pool of trace metals which under melting may promote early spring-time phytoplankton growth at high latitudes. A new study has now been initiated in collaboration with UCT-Engineering on probing trace metal evolution in artificially growing ice.

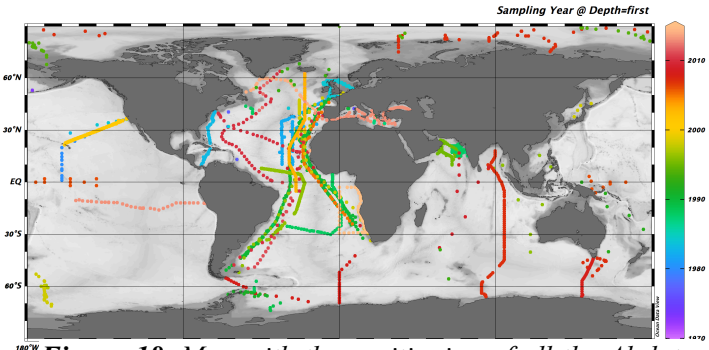


Figure 18*. Map with the positioning of all the Al data. The colors refer to the sampling year of each station.*

- Dr Jan Lukas Menzel compiled a global oceanic aluminium (Al) database containing historical and recent oceanic observational data. We aim to provide the marine scientist community with the first global compilation of Al observational data.

Cruises

- Tommy Ryan-Keogh (CSIR) and Asmita Singh (Stellenbosch University/CSIR) participated in the Norwegian Dronning Maud Land Cruise (#DronningMaudLandCruise2019) on RV Kronprins Haakon from 26th February to 16th of April 2019. They sampled surface waters using a new towfish and deep waters using GoFlo-CTD for trace metal and protein analysis. They also conducted iron addition experiments testing the short-term photophysiological acclimation of sea-ice related phytoplankton communities.

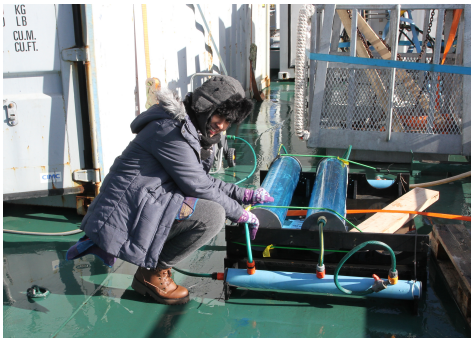


Figure 19. *Asmita Singh preparing the on-deck iron addition incubation experiments.*

New projects and/or funding

- Mackey B, Roychoudhury AN, Vichi M, Findlay, K (2019 – 2022) Humpback whales in changing climate, Donor funding AUD 4,019,503.

Ongoing projects and/or funding

- Fietz S (2018-2020) South African National Antarctic Programme (SNA170506229934) Shifts in phytoplankton and microbial community composition and functional diversity related to trace metal cycling; R914,000.
- Fietz S, Lloyd J (2018-2020) South African bilateral programme, SA-Iran (IRSA170718254901) Carbonic anhydrases from marine microbes and phytoplankton for enzymatic remediation of cadmium-contaminated water resources; R242,950.
- Fietz S, Lloyd J, Makhalanyane T (2018-2020) South African bilateral programme, SA-Mexico (MESA170607237905) Exploiting microbes for remediation of pollution in oceans; R2,284,200.
- Roychoudhury AN (2017-2019) Nanoparticles at Air-Sea interface. NRF Competitive Rated Researcher Grant, R1,550,000.
- Roychoudhury AN (2017-2019) TraceEx: Establishment of Center of excellence in Trace and experimental Biogeochemistry, Donor funding, R 17 Million.
- Roychoudhury AN (2018-2020) Distribution and Speciation of Bioactive Trace Elements in Southern Ocean, NRF SANAP, R1,820,000.
- Ryan-Keogh T, Mtshali T (2018-2020) Seasonal evolution of biogeochemical Fe cycle in the Southern Ocean. NRF SANAP.

Outreach activities conducted

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

New GEOTRACES publications (published or in press)

Main publications by SA researchers:

- Cloete R et al. (2019). Winter and summer distributions of Copper, Zinc and Nickel along the International GEOTRACES section GIPY05: Insights into deep winter mixing. Chemical Geology 511, 342-357. https://doi.org/10.1016/j.chemgeo.2018.10.023
- Fawcett SE et al. (2018) Low-nutrient organic matter in the Sargasso Sea thermocline: A hypothesis for its role, identity, and carbon cycle implications. Marine Chemistry 207: 108-123. https://doi.org/10.1016/j.marchem.2018.10.008
- Menzel Barraqueta J-L et al. (2019) Atmospheric aerosol deposition fluxes over the Atlantic Ocean: A GEOTRACES case study. Biogeosciences, https://doi.org/10.5194/bg-2018-209, accepted
- Ryan-Keogh TJ et al. (2018) Seasonal development of iron limitation in the sub-Antarctic zone. Biogeosciences 15:4647-4660. DOI:10.5194/bg-15-4647-2018
- Viljoen JJ et al. (2018) Response of phytoplankton in growth, community structure and photophysiology to iron and light addition in the Polar Frontal and Antarctic Waters of the

Southern Ocean. Deep Sea research I, 141, 118-129 https://www.sciencedirect.com/science/article/pii/S0967063718301420

- von der Heyden B et al. (2018) Geochemistry of Al and Fe in freshwater and coastal water colloids from the west coast of Southern Africa. Geochimica et Cosmochimica Acta 15:56-68; DOI:10.1016/j.gca.2018.08.043

Co-authored by SA researchers:

- Fripiat F et al., incl. Fawcett SE (2019) The isotope effect of nitrate assimilation in the Antarctic Zone: Improved estimates and paleoceanographic implications. Geochimica et Cosmochimica Acta 247: 261-279. https://doi.org/10.1016/j.gca.2018.12.003
- Gourain A et al., incl. Menzel Barraqueta J-L (2018) Inputs and processes affecting the distribution of particulate iron in the North Atlantic along the GEOVIDE (GEOTRACES GA01) section, Biogeosciences, https://doi.org/10.5194/bg-2018-234, accepted, 2019
- Grand MM et al., incl. Fietz S (2019) Developing autonomous observing systems for micronutrient trace metals. Frontiers in Marine Sciences 6:35. https://doi.org/10.3389/fmars.2019.00035
- Sarthou G et al., incl. Menzel Barraqueta J-L (2018) Introduction to the French GEOTRACES North Atlantic Transect (GA01) GEOVIDE cruise. Biogeosciences, 15, 7097-7109, https://doi.org/10.5194/bg-15-7097-2018.

Completed GEOTRACES PhD or Master theses

- Viljoen, Johannes Jacobus (Stellenbosch University, 2018-12), CHEMTAX determination of Southern Ocean phytoplankton distribution and adaption: An observational and experimental study assessing the co-limitation of Light, Iron and other Trace Metals on phytoplankton productivity and community composition; http://scholar.sun.ac.za/handle/10019.1/104834
- Weir, Ian (Stellenbosch University, 2018-11-16), Phytoplankton variability in the Atlantic and Indian sectors of the Southern Ocean: a biogeochemical approach; http://scholar.sun.ac.za/handle/10019.1/104925

GEOTRACES presentations in international conferences

- Cloete R et al. Winter distribution of Cobalt in the Southern Ocean: First results from the 30˚E line. Goldschmidt, August 2018, Boston, USA (poster); Proceedings: Cloete R, Loock J, Fietz S & Roychoudhury A (2018) Goldschmidt Abstracts, 2018 447.
- Kangueehi K et al. Dust from Saldanha Bay: Assessing impact on human health and marine coastal environment. International Symposium on Medical Geology in Africa (ISMGAf), Johannesburg, South Africa, 11/2018 oral.
- Viljoen JJ, Fietz S. Southern-Atlantic phytoplankton community composition response to light and iron. POLAR 2018 (Davos), 07/2018 oral.
- Weir I, Fietz S. Phytoplankton variability in the Atlantic and Indian sectors of the Southern Ocean: a biogeochemical approach. POLAR 2018 (Davos), 07/2018 oral.

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

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN SOUTH KOREA

April 1st, 2018 to March 31st, 2019

GEOTRACES-related research is continuing in South Korea in a second year. We conducted 2 cruises (Indian Ocean and East/Japan Sea) with trace element clean sampling based on our new research vessel, R/V *Isabu* (2017~) of Korea Institute of Ocean Science and Technology (KIOST). As a new participant of GEOTRACES works, we also tried a inter-comparison work in crossover station in Indian Ocean based on together with a setup a new infrastructure (new clean laboratory and seaFAST ICP-MS for only seawater measurements) in new campus of KIOST. Major funding source of these works are part of research projects (2019-2022) of KIOST. The details of preliminary results of this works are as below:

Cruises

- Two cruises were conducted in Indian Ocean and East/Japans Sea

  We get a new radioactive tracer ^{234}Th data together with dissolved/particulate trace element in the water column of Indian Ocean during a 2 cruises (2018-2019). The trace element measurements are still ongoing. Here, we got a radioactive tracer ^{234}Th data by a onboard measurements of dissolved-/particulate ^{234}Th.

