

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN GERMANY

May 1st, 2017 to March 30th, 2018

New scientific results

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

Cruises

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

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

New projects and/or funding

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

GEOTRACES workshops and meetings

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

Other activities

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

New publications (published or in press)

- Basak, C., Fröllje, H., Lamy, F., Gersonde, R., Benz, V., Anderson, R.F., Molina-Kescher, M., Pahnke, K., 2018. Break-up of last glacial deep stratification in the South Pacific. *Science* 359, 900-904. doi: 10.1126/science.aao2473
- Behrens, M.K., Pahnke, K., Paffrath, R., Schnetger, B., Brumsack, H.J., 2018. Rare earth element distributions in the West Pacific: Trace element sources and conservative vs. non-conservative behavior. *Earth and Planetary Science Letters* 486, 166-177. doi: 10.1016/j.epsl.2018.01.016.
- Behrens, M.K., Pahnke, K., Schnetger, B., Brumsack, H.-J., 2018. Sources and processes affecting the distribution of dissolved Nd isotopes and concentrations in the West Pacific. *Geochimica et Cosmochimica Acta* 222, 508-534. doi: 10.1016/j.gca.2017.11.008.
- Böning, P., Ehlert, C., Niggemann, J., Schnetger, B., Pahnke, K., 2017. Thallium dynamics in the Weser estuary (NW Germany). *Estuarine and Coastal Shelf Science* 187, 146–151.
- Stichel, T., Pahnke, K., Duggan, B., Goldstein, S.L., Hartman, A.E., Paffrath, R., Scher, H., 2018. TAG plume: revisiting the hydrothermal neodymium contribution to seawater. *Frontiers in Marine Science* 5. doi: 10.3389/fmars.2018.00096.
- Browning, T.J., Achterberg, E.P., Rapp, I., Engel, A., Bertrand, E.M., Tagliabue, A. and Moore, C.M., 2017. Nutrient co-limitation at the boundary of an oceanic gyre. *Nature*, 551(7679), 242–246, doi:10.1038/nature24063.
- Rusiecka, D., M. Gledhill, A. Milne, E.P. Achterberg, A.L. Annett, S. Atkinson, A. Birchill, J. Karstensen, M. Lohan, C. Mariez, R. Middag, J. M. Rolison, T. Tanhua, S. Ussher, and D. Connelly (2018): Anthropogenic signatures of lead in the Northeast Atlantic. *Geophysical Research Letters*, <http://dx.doi.org/10.1002/2017GL076825>.
- Goring-Harford, H., Klar, J.K., Pearce, C.R., Connelly, D.P., Achterberg, E.P., James, R.H. (2018). Behaviour of chromium isotopes in the eastern sub-tropical Atlantic Oxygen Minimum Zone. *Geochimica et Cosmochimica Acta*, [doi:10.1016/j.gca.2018.03.004](https://doi.org/10.1016/j.gca.2018.03.004).
- Klar, J.K., Schlosser, C., Miltona, J.A., Woodward, E.M.S., Lacan, F., Parkinsone, I.J., Achterberg, E.P., 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*, <https://doi.org/10.1016/j.gca.2018.02.031>.
- Achterberg, E.P., Steigenberger, S., Marsay, C.M., LeMoigne, F.A.C., Painter, S.C., Baker, A.R., Connelly, D.P., Moore, C.M., Tagliabue, A., Tanhua, T. (2018). Iron Biogeochemistry in the High Latitude North Atlantic Ocean. *Scientific Reports*, 8, Article number: 1283. doi:10.1038/s41598-018-19472-1.
- Bridgestock, L., Rehkämper, M., van de Flierdt, T., Paul, M., Milne, A., Lohan, M.C., Achterberg, E.P. (2018). The distribution of lead concentrations and isotope compositions in the eastern Tropical Atlantic Ocean. *Geochimica et Cosmochimica Acta*, 225, Pages: 36-51, ISSN: 0016-7037.
- Birchill, A.J., Milne, A., Woodward, E.M.S., Harris, C., Annett, A., Rusiecka, D., Achterberg, E.P., Gledhill, M., Ussher, S.J., Worsfold, P.J., Geibert, W., Lohan, M.C. (2017). Seasonal iron depletion in temperate shelf seas. *Geophysical Research Letters*. DOI: 10.1002/2017GL073881.