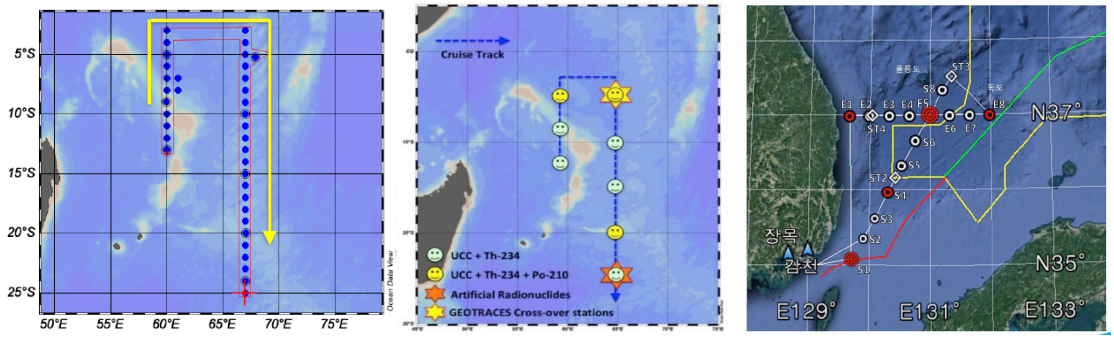


Figure 20. *The entire cruise track (with blue dots of sampling station) of R/V Isabu in Indian Ocean section cruise (Apr. 2018) (Left) and trace element clean sampling stations (Center) in this cruise. The entire sampling stations of East/Japan Sea (Mar. 2019) cruise (white dots) together with trace element clean sampling stations (red dots) (Right).*

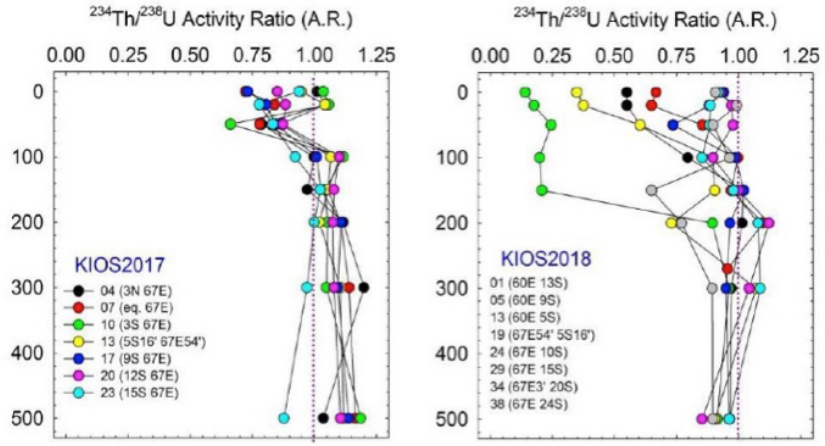


Figure 21. *The preliminary results of 234Th deficiency in the upper column of Indian Ocean in 2017 and 2018.*

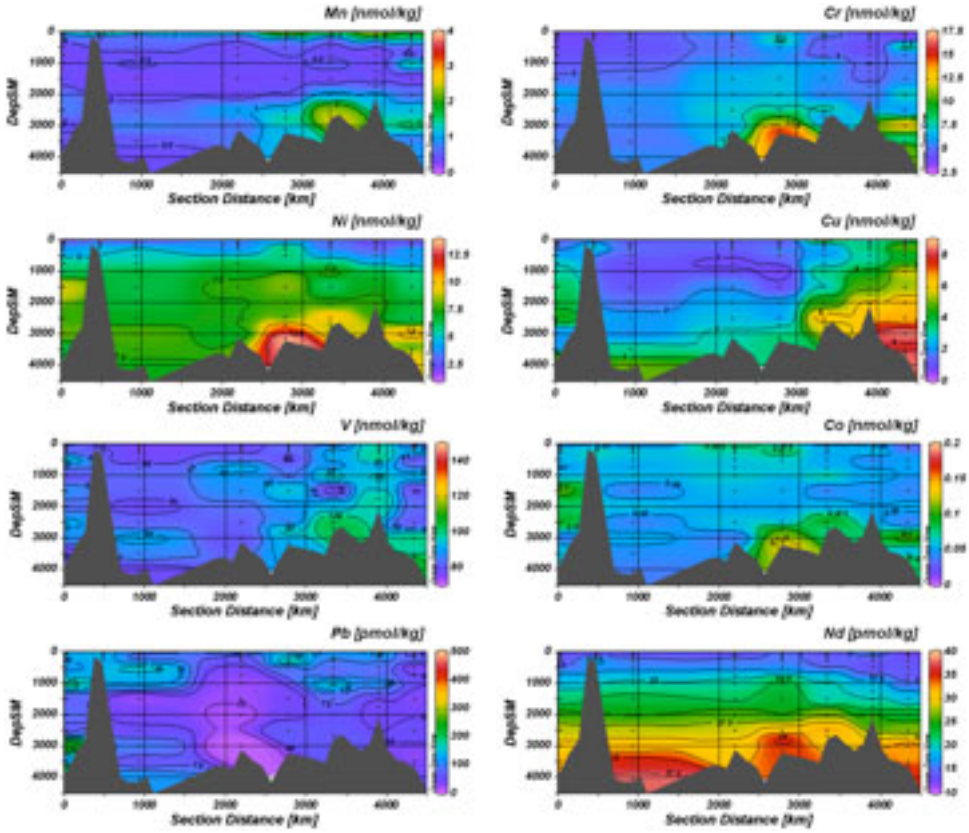


Figure 22. *The preliminary results of dissolved trace elements in the Indian Ocean in 2018.*

Other GEOTRACES activities

- The results of intercomparison works

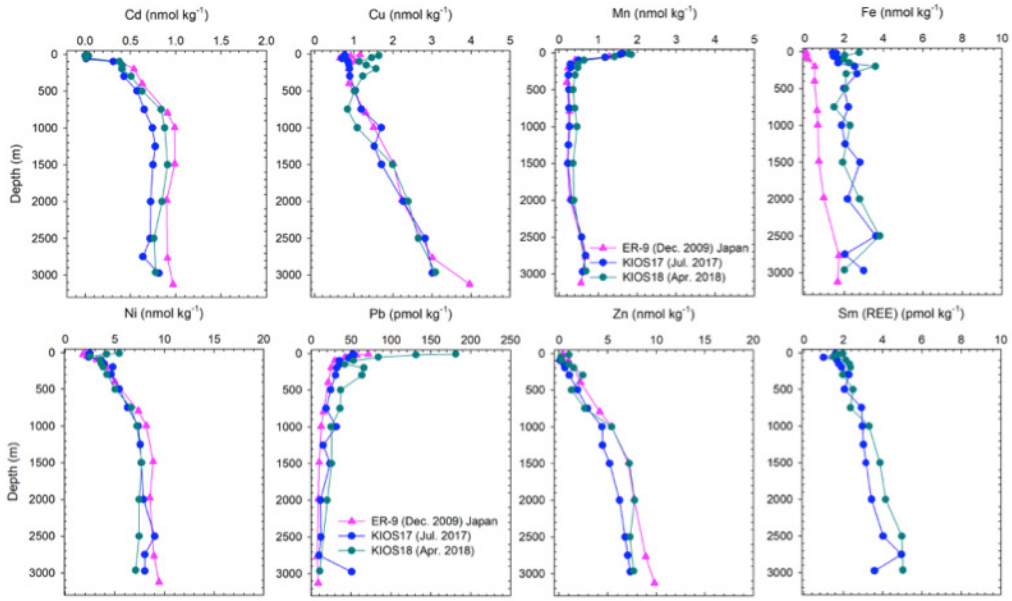


Figure 23*. Inter-comparison results in Indian Ocean cross over station (69.54° E 5.16° S). Pink dots denote the result of previous results from Japanese GEOTRACES cruise (2009 – 2010) and blue- and green dots denote the result from this study, 2017 and 2018 cruises of R/V Isabu, respectively.*

- we also tried to setup a new infrastructure (new clean laboratory and seaFAST ICP-MS for only seawater measurements) in new campus of KIOST @ Busan

***Figure 24**. New clean room facility and newly equipped seaFAST ICP-MS in KIOST*

GEOTRACES presentations in international conferences

- Kim, I., Lee, H. M., Kim, C., Kim, S. H., & Rho, T. K. (2018, December). Latitudinal distributions of 234Th in the upper western Indian Ocean. In AGU 2018 Fall Meeting.

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

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN SPAIN

April 1st, 2018 to March 31st, 2019

Geotraces related articles

- Álvarez-Vázquez, M.A., González-Prieto, S.J., Prego, R., 2018. Possible impact of environmental policies in the recovery of a Ramsar wetland from trace metal contamination Science of the Total Environment, 637-638: 803-812.
- Andreo B, Barberá JA, Mudarra M, Marín AI, Garcia-Orellana J, Rodellas V, Pérez Ramos I (2018) A multi-method approach for groundwater resource assessment in coastal carbonate (karst) aquifers: the case study of Sierra Almijara (southern Spain). Hydrology Journal 26 (1), 41 – 56.
- Castrillejo, M., Casacuberta, N., Christl, M., Vockenhuber, C., Synal, H.-A., García-Ibáñez, M.I., Lherminier, P., Sarthou, G., Garcia-Orellana, J., Masqué, P., 2018. Tracing water masses with 129l/236U in the subpolar North Atlantic along the GEOTRACES GA01 section. Biogeosciences Discuss. https://doi.org/10.5194/bg-2018-228.
- Ceballos-Romero, E., De Soto, F., Le Moigne, F. A. C., García-Tenorio, R., & Villa-Alfageme, M. (2018). 234Th-Derived Particle Fluxes and Seasonal Variability: When Is the SS Assumption Reliable? Insights From a Novel Approach for Carbon Flux Simulation. Geophysical Research Letters, 45(24). https://doi.org/10.1029/2018GL079968
- Cho, H.-M., Kim, G., Kwon, E.Y., Moosdorf, N., Garcia-Orellana, J., Santos, I.R., 2018. Radium tracing nutrient inputs through submarine groundwater discharge in the global ocean. Sci. Rep. https://doi.org/10.1038/s41598-018-20806-2.
- De Soto, F., Ceballos-Romero, E., & Villa-Alfageme, M. (2018). A microscopic simulation of particle flux in ocean waters: Application to radioactive pair disequilibrium. Geochimica et Cosmochimica Acta, 239. https://doi.org/10.1016/j.gca.2018.07.031.
- Gdaniec, S., Roy-Barman, M., Foliot, L., Thil, F., Dapoigny, A., Burckel, P., Garcia-Orellana, J., Masqué, P., Mörth, C.-M., Andersson, P.S., 2018. Thorium and protactinium isotopes as tracers of marine particle fluxes and deep water circulation in the Mediterranean Sea. Mar. Chem. https://doi.org/10.1016/j.marchem.2017.12.002.
- González, A.G., Cadena-Aizaga, M.S., Sarthou, G., González-Dávila, M., Santana-Casiano, J.M., 2018. Iron complexation by phenolic ligands in seawater. Chemical Geology. https://doi.org/10.1016/j.chemgeo.2018.10.017
- González-Ortegón E., Laiz I., Sánchez-Quiles D., Cobelo A., Tovar-Sánchez A.
- Trace metal characterization and fluxes from the Guadiana, Tinto-Odiel and Guadalquivir estuaries to the Gulf of Cadiz. Science of the Total Environment, 650, 2454–2466, 2019
- Herce-Sesa, B.; López-López, J.A.; Moreno C. Ionic liquid solvent bar micro-extraction of CdCln(n 2)- species for ultratrace Cd determination in seawater. Chemosphere (2018) 193, 306-312
- Herce-Sesa, B.; López-López, J.A.; Moreno C. Selective ionic liquid solvent bar micro-extraction for estimation of ultra-trace silver fractions in marine waters. Science of the Total Environment. (2019) 650, 27-33
- Herce-Sesa, B.; López-López, J.A.; Moreno C. Multi-elemental ionic liquid-based solvent bar micro-extraction of priority and emerging trace metallic pollutants (Cd, Ag, Pd) in

natural waters. Journal of Hazardous Materials. (2018) In press. 10.1016/j.jhazmat.2018.02.024
- Laglera L.M., Tovar-Sánchez A., Sukekava C.F., Naik H., Naqvi S.W.A., Wolf-Gladrow D.A. 2019. Iron organic speciation during the LOHAFEX experiment: iron ligands release under biomass control by copepod grazing. Journal of Marine Systems, doi: https://doi.org/10.1016/j.jmarsys.2019.02.002
- López-López, J.A.; Borrego-Corchado, C.; Mánuel-Vez, M.; Espada-Bellido, E. A simple and economical spectrofluorimetric alternative for Al routine analysis in seafood. Talanta (2018) 182, 210-217
- López-López, J.A.; Pirkwieser, P.; Leyma, R.; Kandioller, W.; Krachler, R.; Keppler, B.; Jirsa, F.; Moreno, C. Solvent bar micro-extraction for greener application of task specific ionic liquids in multi-elemental extraction. Journal of Cleaner Production (2018) 201, 22-27
- López-López, J.A.; Mendiguchía C., Pinto J.J., Moreno C. Application of solvent-bar micro-extraction for the determination of organic and inorganic compounds. Trends in Analytical Chemistry, (2019) 110, 57-65
- López-Lora, M., Chamizo, E., Villa-Alfageme, M., Hurtado-Bermúdez, S., Casacuberta, N., & García-León, M. (2018). Isolation of 236U and 239,240Pu from seawater samples and its determination by Accelerator Mass Spectrometry. Talanta, 178. https://doi.org/10.1016/j.talanta.2017.09.026
- López-Sánchez D., Cobelo-García A., Rijkenbergb M.J.A., Gerringab L.J.A., de Baar H. J.W. New insights on the dissolved platinum behavior in the Atlantic Ocean. Chemical Geology, in press.
- Maxime M Grand, Agathe Laes-Huon, Susanne Fietz, Joseph A Resing, Hajime Obata, George W. Luther, Alessandro Tagliabue, Eric 'Pieter Achterberg, Rob Middag, Antonio Tovar-Sanchez. 2019. Developing autonomous observing systems for micronutrient trace metals. Frontiers in Marine Science. doi: 10.3389/fmars.2019.00035.
- Montiel D, Dimova N, Andreo B, Prieto J, Garcia-Orellana J, Rodellas V (2018). Assessing submarine groundwater discharge (SGD) and nitrate fluxes in highly heterogeneous coastal karst aquifers: challenges and solutions. Journal of Hydrology 557, 222 – 242.
- Pirkwieser, P.; López-López, J.A.; Kandioller, W.; Keppler, B.; Moreno, C.; Jirsa, F.Novel 3-hydroxy-2-naphthoate-based task-specific ionic liquids for an efficient extraction of heavy metals. Frontiers in Chemistry (2018) 6, 172, 1-11
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- Periáñez, R., Suh, K.-S., Min, B.-I., & Villa-Alfageme, M. (2018). The behaviour of 236U in the North Atlantic Ocean assessed from numerical modelling: A new evaluation of the input function into the Arctic. Science of the Total Environment, 626. https://doi.org/10.1016/j.scitotenv.2018.01.058
- Pinedo-Gonzalez, P., West A.J., Tovar-Sanchez A., Duarte C.M., Sañudo-Wilhelmy, S.A. Concentration and isotopic composition of dissolved Pb in surface waters of the modern global ocean. Geochimica et Cosmochicmica Acta, Geochimica et Cosmochimica Acta 235, 41–54, 2018. https://doi.org/10.1016/j.gca.2018.05.005

- Rivera-Silva, J., Hurtado-Bermúdez, S., Villa-Alfageme, M., & Manjón, G. (2019). Comparison and validation of methods for the determination of 90Sr by Cerenkov counting in biological and sediment samples, including green chemistry metrics. Journal of Radioanalytical and Nuclear Chemistry. https://doi.org/10.1007/s10967-019-06436-6.
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- Samperio-Ramos, G., Santana-Casiano, J.M., González-Dávila, M., 2018. Effect of Organic Fe-Ligands, Released by Emiliania huxleyi, on Fe(II) Oxidation Rate in Seawater Under Simulated Ocean Acidification Conditions: A Modeling Approach. Front. Mar. Sci. 5, 210. https://doi.org/10.3389/fmars.2018.00210
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Books and Chapters

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Meetings

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- David Sánchez-Quiles, Francisco Delgadillo-Hinojosa, María L. Lares, Antonio Tovar-Sánchez, Miguel A. Huerta-Diaz, Eunise V. Torres-Delgado, Erica Gutiérrez-Mejía, Sergio Sañudo-Wilhelmy. The remote origin of dissolved lead in the water column of the Gulf of Mexico. XIX Iberian Marine Chemistry Seminary-SIQUIMAR, Vigo: 20-22 Junio, 2018, Spain (Poster communication).
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- Kenna, T., et al. Distributions, inventories, and isotopic compositions of anthropogenic radionuclides measured on GEOTRACES cruises in the Atlantic and Pacific Ocean basins. Ocean Science Meeting. 2018. Portland, USA.
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- Chairwoman and Session organiser. Topic area: Biogeochemistry and Nutrients. A Multidisciplinary Approach to the Biological Carbon Pump: Understanding its Efficiency and Predicting its Future. Ocean Science Meeting 2018.
- López-López, J.A., Mendiguchía, C.; Asensio, E.; Pinto, J.J.; Moreno, C.; Soula, M.; Ferreiro, M.; Regueiro, L.; Agraso, M.M.; Vélez, J.. Sustainability indicators for pond and raft aquaculture. VI International Symposium on Marine Sciences. Vigo (España), 20-22 de junio de 2018. Oral communication.
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- Herce-Sesa, B.; López-López, J.A.; Moreno C. Estimation of ultra-trace silver fractions in marine waters by selective ionic liquid solvent bar micro-extraction. Sample Treatment 2018. Caparica (Portugal), 3-6 de diciembre de 2018. Oral communication.

GEOTRACES related projects

- Effects of ocean acidification, temperature and organic matter on Fe(II) persistence in the Atlantic Ocean. Ministerio de Economía y Competitividad. CTM2017-83476-P (2018-2020)IP: J. Magdalena Santana Casiano, Melchor González Dávila.
- IAEA (United Nations). Anthropogenic 236U, 129I and natural 210Po, 234Th radionuclides as tracers of Oceanography studies in the coordinated Research Project: Behaviour and Effects of Natural and Anthropogenic Radionuclides in the Marine Environment and their use as Tracers for Oceanography Studies. From: 01/06/2017 to: 31/05/2021.
- New capillary based systems for the quantification of trace metals: Joining efficiency, applicability and sustainability (CTM2013-47549-P). Ministry of Economy and Competitiveness. IP: Carlos Moreno Aguilar. Period: 01/01/2014-31/12/2018
- Development of environmental tools for the establishment of protocols to define the loading capacity for sustainable aquaculture (MIMECCA). Fundación Biodiversidad, Ministry for the Ecological Transition. IP: María del Mar Agraso; Period: 01/12/2017-30/11/2018
- Evaluation of environemntal implications of aquaculture on protected áreas: Minimization of aquacutulte effects towars environemntal sustainability (ACUINTEG). Fundación Biodiversidad, Ministry for the Ecological Transition; IP: José Antonio López López. Period: 01/12/2017-31/12/2018.

PhD Thesis

- Oxidation of Fe(II) in North Atlantic Ocean in the presence of organic compounds. 2018. Carolina Santana González. QUIMA-IOCAG, Universidad de Las Palmas de Gran Canaria
- Platinum and other Technology-Critical Elements: Bioaccumulation and Behaviour in Coastal Systems Patricia Neira del Río. 29th March 2019. Director: Juan Santos Echeandía, Co-director: Antonio Cobelo-García. Spanish Institute of Oceanography (IEO) and Marine Research Institute (IIM-CSIC).
- PhD student: Elena Ceballos-Romero (2014-2018). Applied Physics Department, University of Sevilla, Spain. Study of the key processes in the export and storage of carbon in the oceans through radioactive pairs: 234Th-238U and 210Po-210Pb. Co-supervisors: F. de Soto (U Pablo de Olavide), F. Le Moigne (CNRS - Mediterranean Institute of Oceanography).

Teaching

- Master´s Degree in Oceanography. Chemical Reactivity of the Ocean
  Professor: Dr. Antonio Tovar-Sánchez
  Facultad de Ciencias del Mar, University of Cádiz and University of Las Palmas de Gran Canaria (Spain). Academic years: 2018-19

Cruises

- COMICS UK project, funded by NERC (IP Richard Sanders). COMICS 2 cruise (IP: Stephanie Henson) sampled Benguela site, Indian Ocean on board RRS Discovery. April 2018. M Villa is in the scientific team. Depth water and particle profiles were collected at 8 stations for 210Po and 210Pb evaluation.

Other activities

- Geotraces summer school will take place from September 23rd to 28th, 2019 in Cádiz, on board the School Ship Intermares A- 41, in collaboration with the Ministry of Defense and the General Secretary of Fisheries of the Ministry of Agriculture, Fisheries and Food of the Government of Spain.
- A Proposal for a Geotraces Spanish National Net – Geotrac-ES has been submitted to the Ministry of Science, Innovation and Universities to coordinate the GEOTRACES activities in Spain.

Contributors to the report

Magdalena Santana-Casiano; Jordi García-Orellana; Juan Santos-Echeandía; Antonio Cobelo-García; Ricardo Prego; María Villa-Alfageme; Jose Antonio López-López; Antonio Tovar-Sánchez.