- Rapp, I., Schlosser, C., Rusiecka, D., Gledhill, M., Achterberg, E.P. (2017). Automated preconcentration of Fe, Zn, Cu, Ni, Cd, Pb, Co, and Mn in seawater with analysis using high-resolution sector field inductively-coupled plasma mass spectrometry. *Analytica Chimica Acta*, 976, 1-13. DOI: 10.1016/j.aca.2017.05.008.
- Hopwood, M.J., Birchill, A.J., Gledhill, M., Achterberg, E.P., Klar, J., Milne A. (2017). A comparison between four analytical methods for the measurement of Fe(II) at nanomolar concentrations in coastal seawater. *Frontiers in Marine Biogeochemistry*, 4, 192. DOI=10.3389/fmars.2017.00192.
- Hopwood, M., Rapp, I., Schlosser, C., Achterberg, E.P. (2017). Hydrogen peroxide in deep waters from the Mediterranean Sea, South Atlantic and South Pacific Oceans. *Scientific Reports*, 7:43436, DOI: 10.1038/srep43436.
- Bridgestock, L., Rehkämper, M., van de Flierdt, T., Murphy, K., Khondoker, R., Baker, A.R., Chance, R., Strekopytov, S., Humphreys-Williams, E., Achterberg, E.P. (2017). The Cd isotope composition of atmospheric aerosols. *Geophysical Research Letters*, 44, 2932-2940, ISSN: 0094-8276 DOI: 10.1002/2017GL072748.
- Hopwood, Mark J., Cantoni, C., Clarke, Jennifer S., Cozzi, S. and Achterberg, Eric P. (2017). The heterogeneous nature of Fe delivery from melting icebergs. *Geochemical Perspectives Letters*, 3. 200-209. DOI 10.7185/geochemlet.1723.
- Browning, T.J., Achterberg, E.P., Yong, Y.C., Rapp, I., Utermann, C., Engel, A, and Moore, C.M. (2017). Iron limitation of microbial phosphorus acquisition in the tropical North Atlantic. *Nature Communications*, 8, 15465, doi:10.1038/ncomms15465.
- de Baar H.J.W. van Heuven S.M.A.C., Abouchami W., Xue Z., Galer S.J.G., Rehkämper M., Middag, van Ooijen J. Interactions of dissolved CO₂ with cadmium isotopes in the Southern Ocean. *Mar. Chem.* 195, 105121.
- Janssen D.J., Abouchami W., Galer S.J.G., Cullen J.T. Finescale spatial and interannual cadmium isotope variability in the subarctic northeast Pacific. *Earth Planet. Sc. Lett.*, <http://dx.doi.org/10.1016/j.epsl.2017.04.048>.
- Xie R.C., Galer S.J.G., Abouchami W., Rijkenberg M.J.A., De Jong J., de Baar H.J.W., Andreae M.O. Non-Rayleigh control of upperocean Cd isotope fractionation in the western South Atlantic. *Earth Planet. Sc. Lett.*, <http://dx.doi.org/10.1016/j.epsl.2017.04.024>.
- Grasse, P., Bosse, L., Hathorne, E.C., Böning, P., Pahnke, K., and Frank, M. (2017): Short-term variability of dissolved Rare Earth Elements and neodymium isotopes in the entire water column of the Panama Basin.- *Earth and Planetary Science Letters* 475, 242-253.
- Laukert, G., Frank, M., Bauch, D., Hathorne, E.C., Gutjahr, M., Janout, M., and Hölemann, J. (2017): Transport and transformation of riverine neodymium isotope and rare earth element signatures in high latitude estuaries: A case study from the Laptev Sea.- *Earth and Planetary Science Letters* 477, 205-217.
- Laukert, G., Frank, M., Hathorne, E.C., Krumpfen, T., Rabe, B., Bauch, D., Werner, K., Peeken, I., and Kassens, H. (2017): Pathways of Siberian freshwater and sea ice in the Arctic Ocean traced with radiogenic neodymium isotopes and rare earth elements.- *Polarforschung* 87, 3-13.
- Molina-Kescher, M., Hathorne, E.C., Osborne, A.H., Behrens, M.K., Kölling, M., Pahnke, K., and Frank, M. (2018): The influence of basaltic islands on the oceanic REE distribution: A case study from the tropical South Pacific.- *Frontiers in Marine Science* 5:50, doi: 10.3389/fmars.2018.00050.