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

New scientific results

- Trace element fractionation in core sediment

  During GEOTRACES MedBlack Sea cruise, our work was focused on physicochemical parameters measurements, water sampling and short core sediment sampling. Trace elements necessitate trace metal clean CTD system sampling. Analysis are assessing nutrient, trace element (Fe, Pb, Cd, Zn, Co, Mo, Cu and Ni) and trace element fractionation, carried out on sediment in eastern and western surface sediment. The X-ray diffraction is applied on the clay fraction. Results salinity section plot shows some clearly recognizable water masses. Clay minerals assemblages have distinctive sources and their dispersal reflects different agents of transport in the eastern Mediterranean Sea. Nutrients show more oligotrophic condition in eastern area. The most important sources of dissolved silicate in the Mediterranean Sea come from the continental fluvial system and from groundwater discharges. Electronic microscopy shows dominance of diatoms, which play an important role in organic matter export to the deep sea. Trace element fractionation differentiates five fractions the forth first fractions constitute bioavailable fraction that is compared to deep water (near sediment water interface). This comparison shows at first the impotence of surface sediment as potential pump of trace element to the water column and the deep influence of continental discharges on surface sediment trace element accumulation and the deep water mainly for Fe, Cu and Co.

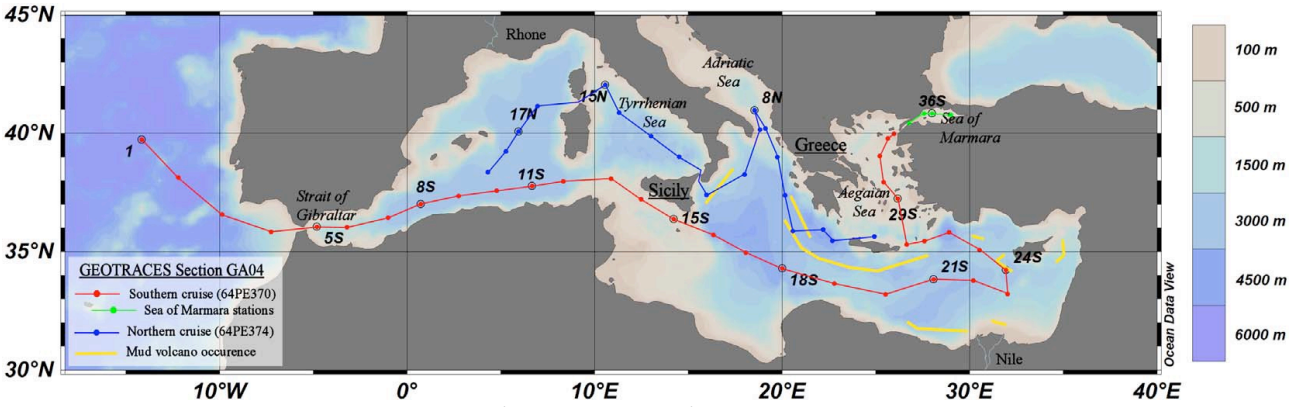


Figure 25. *Sampling sites in Mediterranean Sea.*

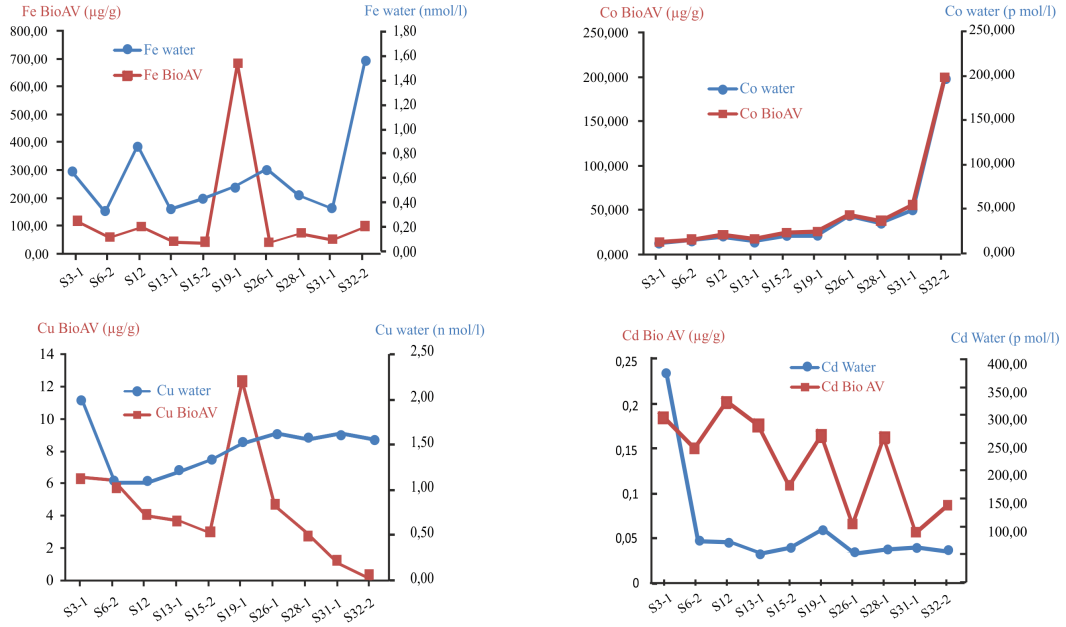


Figure 26. *Trace element in deep water and surface sediment bioavailable fraction in Mediterranean sea.*

Cruises

- Participation on Med and Black Sea cruise 64PE370.

GEOTRACES presentations in international conferences

- Smart & Intelligent Monitoring, Maintainance & Sustainable Repurposing System For Sealines Sealines Start-Up Action Proposal on Bluemed Project Initiative 28th of March, 2019 First workshop meeting Rosetti Marino Company Group Via Trieste 230, Ravenna Italy.

  Nutrients, trace element in Western and Eastern Mediterranean sea surface sediment: environmental variability and anthropogenic footprint Zaaboub et al. Marine Enviroment Laboratory, National Marine Sciences and Technologies, Tunisia.

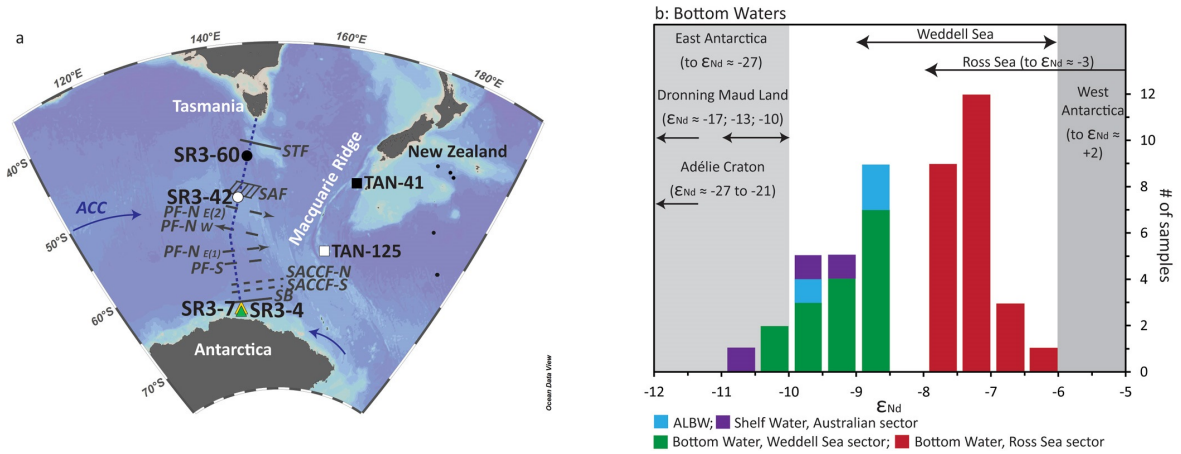
Submitted by Zaaboub Noureddine (nouri_zaaboub@yahoo.fr).

New scientific results

- Local Geologies Imprint the Antarctic Bottom Water Neodymium Isotopic Signatures

  Lambelet and co-authors (2018, see reference below) present the first dissolved neodymium (Nd) isotope and concentration measurements for Adélie Land Bottom Water (ALBW), a variety of Antarctic Bottom Water formed off the Adélie Land coast of East Antarctica. Summertime ALBW is distinct from Ross Sea Bottom Water and similar to Weddell Sea Bottom Water. This underlines that Antarctic Bottom waters are not uniform around the continent and carry Nd isotope fingerprints characteristic of their formation area (local geology). This makes these water masses traceable back in time and is hence important for paleoceanography and for the study of past climate change.

  Lambelet et al. (2018), Geophysical Research Letters.



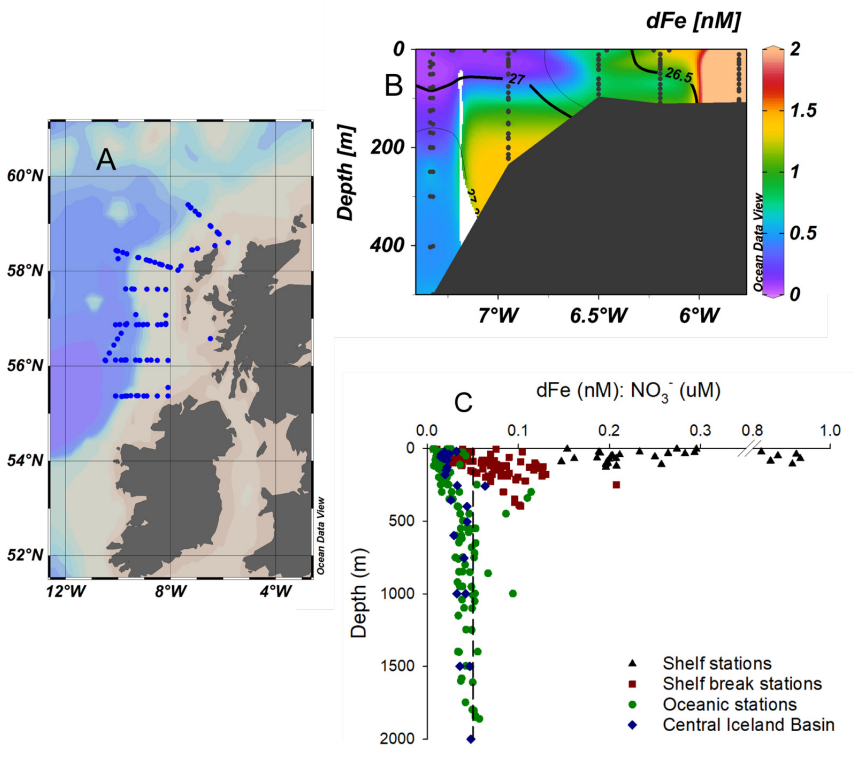
Figures 27. *a) Map of the sampling area, with the major fronts crossing the section at the time of the survey depicted in dark grey. b) Histogram representing ε_{Nd} for bottom waters in the different sector of the Southern Ocean, underlining that Antarctic Bottom waters are not uniform around the continent and carry Nd isotope fingerprints characteristic of their formation area.*

http://www.geotraces.org/science/science-highlight/1627-local-geologies-imprint

- The Scottish Shelf Break is not a Significant Source of Iron to North Atlantic Surface Waters

  A high-resolution survey of the distribution of dissolved iron (dFe) over the Hebridean (Scottish) shelf break was conducted as part of the U.K. Shelf Sea Biogeochemistry programme, a GEOTRACES process study (GApr04). Despite the close proximity to shelf sediments, which are known to supply large quantities of dFe to overlying water column, the results revealed surprisingly low concentrations of dFe (<0.1 nM) in surface waters overlying the shelf break. Birchill and colleagues (2019, see reference below) relate this to the prevailing physical circulation of the region, which limits off shelf transport in surface waters, and conclude that this shelf system is not a significant source dFe to high latitude North Atlantic surface waters. It is therefore suggested that the conditions leading to

seasonal iron limitation of phytoplankton in the Iceland and Irminger basins extend much further eastwards than previously identified.



Birchill et al. (2019), Scientific Reports.

Figure 28. *(A) Map of the survey region with sampling locations. (B) Example of cross shelf transect of dFe distribution, detailing the contrast between shelf waters with high dFe concentrations (>2 nM) and surface oceanic waters with remarkably low dFe concentrations (<0.1 nM). (C) Depth profile of dFe: NO_3^-, oceanic stations close to Hebridean shelf have similar values to those previously reported for the seasonally iron limited Icelandic Basin. Dashed line denotes 0.05 dFe:NO_3^- (nM:µM), the lower limit observed in Fe replete cultured phytoplankton.*

http://www.geotraces.org/science/science-highlight/1627-local-geologies-imprint

- Reconciling linkages between Zn and Si in the global ocean.

  Weber et al. (2018), Science.

- Comparison of ^{231}Pa and ^{230}Th in freshly ventilated waters with CFC ages enables testing of the ^{231}Pa/^{230}Th proxy, and a full budget for these nuclides in the North Atlantic.

  Deng et al. (2018), Biogeosciences.

- The role of melting ice in driving the slowdown of circulation in the western Atlantic Ocean revealed by protactinium-thorium ratio.

  Ng et al. (2018), Nature Communications.
  http://www.geotraces.org/science/science-highlight/1586-amoc-protactinium-thorium-ratio

- Isotopic chromium variations do not always reflect the occurrence of low oxygenated waters.

  Goring-Harford et al. (2018), Geochimica et Cosmochimica Acta.
  http://www.geotraces.org/science/science-highlight/1672-isotopic-chromium-variations

New projects and/or funding

- Al Tagliabue (University of Liverpool, UK), Kristen Buck (USF, US) and Peter Sedwick (Old Dominion University, US) won funding for a joined NSF-NERC project: 'NSFGEO-NERC: *Using Time-series Field Observations to Constrain an Ocean Iron Model.'*

GEOTRACES workshops and meetings organised

- Susan Little (Imperial College London) and Gideon Henderson (University of Oxford) were part of the workshop planning committee for the GEOTRACES-PAGES Synthesis workshop: Trace Element and Isotope Proxies in Paleoceanography, 2-5 December 2018, Aix-en-Provence, France.
- Alessandro Tagliabue (University of Liverpool) was one of four conveners of 'Biogeoscapes' scoping meeting in Woods Hole, November 2018.
- Alessandro Tagliabue (University of Liverpool; co-chair DMC) hosted the 2018 Data Management Committee meeting in Liverpool.

Outreach activities conducted

- Kate Hendry (University of Bristol) and Allyson Tessin (University of Leeds) wrote an article for 'The Conversation' on *Why we're looking for chemicals in the seabed to help predict climate change* (28 January 2019). https://theconversation.com/why-were-looking-for-chemicals-in-the-seabed-to-help-predict-climate-change-110452?fbclid=IwAR39A3QMkpFJ9LgdkOtjKxqunGKlsAALpb4k0BeP4uaasZSeJN1CuqXbCzQ
- Susan Little (Imperial College London) wrote a blog about the GEOTRACES/PAGES synthesis workshop in Aix-Marseille, France (January, 2019). *The Present is the Key to the Past*. https://geochemistry.group/2019/01/07/113/
- The MAGIC group at Imperial College London (including Mark Rehkämper, Tina van de Flierdt and Susan Little) organised a stand for the annual Imperial College festival where 100s of under 12-years were turned into mini scientists and learned about elements and isotopes. http://www.imperial.ac.uk/news/185986/imperial-festival-transforms-under-12s-into-mini/
- Will Homoky (University of Oxford) designed and delivered a talk and a learning activity entitled *Ocean Connections* to two classes of Key Stage 2 (Year 4) pupils (60 pupils in total) for a local primary school initiative to consider the ocean in many aspects of their curricula. GEOTRACES data and fieldwork experiences were presented, and the roles of trace elements and ecology in the ocean were introduced.

Other GEOTRACES activities

- Maeve Lohan (NOCS, co-chair) and Tina van de Flierdt (Imperial College London, committee member) attended Standards & Intercalibration (S&I) meeting in Marseilles, France, 6-7 December 2018.
- Maeve Lohan (NOCS, S&I, co-chair) Alessandro Tagliabue (University of Liverpool, DMC, co-chair) attended DMC meeting in Liverpool, UK, summer 2018.
- Maeve Lohan (NOCS, S&I, co-chair) Alessandro Tagliabue (University of Liverpool, DMC, co-chair) attended Toulouse meeting planning a data portal (26-27 September 2018).

- Maeve Lohan (NOCS), Tina van de Flierdt (Imperial College London) and Gideon Henderson (University of Oxford) attended SSC meeting in Tapei Taiwan, 23-25 July, 2018

New GEOTRACES publications (published or in press)

- Achterberg, E.P., Steigenberger, S., Marsay, C.M., LeMoigne, F.A.C., Painter, S.C., Baker, A.R., Connelly, D.P., Moore, C.M., Tagliabue, A., Tanhua, T. (2018), Iron biogeochemistry in the high latitude North Atlantic Ocean, Scientific Reports, 8, 1283, doi:10.1038/s41598-018-19472-1.
- Birchill, A. J., Hartner, N. T., Kunde, K., Siemering, B., Daniels, C., González-Santana, D., Milne, A. Ussher, S. J., Worsfold, P. J., Leopold, K., Painter, S. C., Lohan, M. C. (2019), The eastern extent of seasonal iron limitation in the high latitude North Atlantic Ocean, Scientific Reports, 9(1), 1435, doi:10.1038/s41598-018-37436-3.
- Bowie A. R. and Tagliabue, A. (2018), Geotraces Data Products: Standardising and Linking Ocean Trace Element and Isotope Data at a Global Scale, Elements, 14(6), 436-437, doi:10.2138/gselements.14.6.436.
- Bridgestock, L., Hsieh, Y-T., Porcelli, D., Homoky, W.B., Bryan, A., Henderson, G.M. (2018), Controls on the barium isotope compositions of marine sediments, Earth and Planetary Science Letters, 481, 101-110, doi.10.1016/j.epsl.2017.10.019.
- Caputi, L., et al. (incl. Tagliabue, A.) (2019), Community□Level Responses to Iron Availability in Open Ocean Plankton Ecosystems, Global Biogeochemical Cycles, 33, doi:10.1029/2018gb006022.
- Chase, Z., Elwood, M.J., van de Flierdt, T. (2018), Discovering the ocean's past through geochemistry, Elements, 14 (6), 397-402, doi:10.2138/gselements.14.6.397.
- Davis, C., Lohan, M.C., Tuerena, R., Cerdan-Carcia, E., Woodward, E.M.S., Tagliabue, A., Mahaffey, C. (2019), Diurnal variability in alkaline phosphatase activey and the potential role of zooplankton, Limnology and Oceanography Letters, doi. 10.1002/lo2.10104.
- Deng, F., Henderson, G.M., Castrillejo, M., Perez, F.F., Steinfeldt, R. (2018), Evolution of 231Pa and 230Th in Overflow Waters of the North Atlantic, Biogeosciences 15, 7299-7313, doi:10.5194/bg-15-7299-2018.
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Completed GEOTRACES PhD or Master theses

- PhD - Allison Bryan (2019). 'Cadmium isotope signatures in modern sediments and waters as a potential tracer for paleoproductivity'. University of Oxford. Thesis advisors: Gideon Henderson and Don Porcelli (University of Oxford).
- MSc – Mingpei Li (2018). 'Distribution and solubility of total trace metals concentration over the Atlantic Ocean.' Thesis advisor: Alex Baker (UEA).
- MSci – Lena Chen (2019). 'Cadmium Isotopes in Continental Margin Sediments'. Thesis advisor: Susan Little (Imperial College London).

GEOTRACES presentations in international conferences

RaRn workshop, Delmenhorst, Germany, 7-9 June 2018

- Selzer, S., Annett, A.L., and Homoky, W.B., 'RaDeCC Reader: A programme to automate corrections and error propagations from RaDeCC data files.'

Goldschmidt conference, Boston, USA, 12-17 August 2018

- Gideon Henderson and Laura Robinson co-chaired session 07l: 'Carbon storage in the ocean now and over time'.

- Will Homoky co-convened / co-chaired GEOTRACES session 07i: 'New Insights in marine Trace Element Biogeochemistry'.
- C. Archer, D. Vance, M. Lohan, 'Ni isotope fractionation associated with phytoplankton uptake in the South Atlantic Ocean - is it significant?'
- A. Bryan, A. Dickson, J. Sorensen, D. Porcelli, S. van de Boorn, G. Henderson, 'Redox cycling control on the cadmium-isotope composition of waters, porewaters, and sediments in the Saanich Inlet.'
- D. Gonzalez-Santana, L. Artigue, A.J.M. Lough, A. Tagliabue, H. Planquette, G. Sarthou, M.C. Lohan, 'DFe(II) variability across hydrothermal vents in the Mid Atlantic ridge.'
- J. Hatton, K. Hendry, J. Hawkings, J. Wadham, T. Kohler, M. Stibal, 'An interrogation into subglacial processes to investigate the variation of silicon isotope composition of glacial meltwaters.'
- Y-T Hsieh, L. Bridgestock, W.B. Homoky, G.M. Henderson, 'Barium isotopes in South Atlantic sediment pore waters.'
- S. Little, A. Chatterjee, E. Ciscato, J. McManus, D. Vance, 'Invited: Metal isotope signatures in Mn-rich Pelagic Sediments: Implications for Oceanic Budgets.'
- C. Peacock, J. Rodley, S. Dixon, S. Poulton, I. Parkinson, R. James, Invited: Understanding trace metal sorption by marine minerals to validate and calibrate geochemical palaeoproxies.'
- H. Pryer, J. Wadham, K. Hendry, L. Robinson, J. Hawkings, J. Ward, J. Hatton, 'Silicion isotopes in Patagonian Rivers: Investigating how variable glacial cover affects the biogeochemical cycling of silicion.'
- C. Schlosser, G. Henderson, A. Tagliabue, J.K. Klar, E.M.S. Woodward, E.P. Achterberg, 'Iron fuels vast phytoplankton bloom along 40° South in the Atlantic Ocean.'
- B. Summers, W. Homoky, R. Mills, S. John, T. Conway, 'Investigating the isotopic signature and release of iron sourced form sediments to the UK South Atlantic GEOTRACES GA10 section.'