PhD theses

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

Master theses

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

Presentations in international conferences

- Böning, P., Pahnke, K., Schnetger, B., Brumsack, H.-J., 2017, Iron Cycling in Sediments from the Benguela Upwelling System (BUS), Goldschmidt Abstract 2123.
- Liguori, B.T.P., Ehlert, C., Pahnke, K., 2017, A Terrestrial Influence on the Central Arctic Ocean Silicon Biogeochemical Cycle, IBIS Conference, Blanes, Spain.
- Pahnke, K., Behrens, M., Rehbein, M., Paffrath, R., 2017, Dissolved rare earth element ratios trace hydrothermal scavenging and water mass transport. Goldschmidt Abstract (talk).
- Paffrath, R., Pahnke, K., Schnetger, B., Brumsack, H.-J., 2017, Dissolved Rare Earth Element Concentrations from the Barents Sea to the Central Arctic. Goldschmidt Abstract 2212.
- Pedreira, R.M.A., Hatje, V., Böning, P., Pahnke, K., 2017, Anthropogenic Impacts on the Distributions of Rare Earth Elements in Coastal Waters. Goldschmidt Abstract 2193.
- Goldschmidt, Paris, August 2017. Browning, T.J., Achterberg, E.P., Rapp, I., Engel, A., Bertrand, E.M., Tagliabue, A. and Moore, C.M. Direct experimental evidence for nutrient co-limitation from the South Atlantic GA08 GEOTRACES expedition.
- 9th International Workshop on Sand/Duststorms and Associated Dustfall, Tenerife, May 2018. J.C. YONG, T.J. BROWNING, M. GLEDHILL, Z.B. SHI, E.P. ACHTERBERG. Sources and composition of water-soluble trace elements in aerosols over the South Atlantic, Arctic and Equatorial Pacific oceans.
- Xie RC, Janssen DJ, Abouchami W, Galer SJG, Rijkenberg MJA, Cullen JT, de Baar HJW, De Jong J & Andreae MO, Controls on Upper Ocean Cd Isotope Fractionation (invited). Goldschmidt conference, Paris, August 1318, 2017
- Galer S, Abouchami W, Middag R & de Baar H, Barite Control on the Southern Ocean Barium Isotopic Signature. Goldschmidt conference, Paris, August 1318, 2017
- Guinoiseau D & Galer SJG, Effect of CdS Precipitation on the Partitioning of Cd Isotopes Ocean Sciences. Goldschmidt conference, Paris, August 1318, 2017
- Janssen D, Abouchami W, Galer SJG, Purdon K and Cullen JT. Particulate Cd isotopes demonstrate a dynamic oceanic Cd cycle. Portland, Oregon, 2018

- Guinoiseau D, Abouchami W, Galer SJG. Effect of CdS precipitation on the partitioning of Cd isotopes: implications for Cd oceanic cycle. EGU (Vienna, 2018).

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