Challenger Conference, Newcastle, UK, 10-13 September 2018

- A. Annett, R. Sherrell, K. Hendry, 'Glacial iron supply to southwest Greenland: Distribution and longevity of bioactive trace metals.'
- E. Cerdan, T. Bibby, M. Moore, J. Robidart, M.C. Lohan, C. Mahaffey, 'Controls on diazotroph populations across the oligotrophic North Atlantic.'
- K. Hendry, H.C. Ng, R. Pickering, M. Woodward, M. Leng, J. Opher, A. Brearley, 'Glaciers, icebergs and silicon: Preliminary findings from the ICYLAB.'
- W.B. Homoky, T.M. Conway, S.G. John, E.M.S. Woodward, A. Tagliabue, R.A. Mills, 'Oxic ocean margins: lithogenous factories of colloidal iron isotopes for seawater budgets.'
- A. Lough, M. Lohan, A. Tagliabue, 'Iron supply from the Mid Atlantic Ridge to the North Atlantic Ocean: GEOTRACES GA13.'
- L. Ratnarajah, A. Tagliabue, 'Modelling the effects of nutrient limitation on phytoplankton bacterial interactions.'
- K. Schmidt, S. Ussher, A. Milne, A. Birchill, M. Woodward, G. Tarran, C. Widdicombe, L. Polimene, J. Clarke, M. Lohan, M. Whitehouse, R. Korb, T. Klevjer, A. Atkinson, 'Departing from Redfield: Case scenarios in the Southern Ocean and North Atlantic.'

- S. Selzer, A.L., Annett, W.B. Homoky, 'Radium isotope inputs and dispersion from hydrothermal vent sites of the Mid-Atlantic Ridge.'
- A. Tagliabue, A. Bowie, M. Ellwood, W. Landing, A. Milne, D. Ohnemus, B. Twining, P. Boyd, 'What governs the internal cycling of dissolved iron?'
- W. Wang, A. Lough, M.C. Lohan, D. Connelly, R.H. James, 'Behavior of iron isotopes in hydrothermal systems.'

GEOTRACES/PAGES workshop, Aix-en-Provence, December 2018

- 11 participants from the UK
- L.F. Robinson co-chaired break out session
- G. Henderson and F. Deng, 'Does the 231Pa/230Th ratio record information about rates of ocean circulation?'
- K. Hendry, 'Probing the silicon cycle with novel isotope systems.'

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

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN UNITED STATES

April 1st, 2018 to March 31th, 2019

U.S. GEOTRACES Meetings

The US GEOTRACES Scientific Steering Committee (SSC) met on 20-21 June 2018 at the US National Science Foundation (NSF), thereby facilitating interaction with NSF program officers who oversee support of US GEOTRACES activities. Cruise leaders from GA03, GP16, GN01 as well as GP15 attended the SSC meeting. The SSC reviewed the publication of results from completed cruises and discussed the preparations for GP15. Bob Anderson gave a presentation outlining the principal research objectives of GP17. Bill Landing, co-chair of the GEOTRACES Data Management Committee, led a discussion of GEOTRACES data management activities, and presented preliminary plans for a new GEOTRACES data portal to facilitate all aspects of submitting, compiling and distributing GEOTRACES data.

Cruise-related Activities

North Pacific Meridional Section Under the leadership of Greg Cutter (Chief Scientist, Old Dominion University) as well as co-Chief Scientists Phoebe Lam (University of California Santa Cruz) and Karen Casciotti (Stanford University), US GEOTRACES completed the Pacific Meridional Section GP15 (Figure 29). Sailing aboard the R/V Roger Revelle, the expedition departed Seattle Washington on 18 September 2018 and arrived in Papeete Tahiti (with a port stop in Hilo, Hawaii) on 24 November 2018.

Principal research targets on the GP15 Section include:

1) Sources of trace elements and isotopes (TEIS) at an active volcanic arc margin (boundary exchange);
2) Boundary scavenging (TEI removal) in productive subarctic waters;
3) Far-field impact on TEI distributions of hydrothermal plumes emanating from the Juan de Fuca Ridge and from the East Pacific Rise;
4) Micronutrient distributions within subarctic HNLC waters where the efficiency of the biological pump is thought to be limited by Fe;
5) Nutrient – biota (biomass, particles, cell quotas) relationships within and between productive regions (coastal and equatorial), HNLC subarctic waters, and ultra-oligotrophic waters of the North and South Pacific Subtropical Gyres;
6) Micronutrient supply to the equatorial upwelling regimes via the Equatorial Undercurrent, and TEI transport by other subsurface counter- and under-currents;
7) TEI scavenging and removal under regions of high productivity and particle flux at the equator and at the boundary between the subarctic and subtropical gyres;
8) Differences in regeneration patterns (depths) of exported TEIs between productive vs. oligotrophic waters, including micronutrient/macronutrient ratios;
9) TEI distributions within source regions of intermediate waters;
10) TEI distributions in far-field regions of eastern Pacific Oxygen Minimum Zone waters; and
11) TEI distributions, and their ratios to macronutrients, within the oldest deep Pacific waters.

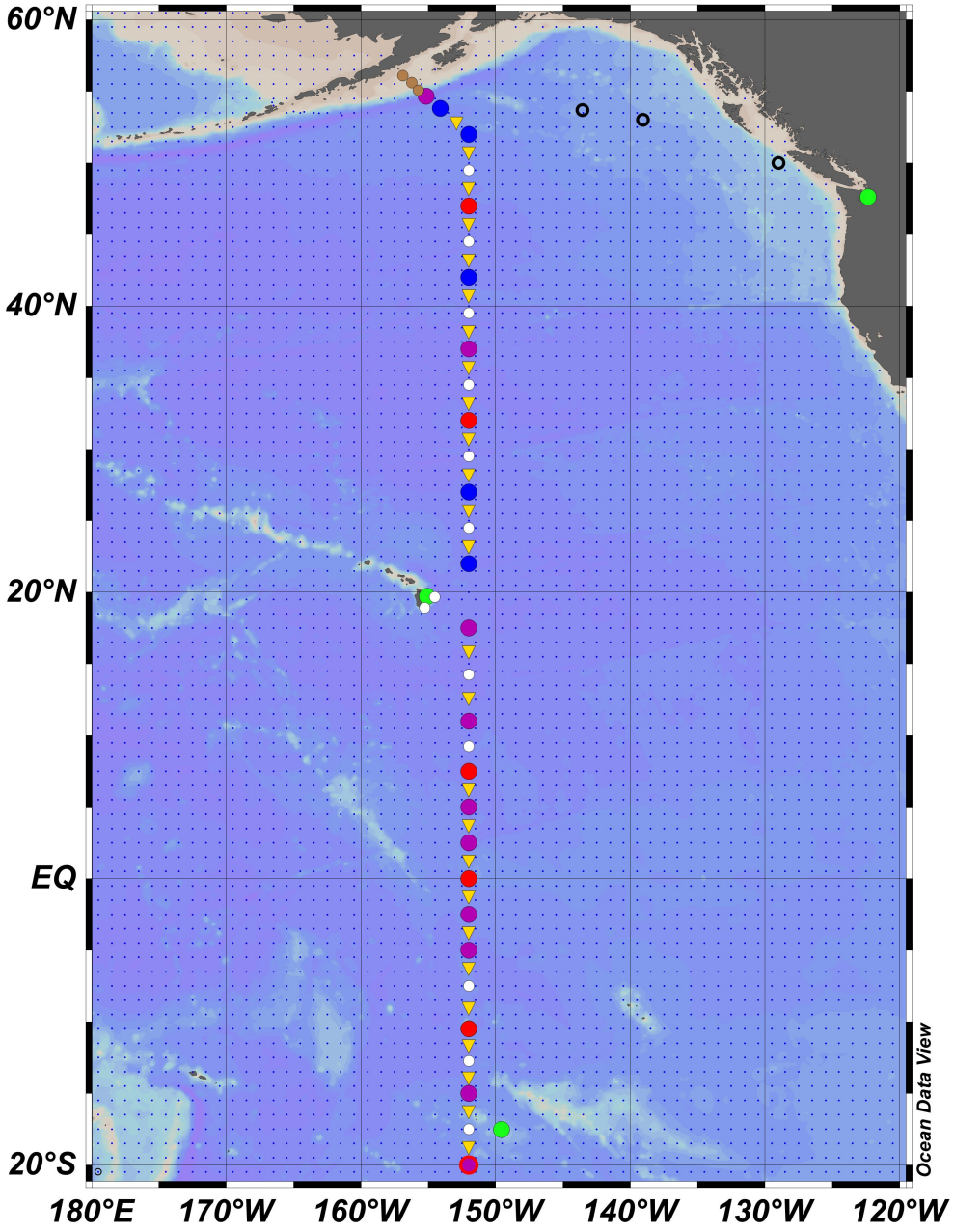

Figure 29. *GP15 Cruise Track: Green circles: ports; open Black circles: rinse stations; brown circles: shelf and slope stations; Purple circles: Full-36-depth stations; Blue circles: Full-24-depth stations; White circles: demi stations; Yellow triangles: intermediate fish samples.*

Although the cruise was only recently completed, already some preliminary results are available to share.

Bill Jenkins (WHOI) and colleagues discovered large helium isotope and trace metal anomalies in the water column above Loihi Seamount, located just to the east of Hawaii. Figure 30 shows the measured profiles for helium and three trace metals. Helium isotope ratio anomalies (shown in panel a) approaching 400% were observed in the core of a ~300 m wide plume, which appeared approximately 100 m above the seafloor. The size of this anomaly is striking, considering that the open-ocean deep Pacific mid-water plume anomalies are

typically of order 20-50%. Corresponding to this maximum was a nearly 22% peak in helium saturation anomalies (panel b). In contrast, over the depth range of the plume, the neon saturation anomaly (shown in panel c, where measurement uncertainties were the size of the dots) was 1.3 ± 0.2%, indistinguishable from intermediate depth measurements made in more distant profiles. This proves that the anomalous helium supersaturation does not come from atmospheric sources.

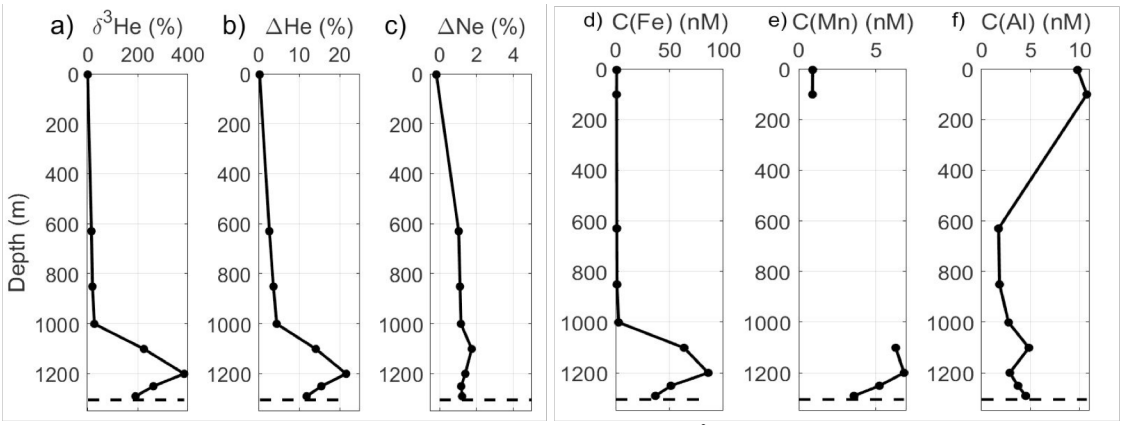

Figure 30. *Profiles of (a) helium isotope ratio anomaly δ^3He in %, (b) dissolved helium saturation anomaly in %, (c) dissolved neon saturation anomaly in %, (d) dissolved Fe in nM, (e) dissolved Mn in nM, and (f) dissolved Al in nM.*

The relationship between dissolved Fe and excess ^{3}He and between dissolved Mn and excess ^{3}He are represented in Figure 31. The slope of the Fe vs ^{3}He relationship, determined by type II linear correlation as shown by the line in Figure 31a, is 7.7 ± 0.7 x 10^6. This value that is similar to that obtained in the South Pacific (GP16), depending on whether estimated from the downstream decrease in these properties along the core of the transpacific horizontal plume (6.4 x 10^6) or the evolution of water column inventories (7.5 x 10^6). In contrast, observations in the North Atlantic TAG hydrothermal plume (GA03) show dFe concentrations of approximately 60 nmol/kg with a corresponding ^{3}He excess of approximately 0.6 fmol/kg, leading to an Fe:^{3}He ratio close to 1 x 10^8, which is about fifteen times higher than in the Pacific. Observations over the Mid-Atlantic Ridge at around 13°S (GEOTRACES, CoFeMUG, compliant data) yield a similarly high value of ~0.7 ± 0.3 x 10^8.

The Mn:^{3}He relationship (Figure 31b) appears somewhat less precisely constrained at 0.5 ± 0.1 x 10^6 when determined by type II linear regression. Moreover, the "scatter" of points for both Fe:^{3}H and Mn:^{3}He appear structurally similar, with the third highest ^{3}He anomaly falling above the trend line. This points to an interesting feature of both elemental distributions, as seen in the depth profiles of the Fe:^{3}He and Mn:^{3}He ratios in Figure 32. That is, the metal:^{3}He ratio is highest above the core of the plume, and systematically lower in and below the ^{3}He maximum. This observation points to the likelihood that dissolved metal concentrations within the plume are depressed by particulate scavenging.

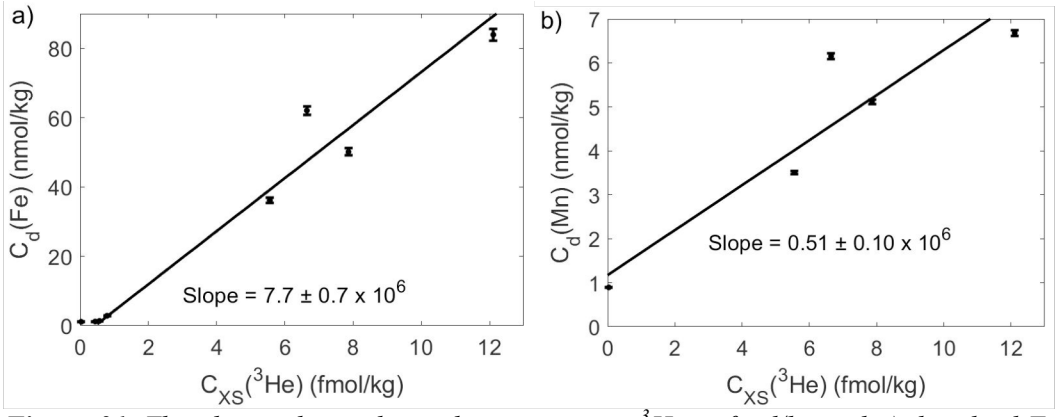

Figure 31. *The observed correlation between excess ^{3}He in fmol/kg and a) dissolved Fe and b) Mn, both in nmol/kg.*

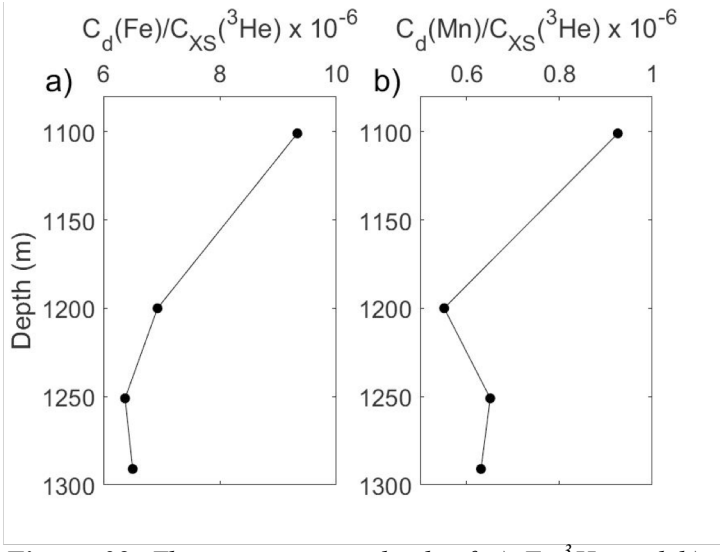

Figure 32. *The variation vs. depth of a) Fe:^{3}He and b) Mn:^{3}He both in units of 10^6.*

Dave Kadko (Florida International University) and coworkers found that the isotope ^{7}Be can be used to estimate the Bulk (wet+dry) deposition velocity (Vb) for trace elements (TEs) delivered by aerosols, where:

Vb = (Flux ^{7}Be)/(aerosol ^{7}Be concentration) = (Ocean inventory ^{7}Be x λ))/(aerosol ^{7}Be concentration)

and where λ =^{7}Be decay constant. The flux of TEs into the ocean = [aerosol TE] x Vb.

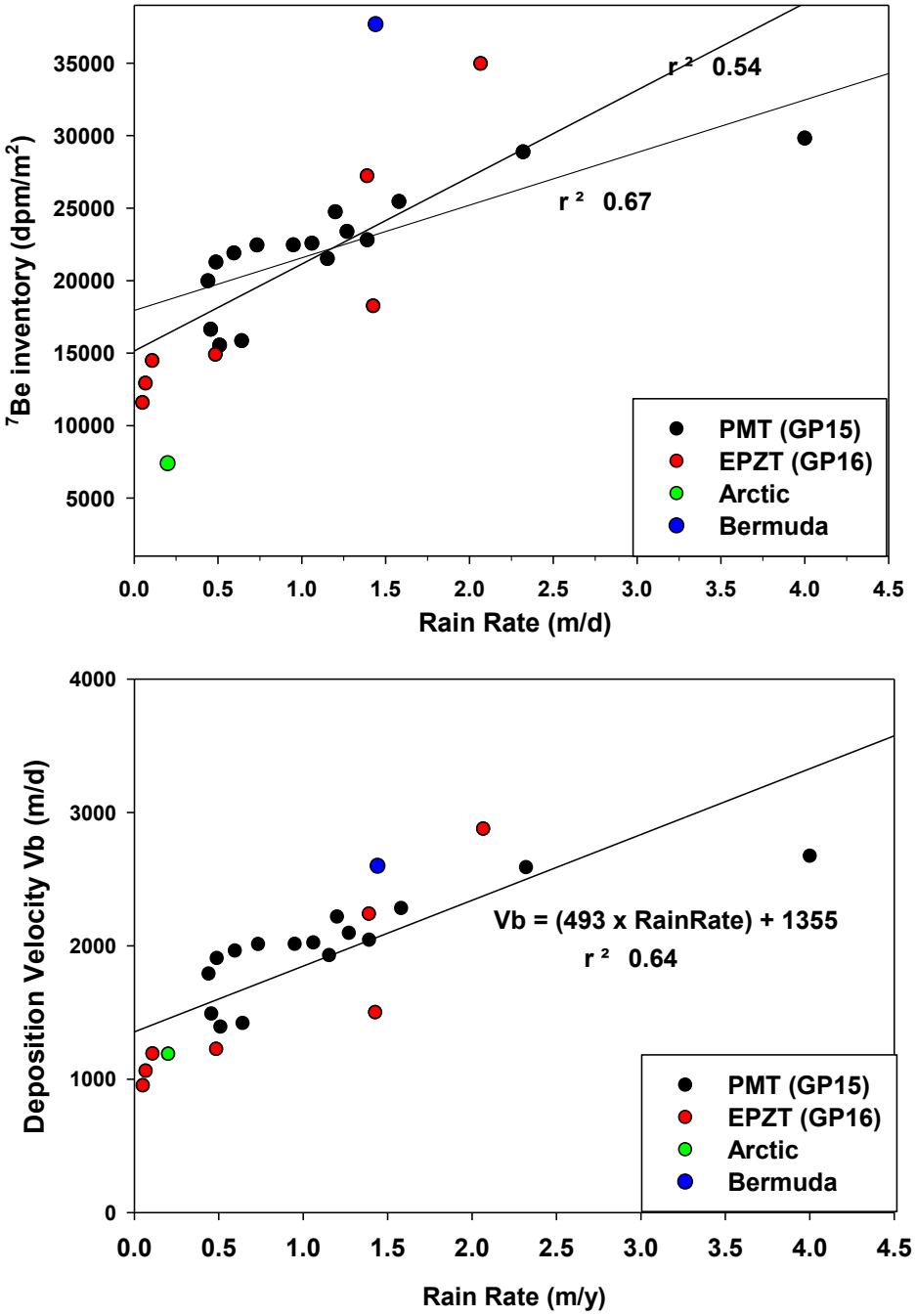

Figure 33. *Top: Globally, the ^{7}Be ocean inventory is to first order dictated by precipitation (R^2=.54). Data from the recent US Alaska - Tahiti cruise (GP15), transecting large gradients in rainfall are included (R^2=.67).*
Bottom: Using the average aerosol ^{7}Be concentration for each region, the Vb is calculated and plotted against rain rate. The y intercept (zero rain) corresponds to a dry deposition velocity of 1355m/d, which is close to the value of 1000m/d often accepted for that parameter. The bulk deposition velocity for TEs can be predicted by the precipitation rate. Aerosol fluxes of TEIs will be compiled once the analysis of GP15 aerosol samples has been completed.

Alan Shiller (University of Southern Mississippi) shared results for barium and for methane measured along the GP15 line (Figures 34 and 35).

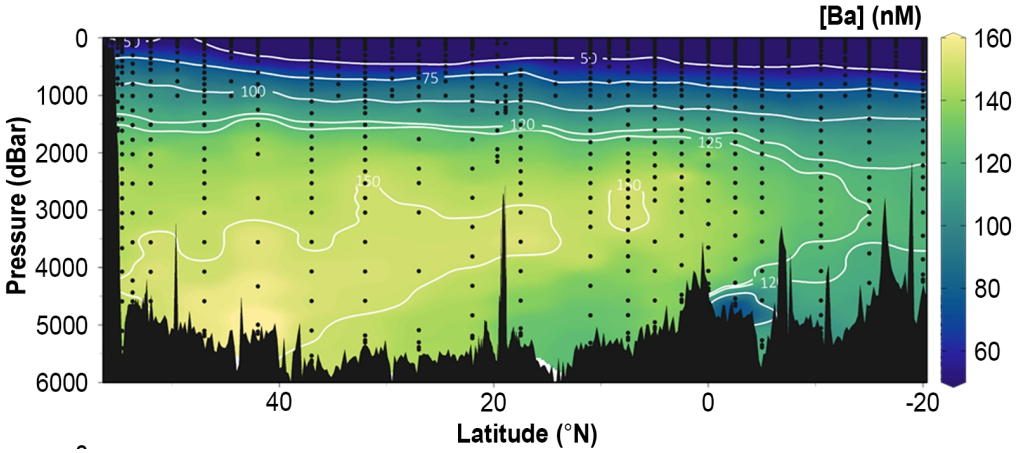

Figure 34. *Dissolved Ba along GP15 produced by Peng Ho, Melissa Gilbert, and Laura Whitmore. The dissolved Ba section is in general agreement with previous Pacific data and the southern end of the section matches well with earlier GP16 Ba data at that location. Comparing the Ba with previous dissolved Si data, the distributions are similar, though the mid-water increase in Ba is a little more gradual than Si and the deep water maximum is lower in the water column for Ba than Si.*

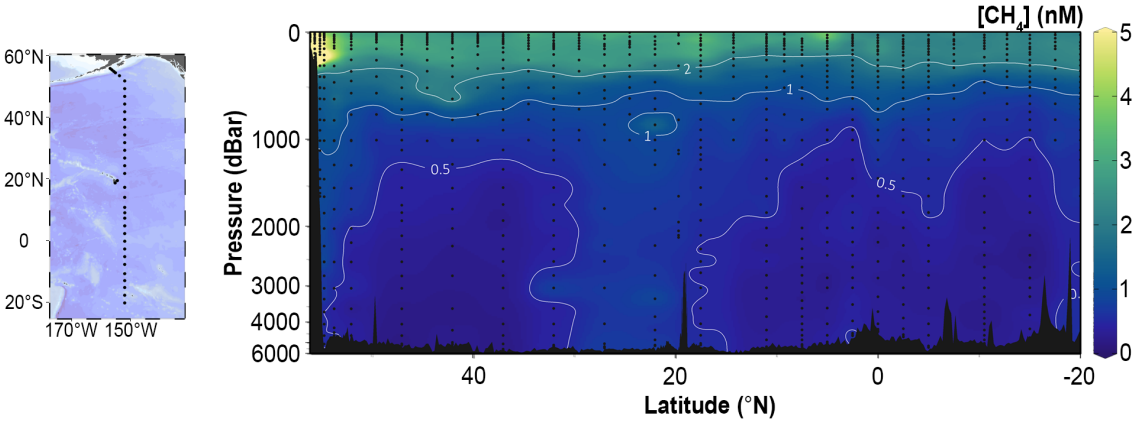

Figure 35*. Methane along the GP15 section. The CH_4 data, produced by Laura Whitmore and Virginie Sanial, show the expected distribuyion with highest concentrations in shallow waters, tapering off rapidly with depth. The highest concentrations were observed near the Aleutian margin. There was also a slight increase in the Loihi plume near Hawaii.*

New Funding

The US GEOTRACES project office received a 3-year renewal of its funding from the US National Science Foundation, beginning 1 October 2018.

Planning for future expeditions

<u>South Pacific Meridional Section</u> The management team for GP17 (Tahiti to Antarctica) is still being constituted. It is anticipated that the cruise leaders will be finalized by the next meeting of the US GEOTRACES SSC (20-21 June 2019 at the US NSF). The anticipated timeline for GP17 is that the cruise leaders will submit a proposal to the US NSF in February 2020 to request support for management of the section, including ship time and shared sampling needs (e.g., trace metal clean sampling system, nutrients, hydrography, *in situ* pumps). Individual PIs will submit their proposals to NSF in August 2020. The target window for GP17 is December 2021 – February 2022.

<u>Gulf of Mexico</u> Alan Shiller continues to hold individual meetings with scientists from other programs to explore options for partnering in studies of the Gulf of Mexico within the 2025 – 2026 time frame. It was decided at the 2018 meeting of the US GEOTRACES SSC that this will likely be the last US GEOTRACES cruise, unless something happens to prolong the program. The Gulf of Mexico expedition may be operated more like a process study, serving as a transition into a new US program that emphasizes process studies to investigate TEI biogeochemistry.

Synthesis

Investigators from the US are contributing to the growing effort to synthesize GEOTRACES data. Four synthesis publications led by US authors appeared during the past year. Full references are given in the publication list that follows.

Hayes et al. (2018a) combined data from thorium isotopes measured along the GA03 section with concentrations of several trace elements measured along the same section to estimate replacement times for those elements. The calculated replacement times are effectively equivalent to the residence time of each element with respect to its supply from dissolution of lithogenic material. These estimates are most useful for elements with very short residence times that are delivered primarily by dust, such as Fe and Mn.

Hayes et al. (2018b) compared four different pairs of naturally occurring radionuclide "rate meters" (^{234}Th-^{238}U, ^{230}Th-^{234}U, ^{228}Th-^{228}Ra and ^{210}Po-^{210}Pb) to estimate fluxes of particulate organic carbon (POC), phosphorus (P) and several trace elements on particles collected by in situ filtration along the GA03 section. Radionuclide-based fluxes were compared against annual average fluxes collected by sediment traps deployed by the Ocean Flux Program near Bermuda. Agreement was good for fluxes of POC and for certain trace elements, but less good for others.

Kadko et al. (2019) used ^{7}Be to estimate fluxes of aerosol-associated trace metals to the central Arctic Ocean (GN01). Residence times of trace metals in the upper water column were calculated using measured water column inventories of the metals and the calculated fluxes from aerosols. The results produced unreasonably large residence times for metals within the Transpolar Drift, indicating that sources other than aerosols are important for these metals in the central Arctic Ocean. Both rivers and the Siberian continental shelf have been proposed as potential sources.

Black et al. (2019) constructed a 2-D mass budget for Co, Mn and Cd along GP16 in the SE Pacific Ocean. Surface fluxes of these elements from the Peru margin into the ocean were calculated using previously published ^{228}Ra data to estimate horizontal mixing rates. Fluxes

of each metal exported to depth from surface waters were calculated using ^{234}Th. A major finding of the paper is that the sinking fluxes of exported metals can be accounted for by mobilization from shelf and upper slope sediments and offshore transport by mixing. Dust is not a significant source for these metals along GP16.

GEOTRACES supports synthesis of findings along three themes: 1) Supply and removal of TEIs at ocean interfaces, 2) Internal cycling of TEIs within the ocean, and 3) geochemical proxies for past changes in ocean conditions. In support of the 3rd theme, Bob Anderson chaired the planning committee for a synthesis workshop co-sponsored by GEOTRACES and by PAGES (Past Global Changes program) held in Aix-Marseille France (3-5 December 2018) https://geotracespages.sciencesconf.org. Anderson also served as co-chair of the workshop.

Outreach and Capacity Building Activities

Greg Cutter (Old Dominion University), Ken Buesseler (WHOI) and Bob Anderson (Lamont-Doherty Earth Observatory) participated in the GEOTRACES-China cruise-planning workshop (5-6 May 2018, Xiamen University) to assist Chinese colleagues in planning for the first open-ocean GEOTRACES-China expedition in the western Pacific Ocean. Cutter had previously spent two weeks with the Chinese investigators training them at sea in the use of a trace metal clean rosette sampling system.

Publications (GEOTRACES, GEOTRACES Compliant and GEOTRACES-related)

During the past year US GEOTRACES investigators published a total of 52 peer-reviewed journal articles, including papers published by lead authors in other nations for which U.S. GEOTRACES investigators serve as co-authors.

In addition, 10 PhD dissertations and 1 masters thesis were completed, and one data product was released.

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Dissertations

PhD

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- Marconi, Dario (2017). PhD Dissertation. Use of the nitrate isotopes in the ocean interior to explore the isotopic composition of sinking nitrogen and its implications for marine biogeochemical cycles. Princeton University, 318 pp.
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Masters

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Other products

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